Wireless World

ELECTRONICS

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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 ("larger screens") 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 converting to line structure, and that any improvement 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 prematurely committed ourselves to a "definite" improvement in quality which 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.


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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

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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 conveyor.

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 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 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 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 10^6 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 0.04 by 0.04 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 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.

Solid 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
in the "Optimat," the circuitry was based on semiconductor devices, and 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-conditions was achieved by a miniature chart recorder, showing 2in diameter chart.

Weighing automatically by a transducer for automatic weighing.

The block diagram of the "Optimat," the circuitry was shown by Electromethods, with their series 5100 recorder, showing 2in diameter chart.

The single-transistor 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 temperature measurement the chart is an orbiting sputniks used in conjunction with the radius of the recorder, complete with its battery pack, can be put into a vacuum flask with leads connected to an external resistance thermometer. When used for potential recording the sensitivity is be discovered so that the counter can be registered. For use with a resistance sensing element, accuracy figures quoted were ±2% of f.s.d. and variation of zero and sensitivity ±0.25%.

Weighing Automatically materials into bins or sacks is a typical example of how automation can reduce the physical work of a task, and at the same time take down clerical work with its opportunities for error. The adaptation of an ordinary weighing machine, too, brings a common problem—the sensing of rotation whose sensitivity is reduced so that the counter can be registered. For use with a resistance sensing element, accuracy figures quoted were ±2% of f.s.d. and variation of zero and sensitivity ±0.25%.

For use with a resistive element on a 32 d.c. amplifiers, the 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.

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sensitive area on the camera tube. The monitor thus displays, side by side the two images, which are dispersed laterally 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 Epsylon, in their range of industrial television equipment also cater for quick changing from one standard to another. The Epsylon equipment incorporates a picture monitoring circuit which adopts 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 form practically any requirement. This first reduces the "electronic" interest of the system, but it must be remembered that the prime requirement for industrial equipment must be dependability. An 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 Combi-elements 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 evaporative 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 collector-emitter voltage is greater than the breakdown voltage, 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.


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" re-

sentor and capacitor should have a high impedance than the corre-

sponding "lower.") Three transis-

tors 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 joins of these segments a sudden change in the scale graduation spac-

ing is produced. An unusual method of sine wave generation is used in the Marconi TF1392 low-frequency (down to 0.0033c/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 give a linear waveform with a distortion of less than 5%. Square waves are also produced from the triangular waveform via a bi-

stable circuit. A three-tube 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 in-

tegral number of sine waves. Such a generator is useful for testing audio amplifiers, since its output provides a simple approximation to the high power conditions of music and speech. When an ampli-

fier is fed with such bursts its output-stage operating point corre-

sponds 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 obtained 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 in-

struments were shown by Microcell and Tektronix®. 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: (G & G), Griffin & Griffin (Sales), Ltd., Ealing Road, Alp-

ton, Wembley, Middx.; (L), Livingston Laboratories, Ltd., Retear Street, London, N.19; (N & T), Nash & Thompson Ltd., Hook Rise, Tolworth, Surbiton, Surrey; (R H C), R. H. Cole (Vestress), Ltd., 2 Caxton Street, London, S.W.1.

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used to obtain a response up to as high as 1000Mc/s in the Tektronix Type 585. A very small (5in x 3in x 6jin) 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 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 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 be 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, Tektronix, and Lumatron. Usually the high-speed sampling pulse is obtained from avalanche-operated transistors and a rise time of about 0.6musec is obtained. In the Lumatron 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 0.4musec.

Transistor Testers.—An unusual measuring meter for such instruments—the quadrant electrometer—is used in the French A.O.I.P. Transistorometer. 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/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 Labgears. 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 Koyo (N & T) Type 585. These consist simply of a calibrated oscillator whose grid current can be measured. They can then be used as an absorption resonance-frequency meter (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 frequency).

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 (RHE) 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 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 dependent 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 bridge 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 P, 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 P 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 P and P2.

Wires carrying alternating current can be detected without having to make any contact with them by picking up the a.c. potential field produced by the current in the Everett Edgcombe "Metrag" 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 11 kV. A circuit diagram is shown in the Southern Instruments E.R.I.C. Universal Electronic Multimeter which can measure both direct voltages and currents. This circuit is direct-current through input 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 <5 mV) 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 0.15±F polystyrene capacitor (producing an input impedance of 10¹²Ω) 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 3 mA full scale without interrupting the circuit under test in the Hewlett-Packard Model 428A 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 is produced in a second 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 that of 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 (<0.5 mH) are introduced into the circuit being measured.

Power Measurement.—In the Burndept BE281 powers can be measured at frequencies up to 1,000 Mc/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 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 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 test set. (Teslac 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

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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 provides a resistance which is sufficiently non-inductive for use up to 30 Mc/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. Since the oscillator frequencies are at 1.5 Mc/s, such beats produce a very exact indication of correct frequency adjustment.

A very simple method of measuring inductors and capacitors used in radio or television receivers is used in the East-German V.E.B. Werck für Fernmeldewesen (G & D) 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.

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. The flat strips have 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 various films such as Terylene. Their surfaces), for the de-icing of aircraft control panels. 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 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 WF-49 "Duolectric" capacitors. These are

Connecting 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 then be passed 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 dissipating rated watts at ratings up to 10 W/in². The resistance values and ratings on one of the panels displayed suggested that it was intended for use as the mains-dropping resistor 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 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 WF-49 "Duolectric" capacitors. These are

PARTS AND MATERIALS

Strip Wiring

Flat-strip cable, by Technograph.

Wireless World, July 1960
Push-button TV Tuners have many of the common "dry" aluminium utilize a construction similar to that conductor material as the "electro-
capacitors," rest of the circuit. A feature of the ing from "busbars" joined to the several double-leaf contacts project-
a button is depressed it allows theappropriate coil strip to rise under and two Band-III channels.

mechanism for selecting two Band-I pentode frame-grid cascode triode and triode Products had on show a new four-
the fine tuner as well. A.B. Metal

cemented to

cans

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: Demonstration circuit board with components con-
ed "Pristincert" principle.

texture of the equivalent rating of waxed-
paper types. To achieve this reduc-
polyester film has been used as the tion, 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 electrodcs has been employed. The largest Duo-

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 cera-

mic or by the magnetostrictive 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 1/2-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 1/4 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%, 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 consequence 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 treat-
ment n-type impurities diffuse into the germanium wafer from both pellets to produce an extremely thin base layer between the emitter and base electrodcs. At the same time, p-type impurities diffuse 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 OCI70 and OCI71 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 circuit in computers operating with p.r.fs 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 1 micro-

second. 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 1, while an avalanche switching transistor was capable of producing 50mA pulses with a rise time of 1 nanosecond (10^-9 sec).

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 tran-
sistors, 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 XC161, 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 thyratron and other large devices. It enables several kilowatts of power to be controlled by a few milliwatts. Examples were shown by the Westing-

house and International Rectifier. On the Westinghouse stand an impres-
sive demonstration was given of a 10kW tungsten-lamp sign being turned on and off by two silicon con-
trolled rectifiers connected, in inverse parallel, between the a.c. supply and the load. The r.m.s. output voltage was varied by controlling the propor-
tion of each half cycle for which the rectifiers were conducting.
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 in 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. Bevins 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.

TABLE I

<table>
<thead>
<tr>
<th>Band</th>
<th>Range (Mc/s)</th>
<th>405 lines 5 Mc/s channels</th>
<th>625 lines 8 Mc/s channels</th>
<th>No. of programmes which could be provided using</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>405 lines and 5 Mc/s channels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>3</td>
<td>2 (98%) &amp; 2 (98%)</td>
</tr>
<tr>
<td>I</td>
<td>41-68</td>
<td></td>
<td></td>
<td>12/13 95%</td>
</tr>
<tr>
<td>III</td>
<td>174-216</td>
<td>8</td>
<td>5</td>
<td>or 17/18 95%</td>
</tr>
<tr>
<td>IV</td>
<td>470-582*</td>
<td>22</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>606-800*</td>
<td>38</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>


‡ See Appendix II for list of present members.

WIRELESS WORLD, JULY 1960
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 T.A.C. were informed, however, 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 Australia 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 dissentent, 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 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. Wolverson (Post Office).
- Sir Robert Fraser (I.T.A.).
- G. Darnley Smith (Radio Industry).
- C. 0. Stanley (Post Office).
- 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. Peverell (Post Office).
- T. C. Macnamara (Associated Television).
- Dr. L. P. 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. M. Sowton (Post Office), secretary.

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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 southwest—Stockland Hill, Devon (channel 9) and Caradon Hill, Cornwall (12)—and Caldbec, near Carlisle (11). Towards the end of 1961 a high-powered transmitter will be opened in Kinross-shire, 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, while South Africa follows with £229,000. The third largest market is with the Netherlands with £157,000.

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.
- 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. McPetrice, 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.
- Dr. R. Clay, 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.E.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. Benley Dacre (chairman); Dr. A. M. Urley, 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. Bentley Dacre; 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., Savoy Place, London, W.C.2, 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.
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); Grampian Reproducers (J. A. Catchpole); 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 the 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. He is again vice-chairman. Lord Halsbury 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 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., and 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, St Albans, serves on the City and Guilds Advisory Committee on Telecommunications Engineering, and the membership committee of the Brit.I.R.E.
E. David Parchment, who joined Leevers-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.

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 £2 M for depreciation and provision for renewal of equipment and £128,182 for taxation, the year's net profit was just over £1 M. 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 tires 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 electro-chemical couples, including fuel cells, and into the problems of extending life and reducing weight and cost of different 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 Ayron 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).

of electronics 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 town. The factory, which is planned to begin operation in September, will initially produce only a 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 Wolfeys 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 Caldebeck 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. of 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

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 million (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 ± 2dB is guaranteed in all parts of the system. Local distribution amplifiers are housed...
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 ½ 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.

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, unscreened 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

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 polyester 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 200µV/m. Interference picked up on the unscreened 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 unscreened feeders is negligible.

**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.
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 5in x 2½in 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 2Me/s is caused and too high a capacitance in the second amplifier cathode circuit causes a less-severe ring at about 1Me/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

† This is an abridged version of a paper published in Mullard Technical Communications No. 12 (May 1955), p. 42.
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”
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-µH choke in series with the cathode follower output when using a low i.f.

Where 3-in diameter formers are not available 0.3-in diameter can be used. For the 130-µH and 100-µH coils use wire gauge and spacing as shown in Fig. 4 but increase each section to 65 turns. The 70-µH coil would be sectionally wound with similar dimensions to the 100-µH choke, but each section would contain 50 turns.

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**Birmingham-London TV Link**

So that programmes, rehearsals and advertisements originating at A.TV Alpha Studios, Aston Road, Birmingham, can be seen at Associated Television’s headquarters in London, Pye Telecommunications Ltd. have installed for A.TV 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 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.

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**SHORT-WAVE CONDITIONS**

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.

Prediction for July

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**Wireless World, July 1960**
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.

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.
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."

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 "earthly" 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 nanofarad unit of capacitance (1nF=1000 pF or 10^-9 farad) is yet another valuable aid in cutting down...
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 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 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.

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**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 (1960kc/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.

Presstyn.—Meetings of the Flintshire Radio Society are now held at the Frith Hotel, Frith, 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.

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*P. R. Macmillan Ltd. 15/-, pp. 238. 14 Illustrations.
13. 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.
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

\[
\eta_2 = \frac{V_2 \times 100}{u}
\]

where \(\eta_2\) is the percentage second harmonic distortion, \(V\) the peak recorded velocity, \(\alpha\) 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 4" in on a record rotating at 33\(\frac{1}{2}\) r.p.m., and a tracking error of 4 degrees. Then the groove velocity

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

so that

\[
\eta_2 = \frac{5 \times 1.41 \times 4}{21 \times 57 \times 100} = 2.3\%
\]

which, after correcting for the recording characteristic,

\(\approx 1.3\%\) (second harmonic)

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

\[
V_{D3} = \frac{3(\alpha r f V)^2}{4u^2}
\]

where \(V_{D3}\) is the third harmonic distortion velocity, \(r\) the stylus tip radius and \(f\) the frequency.

And, if \(V_{D3}\) is small, this is approximately equivalent to

\[
\eta_3 = \frac{3(\alpha r f V)^2 \times 100}{4u^4}
\]

where \(\eta_3\) 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 3 kc/s.

Then

\[
\eta_3 = \frac{75\pi^2 \times (0.0006 \times 2.54 \times 3000 \times 5 \times 1.41)^2}{21^4} = 4\%
\]

which, after correcting for the recording characteristic,

\(= 1.6\%\) (third harmonic)

i.e. with 5 cm/sec r.m.s. velocity at 3 kc/s, the distortions from a 4-degree tracking error and from a nominally \(\frac{1}{2}\)-thou stylus are about the same.

Moreover, we may say that these much 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

\[
10\text{cm/sec at } 4\text{kc/s}, \text{ we get } 12\% \text{ tracing distortion and } 2.6\% \text{ tracking-error distortion, even for a nominally } \frac{1}{2}\text{-thou tip, and a nominally } 0.0007\text{-in tip gives } 20\% \text{ tracing distortion. However, I must say that where the values calculated are extremely large, they are not so large by measurement.}
\]

Since an 8-in arm can give a 24-degree tracking accuracy, and certainly better than 4 degrees even with manufacturing tolerances, there would appear to be no advantage in exceeding 8 in 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...
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 (equaling 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 needle with a smaller actual tip radius is used.

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 pick-ups, 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 90 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 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 $x$ of the
peak recorded velocity of 22 cm/sec is appreciably alter F.

In fact the groove displacement at 8 kc/s and a peak recorded velocity of 22 cm/sec is equal to 

\[
\frac{22}{2\pi \times 8000} = 0.00044 \text{ cm}. 
\]

Now consider a 1-gm pickup with an effective stylus tip mass of \( \frac{1}{4} \) mgm and a compliance of \( 25 \times 10^{-6} \text{ cm/dyne} \). 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 (\( 2\pi \times 8000 \times 22 \text{ cm/sec}^2 \approx 1100 \text{ g} \)), 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 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 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.

**REFERENCES**


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

\[ E = IR \]

(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-ohm 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
phasize that reactance is something quite different. It look easier at first but is likely to make things complicated. From his experience. But my main objection is that it brings in a new principle.

In self-defence I might claim that it is wildly remote from Mr. Clay if I object to the above on the ground that "Ohm's law" as meaning "$I=\frac{E}{R}$" I will no doubt be exposing myself to attack. 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 trust 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 mean 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."

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

Having now gone on record as accepting, however reluctantly, "Ohm's law," as meaning "$I=\frac{E}{R}$," 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. (Ideal 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 trust 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.

"Touche," I believe, is the appropriate expression. Not that I concede having said anything actually wrong, but an explanation which left room for such
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 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 c.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-$\Omega$ resistor at that current. The 4-V battery absorbs the same power and has the same voltage across its terminals as an 8-$\Omega$ 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. devices. 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 could 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 Iz leaves E/I, which is "Ohm's law" again. I am assuming that the definers meant strictly the power dissipated as 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 telephony, we can quickly silence them by referring 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.
Demonstrating Electron-spin Resonance

FOLLOWING the description 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 magnetogycric ratio, $\gamma$, 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.

$\gamma$ is given by the relation $2\gamma f = \omega = \gamma B$ 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

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

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, $f$, 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 $B = 4\pi \times 10^{-7} \times \sqrt{8N/5V^2R} \times \sqrt{2f} \text{ weber/m}^2$ where $N$ is the number of turns on each coil and $R$ is the radius of the coils in metres.

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

$$\gamma = \frac{e}{m}$$

to a very good approximation.

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

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

The oscillator 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. RAEB

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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.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

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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.

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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, 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 unbounded 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 usually better, but outside 50 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 detract from 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 a significant factor 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, 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 a v.h.f. tuner in a car by all means, but don't I 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 mention 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. Sauls seems to have made an error in his example of a practical design. In step (e) 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 LT 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 copper loss, resulting in a small improvement in regulation and efficiency.

St. Leonards-on-Sea, Sussex.

W. E. THOMPSON

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The voltage regulation is a function of the sum of the primary resistance, Rₚ, referred to the secondary terminals, and the secondary resistance, Rₛ, that is, the effective secondary voltage drop = 1₂/(Rₛ + Rₚ) where n = 1₂/1ₚ = turns ratio.

The shorter mean length of turn of the secondary winding will reduce Rₛ however the resultant longer mean length of turn of the primary winding will increase Rₚ, 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.

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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

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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 required flux density. Thus, 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.

L.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: IR, 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, R = \sqrt{R_1R_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. Scaull

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 Cratepne and Yelverton Electricity Supply Co., for permission to install on the electricity 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 Freece 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. Pontting-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 during this 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 6.00; admission is 3s 6d.

A.E.I.

Air-Shields (U.S.A.)

Alvar-Electronic (France)

Avionix

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.)

Bird Electronic Works (Japan)

Coulter Electronics

Cox, Stanley

Dawne Instruments

Dias Instrumentation (East Germany)

Ekco Electronics

Electronic & X-Ray Applications

Electronic Industries Assoc. (Japan)

Electronic Machine Co.

Elektronaboratorium (Denmark)

Elema-Schonander (Sweden)

Elegs Products

Endomterics

English Electric Valve Co.

Eley et Consr:\vations Electro-Medicale (France)

Faraday Electronic Insts.

Frieske & Hopfner (W. Germany)

Fukuda Electro Co. (Japan)

Fukuda Medical Electric Co. (Japan)

G.H.S. Electronics

Godart & Minhardt

Godart-Minhardt (Holland)

Heiva Electronic Institute (Japan)

Heller & Co. (W. Germany)

Heywood & Co.

Hilger & Watts

Hitachi (Japan)

Infra Red Development Co.

Japan Radio Co. (Japan)

Leitz, E. (East Germany)

Leland Instruments

Marconi Instruments

Medische Apparaten (Holland)

Mullard Equipment

Multitone Electric Co.

Nagard

New Electronic Products

Nikko Electronic Instrument Co. (Japan)

Nippon Electric Co. (Japan)

Nuclear Enterprises (GB.)

Office of French Electrometrical Engineering (Italy)

Offner Electronic (U.S.A.)

Osa (Switzerland)

Picketer, International Corp. (U.S.A.)

Purrtschell, M. J., & Co. (Switzerland)

R.C.A. Great Britain

S.S. Electronics

Sanborn Co. (U.S.A.)

San'l Instruments Co. (Japan)

San'ei Maschinen Co. (Japan)

Saunders-Roe & Nuclear Enterprises

Schwarzer, F. (West Germany)

Selig Electromagnetics

Shibata Seisakusho (Japan)

Siemens-Reiniger-Werke (West Germany)

Siemens-Ruhe- heckwerk (Switzerland)

Stere

South London Electrical Equipment Co.

Telco (France)

Telefunken (West Germany)

Timex & Co.

Timovo Shibaura Electric Co. (Japan)

Dr. Ing. J. F. Tonnis (West Germany)

Townson & Mercer

Winston Electronics
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 hatters 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*, 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 Log* 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...
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

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

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a practical set of phase-lag correction curves for the results from absorption of energy by position or distance determination. This phase lag which is of fundamental importance when the transit time of low-frequency signals forms the basis of which 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 \( \sigma = 5 \times 10^{-7} \) c.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.

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 \( \psi \) 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 correction 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 \( \sigma = 5 \times 10^{-7} \) c.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.](image)

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.).

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

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**Table: Typical values for frequency and lane width**

<table>
<thead>
<tr>
<th>Function</th>
<th>Carrier Frequencies (kc/s)</th>
<th>Phase Comparison Frequencies (harmonic)</th>
<th>Lane Width (v = 299,650 km/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
<td>177.6</td>
<td>12f</td>
<td>281.2</td>
</tr>
<tr>
<td>Master Identification (Lambda system only)</td>
<td>162.8</td>
<td>11f</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>133.2</td>
<td>9f</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>118.4</td>
<td>8f</td>
<td>421.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Waveform</th>
<th>Lane Width (v = 299,650 km/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lambda cf / 2 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8f</td>
<td></td>
<td>421.8</td>
</tr>
<tr>
<td>10f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12f</td>
<td></td>
<td>281.2</td>
</tr>
<tr>
<td>14f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16f</td>
<td></td>
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<tr>
<td>18f</td>
<td></td>
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<tr>
<td>20f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22f</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24f</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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.).

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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 $V_0$ 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 daylight, 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 0.5μsec pulse having a recurrence frequency equal to the fundamental value $f_0$, 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 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 $6f_0$, 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 fiberglass tube containing a length of insulated wire. The receiver

![Fig. 3. Fixing-accuracy contours in feet for summer daylight operation. Contours are drawn for a 0.01 lane deviation.](image-url)
Lane Identification in the Lambda System

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 \( \pm 210 \) metres and from the green to better than \( \pm 140 \) 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 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 \( \pm 5 \)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 “referred” 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.
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.

Wireless World, July 1960
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 positive and negative 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. The 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

**REFERENCES**

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, C, 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 C, to point X, which (by cathode follower action) will follow the potential of Y. Thus, by positive feedback via C, a constant potential can be maintained across R, through which the timebase capacitor C is being charged. As a result C charges linearly.

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

(a) the value of C, is very much greater than C;
(b) the time constant C,R, is large compared with the duration of the sweep. Voltage changes across C, during the sweep must be small, otherwise the voltage across R will not be constant, thus causing non-linearity;
(c) the time constant C,R, 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 R,, R and V1 to earth. During the period of the sweep, the current through R remains constant but the decrease in current through R, is made up by that flowing through C,.

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 x 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.
Screened Jack Plug

A FULLY screened telephone or microphone plug with standard 1-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 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 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 3-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-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 15Ω may be obtained from an input of 2mV r.m.s. at 300 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 damaged by the application of a reversed voltage. The weight of the "Lilliput" amplifier is 5ib and its size 6¾in 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 250kΩ/V and indicates over the ranges 0 to 100V, 0 to 20kV (direct only) and 0 to 300MΩ on a 4-in scale. Using a 100-µA basic movement, the 4-µA 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 25MΩ, corresponding to the 100-V range. To change to the 20kV range a 5-GΩ (5,000MΩ) 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.


100-V and 25-kV meter has sensitivity of 250kΩ/V.
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. Argulymbau 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 deviation 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. If the deviation of a signal normally just outside the passband is increased, the interference, of course, increases to zero from 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 Blattnerphone 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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**Technical Notebook**

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**Additions to the TRIX Sound Equipment range**

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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 against the law to undertake such work if you haven't got these certificates. Whether or not it should be is a moot point. Whether or not it should is a moot point.

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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 a 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,
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 subtitle "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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Radar 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 specially applied version 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 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 retina.

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 retina.

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 curious 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,
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Low cost monitors, precision oscilloscope tubes, image converters and camera tubes—all are available from Mullard. Some of these tubes from the current range of over forty basic types of industrial display device are shown opposite. Whatever your interest in industrial cathode ray tubes and other display devices, it will pay you to have a word with Mullard. Not only does the current range include tubes for all sorts of applications—research and development is intensive and well advanced in a number of new fields, some of them being described below:

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.

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.

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.

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.

Deflection sensitivities of both magnetic and electrostatic industrial and radar tubes of conventional design can, under certain conditions, be increased by factors of 10 times by the use of magnetic and electrostatic lens systems of scan magnification. Substantial progress is being made at the Mullard Research Laboratories in the complex problems which must be resolved before this attractive system becomes a practical proposition.
display devices

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**AW17-20 Television Camera Viewfinder**
This high quality viewfinder and monitor tube has a 6\(\frac{1}{2}\)-inch diagonal rectangular screen. Compared with earlier 5-inch round tubes, the rectangular screen of the AW17-20 provides nearly twice the useful screen area for an increase of only 20% of the face plate area.

**ME1201AA Image Converter**
One of the most important applications of the image converter is as an electronic shutter in high speed photography. With the grid controlled ME1201AA, exposures as short as a thousand-millionth of a second are possible.

**MM13-10 High Brightness Radar Tube**
At high altitudes ambient light is strong, and for easy viewing, radar tubes are made with a very high brightness. The MM13-10 is a five-inch magnetic tube specially designed for such applications.

**DH10-78 Helical P.D.A. Tube**
The DH10-78 is a 4-inch diameter flat faced instrument tube which employs a helical post deflection acceleration system. The characteristics have been carefully determined to suit it for a wide variety of applications ranging from simple inexpensive oscilloscopes to precision laboratory apparatus.

**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.

**AW36-48 Studio Monitor Tube**
The high-brightness and definition of this 14-inch tube are of particular value in television studio monitors. Deflection is magnetic and focus electrostatic.

**DH3-91 Waveform Monitor Tube**
One of the simplest and most economical systems of waveform monitoring is provided by the DH3-91. This is an inexpensive one-inch tube that in most equipment can be operated from existing H.T. lines.

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HIGH-NOTE PRESSURE TYPE UNITS

Designed and developed in CELESTION Laboratories this class of unit has been manufactured for special purposes over the past five years. A new unit, Model HF.1300, has been introduced for the new stereophonic system and its smooth response and wide dispersion ensure an exceptionally high standard of reproduction of the higher frequencies.

LOW-NOTE REPRODUCER G—44

This new 12in. Loudspeaker has been designed specially to work in conjunction with the HF.1300. A skillfully balanced voice coil and cone assembly with correct cone edge termination result in a level and clean low frequency response.

COMPLETE SYSTEM

The system uses only one enclosure, 15in. high x 42in. wide x 18in. deep, having a central dividing partition with one G.44 unit mounted at each end. The enclosure should then be positioned near the centre and against one wall so that the speakers are facing outwards and are about 2ft. 6in. from the floor.

The two HF.1300 units should then be placed near the corners of the room, one on each side of the enclosure and approximately 4 feet above the floor. The width of sound will very nearly correspond to the distance between these two units. No elaborate cross-over networks are required and the system is completed by a 12 Mfd. capacitor in series with each high note unit.

The price for two HF.1300 and two G.44 units, complete with enclosure details is:—

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**D31** double beam Serviscope... a logical development of the original, highly successful S.31 single beam Serviscope. Though weighing only 26 lbs. in its rugged steel case, the D.31 has capabilities greater than many more elaborate instruments, plus many improved features which make for wider application, more accurate measurements and simpler operation.

D.C. amplifiers and slow speed time base (down to 5 sec/cm if necessary) are eminently suitable for servo work and similar applications. Fast rise time (0.06 μsec) and high writing speed (10 cm/μsec at maximum expansion) are essential for any work dealing with fast pulses or TV waveforms. The unique triggering arrangements enable complex waveforms to be examined in detail with complete accuracy of synchronisation. At this moment D.31 is in use in the diverse fields of computer development and servicing, radar equipment, telemetering applications, closed circuit and broadcast TV, automatic telephone equipment—in fact in any field where a double beam oscilloscope is essential.

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Twin Stereo Speaker Systems Model SSU-I... £20 11 0
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The absence of cabinet resonance produces bass of unusual crispness normally associated with larger and more expensive speakers.

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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.

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R-C Oscillator Type TF 1101
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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 µW to 6 W, and 51-inch meter provide excellent discrimination. Impedance range: 2.5Ω to 20kΩ in 11 steps. Frequency characteristic substantially flat from 50 c/s to 20 kc/s.

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 µW to 10 watts and the input impedance can be set to any of 48 different values between 2.5 ohms and 20 kΩ.

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 µV to 300 volts.

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.

Measurements of audio performance to modern standards call for the very best in test equipment. Marconi’s offer an unrivalled range of instruments to meet the most exacting requirements at every stage in the design-production cycle. From first evaluation of laboratory models to final testing in the factory, and maintenance in the field, there is a Marconi instrument to meet the need.

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TC 172
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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

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The famous H.F.1016 at £7.12.3.
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H.F.817 Speaker £10.16.6.

T.359 Cone Tweeter Unit 33/3.

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Inglesbourne 42901
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.

_SenTerCel_ FST1/4 silicon rectifiers are miniature wire ended devices which can be speedily mounted to tag panels, no heat sink being required. Typical performance curves and design procedure are included in leaflet MF/109.

**Important advantages of the FST1/4 silicon rectifiers are:**

- Large Power Output
  - for Small Size

- 35 Amp Surge Current
  - Rating (5 m/secs.)

- High Ambient Temperature Operation

- No Heat Sink Required

- High Output Voltage

- No Forward Ageing

- High Efficiency

- Low Cost
Hewlett Packard 302A Wave Analyzer

Advantages:
- No calibration or stabilization needed
- Direct readings; accurate
- Measures frequencies 20 cps to 50 KC
- Completely transistorized
- Battery or ac powered
- Hum free
- Low power consumption
- No warm-up needed
- Very sharp acceptance circuits
- AFC
- Also frequency restorer circuit
- Compact, rugged, versatile.

Specifications:
- Frequency Range: 20 cps to 50 KC.
- Frequency Calibration: Linear graduation 1 division per 10 cycles. Accuracy ± (1% × 5) c/s.
- Voltage Range: 3v to 300v.
  - Ranges provided by an input attenuator switch and a meter range switch in steps of 1: 3 or 10 db. Meter range is indicated by a dial mechanically linked to input attenuator. An absolute-relative switch, in conjunction with a variable 10 db control is provided for adjustment of intermediate values.
- Warm-Up Time: None.
- Voltage Accuracy: ±5% of full scale value.
- Residual Modulation Products and Hum Voltage: Greater than 75 db down.
- Intermediate Frequency Rejection: Intermediate frequency present in input signal rejected by at least 75 db.
- Selectivity: ±31 cycle bw—at least 3 db down.
  ±25 cycle bw—at least 50 db down.
  ±70 cycle bw—at least 80 db down.
  beyond ±70 cycle bw—at least 80 db down.
- Input Impedance: Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on remaining ranges.

New Model 302A Wave Analyzer represents a significant improvement in wave analyzer design. Completely transistorized, sophisticated in design, highly selective, free of tedious calibration and stabilization before use—these are but a few of the important convenience and accuracy features in the new 302A. Other exceptional features are low power consumption (in the order of 3 watts), provision for battery operation (18 to 28 volts) as well as ac line power, and elimination of warm-up time.

Selected Frequency Output: 1v open circuit at output terminal for full scale meter deflection. Output level control provided. Frequency response ±1 db, 20 cps to 50 KC. Output impedance approximately 600 ohms.

B.F.O. Output: 1v open circuit at output terminals. Output level control provided. Frequency response ±1 db, 20 cps to 50 KC. Output impedance approximately 600 ohms.

Automatic Frequency Control: Range of frequency holding is ±100 cycles minimum.

Power: 115/230v ±10%, 50/600 cycles, 3 watts (approx.) Terminals provided for powering instrument from external battery source. Battery supply range 28v to 18v.


Dimensions: Cabinet Mount: 204" wide; 124" high; 144" deep. Rack Mount: 19" wide; 104" high; 134" deep.

Price: Delivered U.K. and exclusive of duty—where payable £718 (cabinet mount)
£712 (rack mount)

Continuous progress in design may affect the above specification which is therefore subject to change without notice.
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STC COMPONENTS

The standard of reliability of STC components is set by the vital roles of the navigation and communications equipments in which many of them are used. The consequent employment of top grade materials and high degrees of skill and care in manufacture ensures that all users of STC components may have the fullest confidence in them.

YOU CAN RELY ON STC COMPONENTS

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Capacitors - Contact Cooled
Rectifiers - Ferrites
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Materials - Quartz Crystals
Relays - Special Valves
Selenium Rectifiers - Silicon
Rectifiers - Silistors
Suppressors - Transistors
Thermistors - Transformers
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Get to know the range of STC Components—write for booklet M103 which lists all components and their relevant technical literature.

Standard Telephones and Cables Limited

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ALPHASIL— the modern core material

The inset curves illustrate the superior magnetic properties of Alphasil cold-reduced grain oriented silicon steel over those of a typical hot-rolled grade (Ferrosil 80). Alphasil has a maximum permeability four times that of the hot-rolled transformer sheet and its core losses are approximately one-third. Initial and incremental permeability, stacking factor and ductility are considerably better than those of hot-rolled sheet.

Alphasil .013" thick is produced in coil 30 inches wide, and can be supplied slit to narrower widths by arrangement.

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<tr>
<th>TABLE OF WATTS LOSSES</th>
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</tr>
<tr>
<td>cycles/second</td>
</tr>
<tr>
<td>ALPHASIL 44</td>
</tr>
<tr>
<td>ALPHASIL 40</td>
</tr>
<tr>
<td>ALPHASIL 37</td>
</tr>
<tr>
<td>ALPHASIL 33</td>
</tr>
</tbody>
</table>

Thin Alphasil for high frequency work is also available in coil in .004" thick in widths up to 5\(\frac{1}{2}\) inches, and in .002" thick, in widths up to 4\(\frac{1}{4}\) inches.

| Frequency | Guaranteed max. total losses |
| cycles/second | at B Max 15 Kilogauss |
| ALPHASIL .004HF | 400 | 80 watts/lb. at B Max 15 Kilogauss |
| ALPHASIL .002HF | 8,000 | 9.50 watts/lb. at B Max 2 Kilogauss |

Full technical data will be supplied on request.

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Enquiries for sheet and strip to be addressed to RICHARD THOMAS & BALDWINS LTD., WILDEN, STOURPORT-ON-SEVERN, WORCS.

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Our Cookley Works is one of the largest in Europe specializing in the manufacture of laminations for the electrical industry.
with the 3A/167M Triode

The 3A/167M is a high performance, long life triode, which has been designed to satisfy the particularly stringent requirements of repeater applications. There is, however, a much wider field of applications fully described in a new Application Report. Send for a copy. The number is MS/109.

Applications include:

- WIDE BAND AMPLIFICATION
- LOW NOISE AMPLIFICATION
- V.H.F. CASCODE AMPLIFICATION
- PULSE AMPLIFICATION
- LOW DISTORTION AMPLIFICATION
- LOW NOISE TRIODE MIXING
- CATHODE FOLLOWER CIRCUITS

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VALVES: Klystrons and Magnetrons for 35/GCS and 75/GCS bands • Monitor Diodes for 1/GCS to 35/GCS
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ensure CONSISTENT magnetic characteristics

with STC permalloys & permendur

PERMALLOY 'C' 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.

PERMALLOY 'D' 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.

PHYSICAL PROPERTIES AND GENERAL MAGNETIC CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>Permalloy 'B'</th>
<th>Permalloy 'C'</th>
<th>Permalloy 'D'</th>
<th>Permalloy 'F'</th>
<th>V-Permendur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>8.3</td>
<td>8.6</td>
<td>8.15</td>
<td>8.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Electrical resistivity</td>
<td>55</td>
<td>60</td>
<td>55</td>
<td>60</td>
<td>55</td>
</tr>
<tr>
<td>Initial permeability</td>
<td>2,000 to 4,000</td>
<td>15,000 to 40,000</td>
<td>1,800 to 3,000</td>
<td>400 to 1,000</td>
<td>400 to 1,000</td>
</tr>
<tr>
<td>Maximum permeability</td>
<td>15,000 to 40,000</td>
<td>50,000 to 150,000</td>
<td>12,000 to 20,000</td>
<td>20,000 to 40,000</td>
<td>3,000 to 6,000</td>
</tr>
<tr>
<td>Magnetising force for Bmax = 5,000 gauss</td>
<td>0.25 to 0.40</td>
<td>0.25 to 0.64</td>
<td>0.2 to 0.5</td>
<td>0.03 to 0.10</td>
<td>0.55 to 0.10</td>
</tr>
<tr>
<td>Maximum flux density gauss</td>
<td>15,000</td>
<td>8,000</td>
<td>13,000</td>
<td>14,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Coercive force in oersteds for Bmax = 5,000 gauss</td>
<td>0.16</td>
<td>0.03</td>
<td>0.15</td>
<td>0.05</td>
<td>3.7</td>
</tr>
<tr>
<td>Remanence in gauss for Bmax = 5,000 gauss</td>
<td>4,000</td>
<td>3,500</td>
<td>3,500</td>
<td>13,000</td>
<td>16,000</td>
</tr>
<tr>
<td>Hysteresis loss in ergs/cycle for Bmax = 5,000 gauss</td>
<td>160</td>
<td>40</td>
<td>240</td>
<td>229</td>
<td>12,500</td>
</tr>
<tr>
<td>Total loss in watts/lb for Bmax = 5,000 gauss 50 c/s 0.015 in. sheet</td>
<td>0.11</td>
<td>0.04</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
</tr>
</tbody>
</table>

* for Bmax = 14,000 gauss    † for Bmax = 20,000 gauss

Write for Technical Data Sheets:

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

MAGNETIC MATERIALS SALES DEPT: EDINBURGH WAY · HARLOW · ESSEX
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 ...

Cabinet by Heals of London

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for the closest 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 to Dept. W.W. for illustrated leaflet.
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.

Please write for full details.
Amplifier volt

- Provided with internal calibration voltages.
- Provided with a 12.5-cm linear scale with anti-parallax mirror reading.
- Protected against overloads.
- For all normal mains supplies (110-245 V, 40 c/s-100 c/s).
- Suitable for use under tropical conditions.

PHILIPS electronic measuring

Provided with a 12.5-cm linear scale with anti-parallax mirror reading.
Provided with internal calibration voltages.
Protected against overloads.
For all normal mains supplies (110-245 V, 40 c/s-100 c/s).
Suitable for use under tropical conditions.

GM 6020

Sold and serviced by Philips Organizations all over the world

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Sole Distributors in the U.K.: Research & Control Instruments Ltd.,
207 King's Cross Road, London W.C. 1
meters

**DC Microvoltmeter, type GM 6020**

<table>
<thead>
<tr>
<th>Input I</th>
<th>Input II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range:</td>
<td>100 µV (f.s.d.)</td>
</tr>
<tr>
<td>100 V in 11 steps</td>
<td>10 mV (f.s.d.)</td>
</tr>
<tr>
<td>Input impedance:</td>
<td>1 MΩ (± 1.5%)</td>
</tr>
<tr>
<td>in parallel with</td>
<td>100 MΩ (± 1.5%)</td>
</tr>
<tr>
<td>20 µF</td>
<td>10 µF</td>
</tr>
</tbody>
</table>

**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 µA (f.s.d.) - 10 µA**

**Accuracy: < 3.5%**

---

**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 impedances:** 4 MΩ in parallel with 20 µF (up to 3 V)
10 MΩ in parallel with 10 µF (in the other ranges).

**Overall accuracy with respect to full scale:**
- within ± 2.5%, 5 c/s - 100 kΩ/s
- within ± 5%; 2 c/s - 1 Mc/s

**Pre-deflection: < 100 µV**

---

**High Frequency Millivoltmeter, type GM 6014**

**Without pre-attenuator**

<table>
<thead>
<tr>
<th>Frequency range:</th>
<th>1 kc/s - 30 Mc/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring range:</td>
<td>1 mV (f.s.d.)</td>
</tr>
<tr>
<td>dB scale:</td>
<td>-80 dB up to -8 dB</td>
</tr>
<tr>
<td>Damping at 1 kc/s</td>
<td>1 MΩ</td>
</tr>
<tr>
<td>1 Mc/s:</td>
<td>700 kΩ</td>
</tr>
<tr>
<td>50 Mc/s:</td>
<td>50 kΩ</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>7 µF</td>
</tr>
</tbody>
</table>

**Overall accuracy within ± 2.5% and ± 5% with respect to full scale.**

**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.

---

**Instruments:** quality tools for industry and research

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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 16½, 33⅓, 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.

....and always
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 breakthrough 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 14¾”. 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 2-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. WRITE NOW FOR ILLUSTRATED BROCHURE.

A.L/120... Price £29. 10. 0
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.
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.

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.

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

Also Acheson Colloids Company, Port Huron, Michigan, U.S.A. and Acheson Colloids N.V. Schermer (Gr.) Netherlands
Another outstanding new Ediswan valve

with a CV4000 specification

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:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament Voltage</td>
<td>2.5 or 5.0</td>
</tr>
<tr>
<td>Filament Power</td>
<td>1.15</td>
</tr>
<tr>
<td>Anode Voltage, max</td>
<td>150</td>
</tr>
<tr>
<td>Screen Voltage, max</td>
<td>150</td>
</tr>
<tr>
<td>Mutual Conductance</td>
<td>4.3</td>
</tr>
<tr>
<td>Anode Dissipation</td>
<td>5.0</td>
</tr>
</tbody>
</table>

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 AEC 1511
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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.

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All high voltages are fully interlocked.

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COMMUNICATIONS SYSTEMS

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FREQUENCY AND TIME MEASURING EQUIPMENT TSA3.HF.

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and time measurement into the bargain!

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A valve by any other name...

...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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### 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**

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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.

**Price £13.13.0**

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**WINSTON DECADE BOXES**

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**

- **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.
- **Dimensions**: Height 3 ins. (7.5 cms.)  Width 8 ins. (20 cms.)  Depth 3½ ins. (9.5 cms.)  Weight 5 lbs. (2.3 Kgs.)

**Decade Resistor Box**

- **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.
- **Dimensions**: Height 3 ins. (7.5 cms.)  Width 8 ins. (20 cms.)  Depth 3½ ins. (9.5 cms.)  Weight 5 lbs. (2.3 Kgs.)

---

**WINSTON ELECTRONICS LIMITED**

GOVETT AVENUE, SHEPPERTON, MIDDLESEX

Telephone: Walton-on-Thames 26321/5
Telegrams: Winston, Shepperton
3000 types of both receiving and transmitting tubes in stock
In addition, a comprehensive range of crystals and some types of
transistors and trustworthy tubes are available.

PRICE AND STOCK LISTS ON APPLICATION

Your specific enquiries for special types to CV, JAN and MIL
specifications are invited.

Our organisation is Air Registration Board approved,
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)

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:**
- Equally suitable for large and small areas or concerns
- Low rental terms
- Virtually no internal wiring

THE MULTITONE
personal call
system of staff location

(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.

MULTITONE ELECTRIC COMPANY LTD., 12/20 Underwood St., LONDON, N.1. (CLErkenwell 8022)
You'll 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 6¼" x 22½" x 9" (16.5 cm x 56 cm x 23 cm). Weight 31 lbs. (19.1 Kg).

Electronic Distributor
Dimensions 19½" x 8½" x 3½" (48 cm x 21 cm x 9 cm). Weight 23 lbs. (10.7 Kg).
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.

ARTICLES IN THE JULY ISSUE INCLUDE:

THYRATRON PULSE GENERATOR
A pulse generator which uses a thyratron 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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FIVE RADICAL DEVELOPMENTS IN MULLARD ALLOY DIFFUSED TRANSISTORS
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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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* 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
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* 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—f₁ is greater than 60 Mc/s.
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* PNPN 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.
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<thead>
<tr>
<th>Coil Type</th>
<th>Description</th>
<th>Price</th>
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<tr>
<td>P50/1AC</td>
<td>M.W. Oscillator Coils, for 176pF Tuning Condenser</td>
<td>5/4d.</td>
</tr>
<tr>
<td>P50/2CC</td>
<td>1st and 2nd I.F. Transformer, 470 Kc/s Operation, &quot;Q&quot; = 150</td>
<td>5/7d.</td>
</tr>
<tr>
<td>P50/3CC</td>
<td>3rd I.F. Transformer, 470 Kc/s Operation, &quot;Q&quot; = 170</td>
<td>6/0d.</td>
</tr>
<tr>
<td>RA2W</td>
<td>L.W. and M.W. Rod Aerial 6in. long, flying-lead connections</td>
<td>12'6d.</td>
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<tr>
<td>LFTD2</td>
<td>Driver Transformer, Split Secondary Type, semi-shrouded, with 6 connecting tags</td>
<td>9'6d.</td>
</tr>
<tr>
<td>PCAI</td>
<td>Printed Circuit Panel, 2½ x 8½in. ready drilled with component positions and references printed on rear</td>
<td>9'6d.</td>
</tr>
<tr>
<td>BOOKLET</td>
<td>DETAILED ASSEMBLY INSTRUCTIONS AND CIRCUIT DIAGRAMS FOR 6-TRANSISTOR LONG AND MEDIUM WAVE SUPERHET</td>
<td>2'0d.</td>
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<table>
<thead>
<tr>
<th>Voltage</th>
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<tr>
<td>5 V</td>
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<td>7 A</td>
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<tr>
<td>110-120 V</td>
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<tr>
<td>10-20-30 V</td>
<td>100 A</td>
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<tr>
<td>110 V centre tapped</td>
<td>25 A</td>
<td>£33</td>
</tr>
<tr>
<td>6-12-18-24-30 V</td>
<td>12 A</td>
<td>£11</td>
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<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
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<td>750 A</td>
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<tr>
<td>36 V</td>
<td>10 A</td>
<td>£26</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>CARBON</th>
<th>WATTS</th>
<th>OHMIC RANGE</th>
<th>TOLERANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Solid</td>
<td>1-2</td>
<td>10-10M</td>
<td>5% &amp; 10%</td>
</tr>
<tr>
<td>2. Cracked</td>
<td>1/30-20</td>
<td>1-500M</td>
<td>5% &amp; 10%</td>
</tr>
<tr>
<td>3. High Stability</td>
<td>1/10-3</td>
<td>1-50M</td>
<td>0.5% &amp; 2% &amp; 5%</td>
</tr>
<tr>
<td>4. Variable</td>
<td>1/10-1</td>
<td>5-2M</td>
<td>5% &amp; 2%</td>
</tr>
<tr>
<td>5. V. High Resistance</td>
<td>1/10-1</td>
<td>50M-10 k</td>
<td>5% &amp; 2%</td>
</tr>
<tr>
<td>6. V.H.F. (Rods &amp; Discs)</td>
<td>1/10-1</td>
<td>10-1 k</td>
<td>1% &amp; 2%</td>
</tr>
<tr>
<td>WIRE WOUND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Rheostats</td>
<td>4-500</td>
<td>10-18k</td>
<td></td>
</tr>
<tr>
<td>8. Vitreous</td>
<td>3-500</td>
<td>1-150k</td>
<td>1% &amp; 2%</td>
</tr>
<tr>
<td>7. Cemented</td>
<td>1-15</td>
<td>1-25k</td>
<td>5% &amp; 10%</td>
</tr>
<tr>
<td>9. Metal oxide</td>
<td>1-2</td>
<td>100-4.2 M</td>
<td>1% &amp; 2% &amp; 5%</td>
</tr>
</tbody>
</table>

*The ubiquitous blue (1%) grey (2%) "HISTABS"

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TYPICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 V</td>
<td>100 V</td>
<td>1, 1.5, 2,</td>
</tr>
<tr>
<td>6 V</td>
<td>200 V</td>
<td>3 or 4 WATT</td>
</tr>
<tr>
<td>6 V</td>
<td>400 V</td>
<td></td>
</tr>
<tr>
<td>6 V</td>
<td>800 V</td>
<td></td>
</tr>
<tr>
<td>12-18 V</td>
<td>250 V</td>
<td>50 WATT</td>
</tr>
</tbody>
</table>

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SOVIREL'S six basic glasses for valves, tubes and semi-conductors

<table>
<thead>
<tr>
<th>Code</th>
<th>Current Name</th>
<th>Sealing to</th>
<th>Principal uses</th>
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<tbody>
<tr>
<td>S 746 03</td>
<td>SO 14</td>
<td>FeNiCo Alloys (Nilo K, Kovar, Therlo etc)</td>
<td>Power and transmitting valves Camera and Storage Tubes Spécial Tubes</td>
</tr>
<tr>
<td>S 747 01</td>
<td>7056</td>
<td>FeNiCo Alloys (Nilo K, Kovar, Therlo etc)</td>
<td>All uses where halogen-free Glass required Optical face plates</td>
</tr>
<tr>
<td>S 732 01</td>
<td>SOLIDEX</td>
<td>Tungsten</td>
<td>X-Ray-Tubes -Spécial Lamp Bulbs</td>
</tr>
<tr>
<td>S 740 01</td>
<td>B 40</td>
<td>Tungsten</td>
<td>Power Valves -Spécial Lamp Bulbs</td>
</tr>
<tr>
<td>S 750 01</td>
<td>MO</td>
<td>Molybdenum</td>
<td>X-Ray Tubes</td>
</tr>
<tr>
<td>S 190 01</td>
<td>G 12</td>
<td>Chrome Iron Alloys</td>
<td>Cathode-Ray Tubes</td>
</tr>
</tbody>
</table>

GLASS ENVELOPES AND TUBING FOR
a) Special cathode Ray Tubes
b) Camera Tubes, Storage and Display
c) X-Ray Tubes
d) Power and Transmitting Valves

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Collector current (mA) ................................................................. -100
Collector dissipation \(T_{\text{amb}}=25^\circ\text{C}\) (mW) ............................ 120
Collector dissipation \(T_{\text{amb}}=71^\circ\text{C}\) (mW) ............................... 10

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>XA141</th>
<th>XA142</th>
<th>XA143</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static current amplification at (V_{cc}=-7V, I_c=-5\text{mA}) (hFE)</td>
<td>Minimum</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Collector to base capacity (pF)</td>
<td>Average</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Gain/bandwidth product (frequency for current gain=1) at (V_{cc}=-7V, I_c=-5\text{mA}) (Mc/s)</td>
<td>Minimum</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>30</td>
<td>50</td>
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</tbody>
</table>

*Typical production spreads

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Associated Electrical Industries Ltd
Radio and Electronic Components Division
PD 15, 155 Charing Cross Road, London, W.C.2
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JULY 1960

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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 theFuse-element. This may be an open wire bridging two terminals, or it may be supported on a carrier and enclosed in a cartridge, the element and its immediate container being called aFuse-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 means that its performance will be affected. Thus, a fuse-element made of a material which melts at 50°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 any installation should not be altered indiscriminately.

(To be continued)
CONTROLLED POWER

New G.E.C. Silicon Controlled Rectifier now available

The SCR96 silicon controlled rectifier is a three-junction semiconductor device developed and manufactured by G.E.C. for use in power control and power switching applications requiring blocking voltages up to 200V and load currents up to 10A. Series and parallel circuits may be used for higher power applications.

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Continuous P.I.V. (V)</th>
<th>Maximum Transient P.I.V. (5ms)* (V)</th>
<th>Maximum average current† (A)</th>
<th>Peak one-cycle surge current (A)</th>
<th>Maximum average gate power (W)</th>
<th>Average gate current to fire (mA)</th>
<th>Typical turn-on time‡ (μs)</th>
<th>Typical turn-off time‡ (μs)</th>
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<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

* For zero or negative gate voltages  † Depends on cooling system and conduction angle.  ‡ Value depends on circuit.

G.E.C.

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THE GENERAL ELECTRIC CO. LTD., SEMICONDUCTOR DIVISION, SCHOOL STREET, HAZEL GROVE, STOCKPORT, CHESHIRE
MEASUREMENT OF AM REJECTION RATIO

The unwanted AM audio signal depends in general on the amplitude of the signal which differs from the maximum amplitude of the original carrier signals, and on the unbalance of the discriminator circuit. The FM detector characteristic must be linear over a range of ±22.5 kc/s deviation in order to use a lower frequency for the frequency modulation and to separate the audio modulation output by means of a high pass audio filter.

Useable 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

\[
\text{rms audio output produced by FM} \times 10 \text{dB} = \text{rms audio output produced by AM}
\]

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.

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NEW VERY HIGH SLOPE SCREENED HF PENTODE

EDISWAN MAZDA 6F24

The 6F24 has a slope of 15 mA/V at 10 mA anode current and a high "Figure of Merit," both results achieved by incorporating the new frame grid technique. This new screened HF Pentode enables improved performance to be obtained as an IF amplifier in a.c. or a.c./d.c. television receivers.

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) \( V_{h-k} \) 150
Control Grid to Cathode Resistance (megohms) \( R_{g1-k} \) 0.6

With grid to cathode resistance not exceeding 10 kΩ.
†With cathode to higher potential heater pin.
‡With \( P_{a(max)} = 2 \text{ W} \); \( P_{g2(max)} = 0.5 \text{ W} \); and assuming a common anode and screen decoupling resistance \( < 2.2 \text{ kΩ} \pm 10\% \).

Inter-Electrode Capacitances (pF)
Input Capacitance \( C_{in} \) 8.8
Output Capacitance \( C_{out} \) 2.6
Grid 1 to Anode \( C_{g1-a} \) 0.006
Grid 1 to Grid 3 \( C_{g1-g3} \) 0.1
Grid 1 to Grid 2 \( C_{g1-g2} \) 2.0
Grid 1 to Cathode \( C_{g1-k} \) 6.2
Grid 2 to Anode \( C_{g2-a} \) 0.15
Grid 3 to Anode \( C_{g3-a} \) 0.47
§Measured in fully shielded socket, without can.

TYPICAL OPERATION

Anode Voltage (volts) \( V_a \) 170
Screen Voltage (volts) \( V_{g2} \) 170
Self Bias Resistance (ohms) \( R_k \) 150
Anode Current (mA) \( I_a \) 10
Screen Current (mA) \( I_{g2} \) 2.7
Mutual Conductance (mA/V) \( g_m \) 15
Inner Amplification Factor (\( g_1 \) to \( g_2 \)) \( g_{1-g2} \) 65
Equivalent Grid Noise Resistance (ohms) \( R_{eq} \) 370
Input Loss at 38 Mc/s (Pins 1 and 3 strapped) \( \Delta C_{in(w)} \) 8.5
Working Input Capacity** Measured at 38 Mc/s (pins 1 and 3 strapped) \( g_{1-g2} \) 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 \( g = 10^5 \) see "Aspects of Design" No. 1 for further details. (Wireless World July 1958.)

Base: BA9 (Noval) Mounting Position: Unrestricted

Maximum Dimensions (mm)
Overall Length 56
Seated Height 49
Diameter 22.2

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MAZDA
CRC15/57

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AD308 high selectivity receiver and low noise ferrite loop aerial gives continuous reception across the North Atlantic.

AD308 using narrow band L.F. reception clears the HF band for vital ATC communications.

AD308 being automatic, radically reduces the flight deck work load.

AD308 light weight receiver is contained in a short A.T.R. case and weighs only 9 lbs (4.1 Kgs).

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CV 7029 | 600v | 6G8
CV 7028 | 400v | 4G8
CV 7027 | 200v | 2G8
CV 7026 | 100v | 1G8

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And if you're in a rage over rectifiers or in a diode of despair—don't worry. We'll get you out of that too. (Why, we've made some of our customers actually beam at tetrodes!) It's because we've experienced over 40 years bottling up valves—Tx, Rx, rf, audio, hard, soft, govt., special—that problems like this no longer hold any terrors for us. Also, we've everything on the research and production side you could possibly wish for. So the next time you're enveloped in a valve problem, let us know.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>$g_m$ (mA/V)</th>
<th>$C_a - all &lt; g_l$ (pF)</th>
<th>$C_{pl} - all &lt; g_{pl}$ (pF)</th>
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</table>

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Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than -95 dB referred to 30 watt.

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This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional inputs are available to special order. A feed direct out from the mixer is standard and output impedances of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 x 7in. rack panel form or in standard ventilated steel case.

Size 18 x 7½ x 9½in. deep.
Price of standard model £49.
Also 3-way mixers and Peak Programme Meters.
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It is the most comprehensively equipped studio in the world (ready for colour television when it comes), a new centre of lavish entertainment for audiences of millions.

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Can be trunnion mounted if required.

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16 mm. motorised G.P.O. FACO for 36 frame per second, approximately 100' film, £15/0/- in triple anastigmatic lens set up to carry 35' film around £15. New brand and sealed £6/10/- or 20/- deposit and 15 fortnightly payments of 10/-, post and insurance.

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R.238... 78
R.1151A... 78
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R.111T... CAT-46-A/P
R.1740A... RA/20
R.1805... R.224
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R.1904... A.B.
R.G.1066-A/B
R.G.1904-A (R-8)
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0-10 K ohms.
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SQ. & R at 1,000 c/s.

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250 Volts

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0-50/0-

251-

45/-.

69/-.

21 in.

15 V.

300 V.

5 Amps.

10 Amps.

200 V.

2 Amps.

15 Amps.

180 V.

10 Amps.

10 Mils

20 Mils

150 m/A.

300 m/A.

100 m/A.

500 m/A.

25 m/A.

200 m/A.

300 m/A.

500 m/A.

200 m/A.

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VOLTS VOLTS Current Current
150 mv. 7.5 v. 15 ma. 75 ma.
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1.5 v. 7.5 v. 1.5 amp. 15 amp.
3 v. 15 v. 300 ma. 1.5 amp.
15 v. 300 v. 1.5 amp. 7.5 amp.
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2.5 v. 100 micro/A. 1 ma.
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50 v. 50 ma. 1,000 ohms
250 v. 500 ma. 1000 ohms
1,000 v. 1,000 ohms
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ONLY £15 EACH
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D.C. A.C. D.C. A.C.
Volts Volts Current 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.

24 VOLT ROTARY CONVERTERS

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, £13/19/6 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 24 in., 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.

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.

EC 221 HETERODYNE FREQUENCY METERS
125 kc/s to 20 mc/s Complete with all valves, crystal, headset and instruction 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

3½in. 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.

TEST GEAR COMPONENTS (LONDON) LTD

15 ARCANY ROAD, SOUTH OCKENDON, ESSEX  TEL: SOUTH OCKENDON 2610
Each Model incorporates the highly successful HPI/FTR3 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 values for money" Tape Recorders on the market— if you can’t call and hear them send S.A.E. for fully descriptive leaflets.

Before you buy— you should hear these Recorders— they are comparable to the much higher priced models.

Model HF/G2D Amplifier
Permits the Ideal "Link" to add High Quality Tape Recording facilities to existing Audio Installations, such as our MULLARD RANGE of Amplifiers and also, similarly equipped to operate through the Pick-up Sockets of most Radio Receivers.

It incorporates:

• Magic Eye Level Indicator and Control.
• Superimpose Switch.
• Effective Tone Control.
• Monitoring Facilities.
• Extension Loudspeaker Socket.

Inputs: for recording from Microphone, Gram. and Radio Tuner.

Both Units are 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 SELFDIRECTED WORKING unit which requires nothing more than a Cabling and Connecting to the Mains supply.

Model HF/G2P Preamplifier

Is operated direct off 12 volt car battery. We offer it on the UNIT ASSEMBLY BASIS

Hire Purchase Terms: Deposit £3/12/-, 12 monthly payments £210/14.

WE OFFER AS FOLLOWS:

(a) MODEL HF/G2R PORTABLE TAPE RECORDER Includes spool of L.P. tape and crystal microphone.

H.P. Terms Deposit £8/10/, 12 monthly payments £9/2/6.

(b) MODEL HF/G2D, comprising F.M. TUNING UNIT

Amplifier and Tape Deck.

Includes spool of L.P. tape and loudspeaker. 

H.P. Terms Deposit £6/18/0, 12 monthly payments £1/4/6.

(c) ASSEMBLED & TESTED PRE-AMPLIFIER MODEL HF/G2A

Incorporates the Popular 3-speed COLLARO Type F.M. TUNING UNIT.

H.P. Terms Deposit £6, 12 monthly payments £1/4/6.

(d) MODEL HF/G2C PORTABLE TAPE RECORDER

Comprises portable case (like HF/G2B).

H.P. Terms Deposit £6, 12 monthly payments £1/4/6.

(e) ASSEMBLED & TESTED PRE-AMPLIFIER MODEL HF/G2P

Incorporates high grade L.P. Tape.

H.P. Terms Deposit £6, 12 monthly payments £1/4/6.

THE "ADD-A-DECK"

incorporating the NEW B.S.R. "MONARDECK" and MATCHED PREAMPLIFIER £17.17.0

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 Preampifier, and operates at 33 1/3/sec. speed. It uses 5in. Tape Spools, thus providing up to 1½ hours’ playing time on L.P. Tapes or 1 hour on the standard 6in. Tape Spool.

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.

STERNS’ 12 VOLT CAR RADIO

incorporating...

Printed Circuit and Power Transformer

A recent design covering both LONG and MEDIUM WAVELANDS, incorporating a Transformer Output thus having very low battery consumption, is operated direct off 12 volt battery. We offer this unit on the UNIT ASSEMBLY BASIS

HIRE PURCHASE: Deposit £1/6/12 (plus 7/- car. and ins.)

Terms: Deposit £3/12/-, 12 monthly payments £1/4/6.

WE OFFER AS FOLLOWS:

(a) UNIT ASSEMBLY BASIS £25.15.2

(b) UNIT ASSEMBLY BASIS £27.6.0

(c) UNIT ASSEMBLY BASIS £24.13.4

Prices quoted are including Sales Tax.
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. H.P. Terms: Deposit £6/18/- and 12 months £1/7/10. Complete Kit of Parts £32.10.0
(b) The new TRUVOX Mk. VI Tape Deck. H.P. Terms: Deposit £6/18/- and 12 months £1/7/10. Complete Kit of Parts £32.10.0
(c) The BRENNEL Mk. V 3 speed Deck. H.P. Terms: Deposit £6/18/- and 12 months £1/7/10. Complete Kit of Parts £35.00.0
(d) The WEARITE 4A TAPE Deck. H.P. Terms: Deposit £6/18/- and 12 months £1/7/10. Complete Kit of Parts £35.00.0

STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER-ERASE UNIT INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTORS.

PRICES: INCLUDING SEPARATE SMALL POWER SUPPLY UNITS COMPLETE KIT ASSEMBLED AND TESTED £14.00.0

OF PARTS Deposit £3/18/- and 12 months of £1/4/11. Assembled unit only.

£11.15.0 respectively. (Carr. and Ins. 5/- each)

Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual.

WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED.

FOR PERMANENT HIGH FIDELITY INSTALLATIONS WE ALSO OFFER (excluding Case) the following:

(a) The COLLARO "STUDIO" TAPE DECK and the Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested. H.P. Terms: Deposit £6/18/- and 12 months at £1/7/10. Complete Kit of Parts £32.10.0
(b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts. H.P. Deposit £8/8 and 12 months £3/18/6. £29.00.0
(c) The COLLARO IV TAPE DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested. H.P. Deposit £8/8 and 12 months £3/18/6. £35.00.0
(d) As in (c) above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts.

£32.10.0
£29.00.0
£35.00.0
£29.00.0

(c) The WEARITE 4A DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested. H.P. Deposit £11/4/- and 12 months £4/2/1. Complete Kit of Parts £56.00.0

£32.10.0
£29.00.0
£35.00.0
£29.00.0

(c) The TRUVOX Mk. VI TAPE DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested. H.P. Deposit £11/4/- and 12 months £4/2/1. Complete Kit of Parts £56.00.0

£32.10.0
£29.00.0
£35.00.0
£29.00.0

H.P. TERMS: Deposit £6/- and 12 months £2/6/- per kit extra.

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 £7/14/-, 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 10inx 6in. P.M. LOUDSPEAKER.

ACOS CRYSTAL MICROPHONE 1000ft. 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 HAVE INCLUDE:

(a) The Mk. IV COLLARO "TRANSCRIPTOR" DECK. H.P. TERMS: Deposit £6/-, 12 months of £3/6/- (Carr. and Ins. on all above is £1/6/- each)

£39.15.0

(b) The new TRUVOX Mk. VI DECK.

£45.00.0

(c) As above but HF/TR3 ASSEMBLED and TESTED.

£31.10.0

(d) COMPLETE KIT to build the HF/TR3 Amplifier, with the Mk. IV COLLARO "TRANSCRIPTOR" DECK. H.P. Terms: Deposit £6/12, £12 months £2/1/2. £30.15.0

(e) As above but HF/TR3 ASSEMBLED and TESTED.

£34.10.0

(f) As above but HF/TR3 ASSEMBLED and TESTED.

£39.10.0

(g) COMPLETE KIT to build the HF/TR3 Amplifier, with the WEARITE 4A DECK Switch Banks.

£36.00.0

(h) As above but HF/TR3 ASSEMBLED and TESTED.

£45.00.0

(i) THE ASSEMBLED AND TESTED HF/TR3 AMPLIFIER with the WEARITE 4A DECK Switch Banks. H.P. Terms: Deposit £6/-, 12 months £3/6/-.

£55.00.0

For constructors with their own Cabinet—WE OFFER:

THE HF/TR3 TAPE AMPLIFIER.

£28.00.0

THE NEW COLLARO "STUDIO" TAPE DECK, includes CRYSTAL MICROPHONE 1200ft. SPOOL E.M.I. TAPE—ALL FOR £35.0.0

WE HAVE THE NEW 2-SPEED TWIN TRACK 3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTION PRIZE FOR COMPLETE KIT OF PARTS £12/15/- FULLY ASSEMBLED and Tested £16/10/-

HIRE PURCHASE: Deposit £3/10/6 and 12 months at £1/4/12. A very high quality amplifier based on the very successful Type A- design, completed at the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GLOXON OUTPUT TRANSFORMER. Other features are: Magic Eye Recording Head Indicator—Effective Time Control—Infinite Tone Control—High Fidelity Tone Control—Extension Speaker Sockets—Highly Efficient Power Supply and can be used as independent Amplifier for direct reproduction of Gramophone Records. Further details will be available from us. Overall size 11 x 9 x 6 (inches) Trunox—Collaro—or Breckwell—please specify which type. Telephone: FLEET STREET 5812.3/4.

PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE

STERN RADIO LTD.

DEPT W TS TUS FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

JULY, 1960
STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNs strictly to specification

MULLARD's "5-10" MAIN AMPLIFIER

For use with the MULLARD 7-stage pre-amplifier with which it is associated, the undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES (brand new) and the Receiver Type Transformer and choice of the latest Ultra-linear h.t. or the Stereophonic or Dual Channel Power Transformer.

Price COMPLETE KIT (Parmeke Output Transformer) £10.00

Alternatively we supply ASSEMBLED AND TESTED £11.10.0

STERN MULLARD'S

PRE-AMPLIFIER TONE CONTROL UNIT

For use in the latest R.A.A. or in the latest PARTRIDGE Linear Output Transformer.

Price COMPLETE KIT OF PARTS £6.60.0

ASSEMBLED AND TESTED £8.00.0

STEREO 3-3 MAIN AMPLIFIER

Comprises two "3-3" MAIN AMPLIFIERS in one chassis and is designed to operate with our DUAL CHANNEL PRE-AMPLIFIER for both STEREO or MONOaural operation.

Price COMPLETE KIT OF PARTS £10.00.0

Alternatively ASSEMBLED AND TESTED £11.15.0

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 5-valve Pre-Amps (described above), combined into a Single Unit, enabling it to be used for both STEREOPHONIC or MONOaural operation. It is designed primarily to overcome with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 200 m.v.

Price COMPLETE KIT OF PARTS £12.10.0

Alternatively ASSEMBLED AND TESTED £15.00.0

MULLARD'S 5-10 AMPLIFIER

Two Mullard BC127 Triode Pentode Valves are incorporated in the design, they form an A' single ended output stage in each channel.

H.P. TERMS: Deposit £2 and 12 monthly payments of £1.

COMPLETE MULLARD 3-3 QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-3 WATT AMPLIFIER. A REALLY HIGH QUALITY AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS £7.10.0

Alternatively we supply ASSEMBLED AND FULLY TESTED (plus 6/6 carriage and insurance) £8.19.6

STERN RADIO LTD

REFT. W. 109 FLEET ST.
LONDON, E.C.4

Telephone: FLEET STREET 581/2/J

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 £10.12.0 and 12 months at £17/8.

(e) The COMPLETE KIT OF PARTS to build the Dual Channel "5-10" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested £21.10.0

H.P. TERMS: Deposit £15 and 12 months at £19/6.

(f) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested £25.00.0

H.P. TERMS: Deposit £25 and 12 months at £21/10.

(g) The COMPLETE KIT OF PARTS to build one "5-10" Amplifier (Parmeke Transformer) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested £31.00.0

H.P. TERMS: Deposit £30 and 12 months at £31/10.

(h) Two "5-10" Amplifiers (Parmeke Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested £36.00.0

H.P. TERMS: Deposit £37/4 and 12 months at £37/4.

Prices quoted are subject to 1/6/- extra for Partridge Trans. & carriage and insurance.
HEAVY DUTY L.T. TRANSFORMERS
App. ratings tropical and in perfect condition
No. 2, Pri. 210-220 v, Sec. 10 v, C.T. 2 A and 5 v, C.T. 10 A. Admiralty rating, 27/6, carr. 3/6.
No. 3, Pri. 230 v, Sec. tapped 4, 6, 11 v, 200 amps. £8/10/-, carr. 7/6.
No. 4, Pri. 200-250 v, Sec. 50 v to 30 A. £6/10/-, carr. 7/6.
No. 4, Pri. 200-240 v, Sec. 50 v to 20 A. £4/10/-, carr. 7/6.
No. 5, Pri. 200-250 v, Sec. tapped 28, 29, 30, 31 v, 21 A. £6/11/-, carr. 7/6.
No. 6, Pri. 100-250 v, Sec. two separate windings tapped 15, 16, 17, 19 v, 4 A. 35/-, carr. 4/-.
No. 7, Pri. 220-240 v, Sec. three separate windings 6.5 v, 50 A, 6 v, 230 v. £6/10/-, carr. 7/6.
No. 8, Pri. 220-240 v, Sec. 6.3 v, 15 A. 2 A, potted type. £3/6, carr. 3/6.
No. 9, Pri. 220-240 v, Sec. four separate windings 3 x 5 v, C.T. 4 A, 4 v, A., potted type. £3/6, carr. 3/6.
No. 10, Pri. 200-240 v, Sec. three separate windings 3 x 6.3 v, C.T. 4 A, potted type. £4/10/-, carr. 7/6.
No. 11, Pri. 200-240 v, Sec. 6.3 v, C.T. 3.25 A. 30 v, 12 A, 17 A. £4/6/-, carr. 4/-.
No. 12, Pri. 200-240 v, Sec. 5 v, C.T. 4 A, 2.25 A. £2/6/-, carr. 2/6.
No. 13, Pri. 230 v, Sec. 50 v, 2 A, 6.3 v, 5 A, 6.3 v, 2 A, 6.3 v, 0.6 A, 5 v, 5.6 A., 5 v, 3 A. Brand new, £9/6/, carr. 5/-.
No. 15, Pri. 220-240 v, Sec. tapped 17, 18 v, 10 A. £2/4/-, carr. 4/-.


HEAVY DUTY VOLTAGE CONTROLLERS
1,000 ohm, 0.5/2. 0.16 amps. Rotary switch type with 32 contacts. Completely enclosed with metal control handle. New in maker's cardboard fraction of manufacturer's price. 10/-, P.P. 3/6.

HEAVY DUTY ADIMRALTY

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. 4 ohm, 17/6, Carr. 5/-.

AMERICAN OMMITE RHEOSTATS 15 ohms, 2 1/2 A. 25 ohms, 0.75 A., 15/6 350 ohms, 25 watts, 3/6 Tubular adjustable. Length 10/in., dia. 1/in. 2 ohms amps. 7/6 100 ohms 1 A, 22/6. P.P. on all resistors 2/-.

NUTS, BOLTS, WASHERS Special bargain offer £1. carton of 24, 6 B.A. nuts, bolts and washers, P.P. 1/-, SLEEVING, mixed bundle, 1/- per lb, various colours. Wonderful offer. 2/6 P.P. 9d.

THERMOSTATS A.C. 250 v, 15 AMP 11 in. stem. Adjustable from 100-190 degrees F. Complete with sleeve, 2/6 P.P. 2/6.

169-171 EDGWARE RD., LONDON, W.2. Telephone PAD 7851, AMB 5125
TAPE DECKS
Latest BSR Monodeck. Single speed 31 i.p.s. Will take 5in. spools, £9/19/6. P. & P. 5/-.
Collaro Studio Tape Transcriber. 3 speeds 15, 33, 75 i.p.s. 3 motors, push-button controls. Will take 7in. spools. £17/19/6. P. & P. 7/6.
Collaro Mk. 4 Tele-Deck. Twin track operation. 3 speeds, 31, 75, 15 i.p.s. Will take 7in. spools. £17/19/6. P. & P. 7/6.
Tape Recorder Amplifier, specially designed to match the Collaro Studio Tape Deck. £12/7/6. P. & P. 4/-.
Size 11 x 5 x 3 in., uses 3 valves, magic eye, contact cooled metal rectifier. In- corporations a beltedgram/radio inputs, ext. i.e. jack, super-imposing switch, with machine during.
RECORDING TAPE
By well-known manufacturers, brand new, boxed and fully guaranteed.
1,000ft. on 7in. spool... £5/7/6.
2,000ft. on 7in. spool... £7/15/0.
4,000ft. on 7in. spool... £15/0/0.
Postage and packing 1/- per spool.
AMERICAN RECORDED TAPE
Manufactured by Ferrotronics, brand new and fully guaranteed.
2,000ft. on 7in. spool... £5/0/0.
4,000ft. on 7in. spool... £10/0/0.
Postage and packing 1/- per spool.

MODEL 1629 AM/FM RADIOGRAM CHASSIS BY FAMOUS MANUFACTURER
PRICE £15.19.6 plus 7/- p. & p.

AVANTIC SPA11 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 x 9 x 6. Original Price 28 gns.
P. & P. 7/6.

AVANTIC SP A21 Stereophonic Amplifier. Special feature of this Amplifier is high sensitivity permitting direct operation from Magnetic Pick-up and high im- pedance high fidelity Head-phones. Power output each channel 20 watts peak, rumble filter, L.S. impedance, 4, 8, and 16 ohms., 6-position input selector, bass, treble, volume on/off control. Dimensions 14 x 14 x 6. Original Price £48/10/-.
P. & P. 12/6.

AVANTIC SP21 Stereophonic Pre-Amp. Control Unit, this Unit was primarily designed for use with the Avantic DLT35 Amplifier. Brief specifications, 6 channels for each position, 6-position input selector, bass, treble, volume control, on/off stereo/3D/revolution stereo switch, stereo phase switch, low pass filter. Power re- quirements 6.3 v. at 1.3 A. A.C., 350 v. at 5 mA. D.C. Dimensions 14 x 9 x 6. Original Price £28/10/-.
P. & P. 7/6.

P. & P. 7/6.

P. & P. 7/6.

AVANTIC DL735 Power Amplifier, designed to the highest standard 2 to meet present day demands and when used in conjunction with the SP21 Pre-amp Control Unit perfection in stereo reproduction is achieved. Specifications: output power 54 watts peak, L.S. impedance, 4, 8, or 16 ohms, power inputs 105-250 v. Valve line-up GZ34, 2-EL34, ECC83, BP6. Dimensions 14 x 9 x 6. Original Price £48/10/-.
P. & P. 12/6.

AVANTIC SL12-21 Speaker System employing 12in. dia. P.M. L.S. and high frequency pressure Unit amounted in an acoustically designed enclosure, impedance 15 ohms, dimensions 38 x 18 x 15in. Finished in black and gold. TECHNICAL DETAILS AND DESCRIPTION LITERATURE AVAILABLE.

THE SHIRA 6TR-A 6 TRANSISTOR POCKET RECEIVER complete with Batteries and Pocket Case...
PRICE £14.14.6

MULLARD TYPE 5-10 AMPLIFIER
By Well Known Manufacturers

THE MODEL FMAI FERGUSON FM TUNER...

SEND FOR FULL TECHNICAL DETAILS ON THE ABOVE.
126
AC/P 3/3
BL63 AU4 AR DDS
E1/16/.. 2.
Price E125. Carr. at cost.

simple switch.

A.0 Output 250 v. 75 mA. and 6.3 v. 3.5 amps.

PHONE No.

BRAND NEW ORIGINAL SPARE PARTS

2,000 v. D.C., E2/19/6.

Fully tested

7/6.

ECC9 I

EBC33 EF92 EF85

EF50 EF22

12/6.

black

1/-.

101- P. & P.

leads.

1,600 v

Exceedingly well filtered and matched, excellent for car radios. New. Including one 6×5G valve and vibrator. 176. P. & S./-

CARBON INSET MICROPHONE. G.P.O.
type 2/6. P. & S./-

INSULATION TEST METER. Testing voltage adjustable up to 6,000 v. D.C. Mains supply 180/210 v. in wooden case £25. Carr.


NO. 62 TRANSFORMER-RECEIVER. 1.6 m. 12 mcts in two ranges, designed for mobile use. Total 11 valves. Rx-A super with separate mixer and local oscillator. Tx uses VQ047/4-3 power amplifier VFO or switched selected crystals. C.W., phone (grid modulation) metered for operation and valve testing. Pi output two match rods as above. "Press to send" operation from mike. Size 8½. Price £17.5/6. Weight 12½ lbs. Completely self contained with internal power unit for 12 v. operation. Power consumption 4 A. on send, 3A on receive. As new condition, tested, complete with operation instructions. Price £21/10/. Delivery included.
RIISS RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 12-27 Mc/s, 70-9-8 Mck/s, 1,500-4,500 Mc/s, 500-2,000 kcs., 200-75 kcs. and 1500-600 kcs., 200-200 kcs., 200-72 kcs., and is easily and simply adapted for normal make 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 Blow Motion tuning assembly. Have had some use, but are in excellent condition. ONLY £2/19/6.

C.R.A. MADE POWER PACK OUTPUT STAGE in black, metal case to match receiver, enabling it to be operated immediately, just plugging in, without any modification. Fitted with dim. P.M. Speaker £9/4. DEDUCT 1/6.

IF PURCHASING RECEIVER AND POWER PACK TOGETHER. Send 96¼ for illustrated leaflet, or 1/2 for 16-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 1/6 for Receiver, 6/ for Power Unit.

RCA RECEIVERS (A.M. ONLY). Thoroughly re-conditioned and in perfect working order. Cover 500 kHz-3150 kcs. ONLY £3/0/6 (carriage etc., 20/-).

CRYSTAL CALIBRATOR No. 10

A superb Crystal Controlled WaveMeter just released by the Ministry of Supply. Has directly calibrated dial for normal coverings of 1.5-9 Mc/s, but may actually be used from 800 kcs. up to 50 Mc/s. Complete with 500 kHz, Crystal 2 valves type IT1. 1 or 1½ and 1 of CV100 (Sodium Stabilizer), and Instruction Book. Size 9in. x 7½in. x 4½in., weight 56lb. Used but in first class condition. ONLY 62/19/6. Carry 9/6.

POWER UNITS TYPE 234

Primary 200/250 v. 60 cycles. Outputs of 350 v. 100 mA., and 63 v. 4. range. Fitted double smoothing. For normal rack mounting for bench use having grey front panel size 19in. x 7in. BRAND NEW. ONLY 19/6.

ALSO POWER UNIT TYPE 2. Specification as above, but has two meters included on front panel to read Voltage. BRAND NEW. ONLY 19/6 (carriage 6d).

12 VOLT'S AMERICAN DYNAMOGRAP. Delivers 250 volts at 100 ma. Size 4½ in. x 5½ in. Diameter. Ideal for no. Radio and Electric Shaver, etc., from car battery. ONLY 30/-.

MARCONI SIGNAL GENERATOR TF 144G/7. Coverage Radio and Electric Shaver, etc., from car battery. ONLY 12 VOLS. AMERICAN DYNAMOGRAP. Delivers 250 volts at 100 ma. Size 4½ in. x 5½ in. Diameter. Ideal for no. Radio and Electric Shaver, etc., from car battery. ONLY 30/-.

W 119A WAVEMETER

Crystal controlled heterodyne frequency meter covering 100 kcs. to 20 Mc/s. In 8 switched bands and is virtually the British NCT21. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Tubes, and full set of spare parts. BRAND NEW IN ORIGINAL TRANSIT CASES. ONLY 20/19/6 (carriage 1/-).

CANADIAN RECEIVER No. 52

A magnificent 10 valve Receiver covering 1.75-18.0 Mc/s. (19-170 metres) in 3 switched bands. Has built-in 3 valve Crystal Calibrator employing deal 300/1,000 kcs. Crystal to pass across check points at 20-100-1,000 kcs. Other refinements include Valve-each Voltmeter, Internal 3in. Speaker, R.F. and A.F. Gain Controls, Noise Limiter, R.F. P.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 Fast and Slow Tuning Controls, with additional Oscillator Control for Fine adjustment. In steel casing case as illustrated, size 18in. x 12½ in. x 18½ in. First class condition, thoroughly checked and tested, and in perfect working order before despatch. Circuit supplied. Voltage required 220 volts L.T. and 360 volts H.T. ONLY £11/19/6 (carriage etc., 3/6).

A suitable Power Pack, for use on 110-240 volts A.C. or 12 volts D.C., can be supplied (see outer case) for 60/-, plus 5/- carriage.

RAE 8in. P.M. SPEAKER

In heavy black crackled metal case, designed for use with AR 88 Receiver, or any set with 3 ohm output. BRAND NEW IN MAKER'S CARTONS. ONLY 45/- (Post 3/6).

AMPLIFIER N24

Listening 4 valves, 1 each 6A9G, 6790G, 6J6G, 6J5G and high quality components such as "C" Core Transformer and Black Paper Smoothing Condenser. A.C. Main Pack for normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19in. x 7½in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Tubes and Valve Inspection Panel. BRAND NEW IN MAKER'S PACKING. ONLY 45/- (carriage 10/-).

B.E.T. TRANSFORMERS. 7 V (Rect.) with 5 v. 1 a., 7-5 v. 2 a. (Rect.), 7-5 v. 3 a. (Rect.), 15 v. 0-5 a. (Rect.), for V.C.R. 97 tubes, etc., 4/76 (postage 3/- per piece).

SELECTET TESTMETER D111

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 7½in. x 4½in., with carrying strap. Thoroughly overhauled and in perfect order, with batteries and instructions. A real "snip" while they last. ONLY 87/10/- (postage, etc., 3/6).

UNIVERSAL AVOMETER 34 RANGE MODEL D

A versatile instrument, but thoroughly reconditioned and checked, supplied with internal batteries and in instructions. Covers ranges as follows:

<table>
<thead>
<tr>
<th>Output Voltage (V)</th>
<th>Current (mA)</th>
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<tr>
<td>150</td>
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<td>600</td>
<td>300</td>
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<tr>
<td>1,200</td>
<td>600</td>
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ONLY 28/19/6 (Postage, etc., 3/6).
R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only 25½ GNS. Carr. 17/6.

Can be assembled in about 1 hour.

MERELY CONNECT AMPLIFIER TO DECK AND CABINET IN ASSEMBLY KIT. INSTRUCTIONS TO THE LATEST CONVENTIONS. INSTRUCTIONS INCLUDE THE LINEAL LTQ5 HIGH QUALITY FULLY ASSEMBLED TAPE AMPLIFIER. A HIGH POWER 7-WATT LOUDSPEAKER, BEST OF QUALITY TONE. SPARE TONE ARM, Portable Cabinet, Garrard Meter Rectifiers 0-5 mA.

FEATURES INCLUDE

- 3 SPEEDS. FREQUENCY RESPONSE 50-11,000 c.p.s.
- SWITCHED BACK-EQUALIZATION
- 4 WATTS. MAGIC EYE RECORDING LEVEL INDICATOR.
- 2 MOTORS, Fast rewind. TAPE MEASURING AND CALIBRATING DEVICE. TAKES FAST UNWIND AND NOISE FREE 4 SPEEDS.
- TAPE SPEEDS 3 and 5.HZ for HARMONIC SUM.
- EXTREMELY EFFECTIVE AUTOMATIC ERASURE.

Full descriptive leaflet supplied on receipt of S.A.E. (D.C. Supply Kits and wiring diagrams and instructions are supplied with S.A.E., 45/- or ready for use with 59/-)

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Type RM1. An all dry battery eliminator. Size 5.5 x 4.5 in. approx. Completely replaces batteries supply 1.4 v. and 90 µA. 90 µA is available. Suitable for all battery operated receivers requiring 1.4 v. and 90 µA. This includes latest low consumption types. Complete kit with diagram 30/- or ready for use 40½/-

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PUSH-PULL UNIT
EMISSION STAGES
SILICON VALVES, EEM, 618, 6N7S
R.S.C.
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2 a.
6.3 v.
2 a.
6.3 v.
1.5 a.
FRAMED DROP-THROUGH TYPE
300.0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a.
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TOPS
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R.S.C. A10 ULTRA LINEAR
30 WATT AMPLIFIER TYPE A11
PUSH-PULL
ULTRA LINEAR
OUTPUT
"BUILT-IN"
TONE CONTROL
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STAGES
Two input sockets with associated controls allow mixing of "+" and "-" gram, as in 1.0. High sensitivity, includes
5. Köln, EXXII, EXXII
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250-250 v. 50 c/s. 8.3 v. 4 a., 8.3 v. 1.5 a.
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"96" VALVES

KIT PRICE

£6. 6s. 0d.

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Type A. Low Leakage windings. Optional Boost 95% and 110%.

2 volt 10 each

4 volt 10 each

6 volt 10 each

12 volt 10 each

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High Quality. Low capacity, 10/15 pf.

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2 x 20,000, 5%.

50,000 ohms, 1/10.

3,000 ohms, 1/10.

100 ohms, 1/10.

WIRE-WOUND RESISTORS

20,000 ohms.

10,000 ohms.

5,000 ohms.

1,000 ohms.

500 ohms.

100 ohms.

33 ohms.

16 ohms.

8 ohms.

4.7 ohms.

2.2 ohms.

1 ohm.

0.5 ohm.

0.47 ohm.

0.25 ohm.

0.14 ohm.

0.125 ohm.

5 KOH.

470 ohms.

390 ohms.

100 ohms.

22 ohms.

10 ohms.

4.7 ohms.

2.2 ohms.

1 ohm.

0.5 ohm.

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0.47 ohm.

0.25 ohm.

0.14 ohm.

0.125 ohm.

5 KOH.

470 ohms.

390 ohms.
The world famous E.M.I. Angel Transcription P.U.

* (MODEL 17A)
A PICKUP FOR THE CONNOISSEUR ORIGINALLY PRICED AT £17/10/-. WE CAN OFFER THE LAST REMAINING FEW AT £4.19.6
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SPECIAL OFFER FOR 1 MONTH ONLY

8 WATT Push Pull MONOAURAL AMPLIFIER
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This well-known Plessey 3 ohm Tweeter at our amazing price of . . .
12/6 TAX PAID
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Cost £8/15/-. Brand new.
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NOT GOVT. SURPLUS
½ H.P. 220-250 A.C. motor, ideal for lathe, coil winder, drill, saw motor, etc. Don’t miss it.
Dimensions: 6½ x 3½
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WHY NOT VISIT OUR NEW SHOWROOM. LARGEST WALK AROUND IN LONDON. 1 min. South Wimbledon Tube.
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JULY, 1960

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ALL PARTS AVAILABLE SEPARATELY.

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<th>Model</th>
<th>Price ($)</th>
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<td>NEW LOOK &quot;RAMBLER&quot;</td>
<td>all dry s/het portable</td>
<td>7.50</td>
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<tr>
<td>RAMBLER</td>
<td>Mains Unit (suits most portables)</td>
<td>8.00</td>
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<tr>
<td>ECONOMY FOUR</td>
<td>T.R.F. Mains Receiver</td>
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<td>ECONOMY FOUR</td>
<td>with New Look Cabinet</td>
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<tr>
<td>FAMILIY FOUR</td>
<td>(our new T.R.F. Receiver)</td>
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<td>SUPERIOR FOUR</td>
<td>(four valve mains receiver)</td>
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<td>JASON F.M. Tuner</td>
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<td>16.50</td>
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<td>Fringe area JASON F.M. Tuner</td>
<td>FMT2</td>
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<td>JASON &quot; MERCURY &quot; Switched F.M. Tuner plus ITA/R.B.C. Sound</td>
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<td>R.C. 3/4 Watt Amplifier (with Bass, Middle and Treble controls)</td>
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<td>2-amp. Battery Receiver</td>
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<tr>
<td>R.C. Transistor/Crystal Receiver (phones extra)</td>
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<tr>
<td>R.C. Super Transistor/Crystal Rec. (ditto)</td>
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<td>R.E.P. 1-valve Battery Receiver</td>
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<td>&quot; CRY-BABY &quot; ALARM (Baby Alarm)</td>
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<tr>
<td>MULLARD 510 Amplifier (printed circuit) Ultra Linear Version</td>
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<tr>
<td>MULLARD 510 as above plus input selector and spare power supplies</td>
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<tr>
<td>&quot; DE-LUXE &quot; Printed Circuit Superhet</td>
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<td>MULLARD TYPE &quot; G &quot; Tape pre-amp.</td>
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<td>JASON W11 Wobbulator</td>
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<td>18.00</td>
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<tr>
<td>NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinets</td>
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<td>19.90</td>
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<tr>
<td>NEW JASON FRINGE F.M. TUNER FMT3, as above</td>
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<tr>
<td>PULLIN 6 Transistor Meter</td>
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<tr>
<td>R.C. Super Personal Portable 1-valve (phone extra)</td>
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<tr>
<td>R.C. Super Personal Portable 2-valve (phone extra)</td>
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<tr>
<td>R.C. TRANSJETE 2-Transistor Personal Portable</td>
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<tr>
<td>JASON EVEREST 6-Transistor 2-wave Portable</td>
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<tr>
<td>JASON EVEREST 7-Transistor 2-wave Portable</td>
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<tr>
<td>Computer Multimeter Test Meter</td>
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<td>20.00</td>
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<td>GAR RADIO, Printed Circuit, 2-valve Superhet</td>
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<tr>
<td>JASON Audio Generator AG10</td>
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<td>JASON Oscilloscope OG10</td>
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<td>WAVEMASTER &quot; 7-Transistor Luxury Portable</td>
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<tr>
<td>GOLD STAR &quot; De-luxe 1-valve Portable</td>
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Instruction Books which contain full description, easy-to-follow practical wiring diagrams, theoretical diagrams, itemised price lists, etc., are free of charge with all parcels but may be purchased separately as shown above.

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT

To build yourself Medium and Long Waves—Flash Pull Superhet A.V.C.

Perfect Car Radio reception. Size 10in. x 6in. x 4 1/2in. at base tapering to 4in. at top.

Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. Weight—complete with long-life 7J volt battery—4 lb. & 4ft. Made.


SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—£10.19/6 plus 2/6 P & P. Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately, 2/6, post free.

Our advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited. Please print your name and address!
VISIT OUR FULLY EQUIPPED HI-FI SHOWROOM AT TOTTENHAM COURT ROAD FOR THE PREMIER SELECTION OF THE LATEST HI-FIDELITY EQUIPMENT BY ALL LEADING MANUFACTURERS

GLYNE RADIO ELECTRONIC ORGAN

Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may now be heard and seen, at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, key-boards, chokes, etc., are available ready made. Full constructional details are available In book form at 15/- plus 1/6 per p. We shall be happy to forward a complete parts list on receipt of a stamp. Please address all organ enquiries for the attention of Mr. L. Roche

RECORD PLAYERS

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

DECCA PORTABLE AMPLIFIER. As supplied in famous DECCA-MATIC. Complete with small cream knobs. Full 'Aural' in sound. Controls. Employs ECL82 valve. Size 8 x 3 x 14in. Only 1.9/- plus 6/6 P. & P. SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker 3B/- plus 5/- P. & P. fit.

SUPER ATTACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment. 75/- plus 5/- P. & P. Note: If both items purchased together they will be supplied at the special inclusive price of £8/7/6 plus 6/6 P. & P.

EXTRA SPECIAL OFFER I

A small three-valve PORTABLE RECEIVER CORD-PLAYER AMPLIFIER modelled on baffle 12 x 7in., with High Flux 6J7in. Loudspeaker. Valve line-up ECC83, EL84. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. 75/- plus 5/- P. & P. In stock.

NEW STYLE CABINET finished in two-tone leatherette. Will accommodate above model without modification, also most types of Ancillary Equipment. Overall size 18 x 13 x 8in. Fitted with carrying handle. £3/6/- plus 5/- P. & P. NOTE: If both items purchased together they will be supplied at a special inclusive price of £8/7/6 plus 6/6 P. & P.

TWO-TRANSISTOR PERSONAL PORTABLE. This is an amazing little receiver with built-in serial, and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. Supplied with drilled chassis and colour 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, writing wire and even solder, ONLY 44/- or complete with standard High Resistance earphone at ONLY 62/6, Plus 1/6 P. & P. Parts price list and easy Lay-out plan x 2/- post free.

SUPER PERSONAL PORTABLE. A wonderful little set that you can take anywhere. Covers Medium waveband 200-500 metres. Can be built in an 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 x 2/- post free. Extra for use with the above DLRS balanced armature headphones, 1/6 pair.

SUPER MAGNETIC RECORDING TAPE SPECIALS I | I Trade enquires invited First delivery Famous American neodymium Accents Base High Quality Recording Tape. An enthousiast's "must." Brand new (NOT SUB-STANDARD), Sin. 400ft. 16/4, Sin. 900ft. 18/4, 5in. 1,200ft. 23/4, 7in. 1,200ft. 25/-, 7in. 1,500ft. 35/-, Professional quality "MYSTIC" Ext. Du Pont Sin. 1,200ft. 37/4. 7in. 1,800ft. 44/-, 7in. 2,400ft. 51/4, 7in. 3,000ft. 50/-, each on plastic spool, P. free.

LATEST B.S.R. UA4, 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6, plus 3/- P. & P.

B.S.R. UA8 MONARCH, 4-speed Mixer Autochanger complete with turnover crystal insert and sapphire stylus. Built-in turntable. 12/6, Plus 3/- P. & P. B.S.R. UA8 MONO-AURAL. Few only at £7/19/6, plus 3/- P. & P. Brand new, Fully guaranteed.

No. 38 AFV WALKIE-TALKIE. A wonderful offer. This famous transceiver-unit, with relay operated SEND/RECEIVE switch covering 4.9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/- plus 2/- P. & P. Send for details. Quantity export inquiries welcomed.

LATEST COLLARO STUDIO B.S.R. MONO-AURAL. £7/19/6, plus 3/- P. & P. Brand new, Guaranteed.

AMPLIOVOX 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 6/- P. & P.

ACOS MIC 39-1. Crystal stick microphone. List price 5/- Our price 37/6 plus 1/6 P. & P.

TAPE RECORDER AMPLIFIER for use with Collaro Studio Transcriber. Size 11 x 5 x 3in. Uses 3 valves, magnet eye, contact cued metal rectifier. Incorporates mike/gram/radio inputs, Ext., L.S. socket, etc. £3/6/- plus 3/- P. & P. Complete with matching knobs (Gold/Black). Circuit etc. Post 3/-.

LATEST B.S.R. "MONARDED," Single speed Tape Deck. Takes 5in. spool—21/2 i.p.s. At £4/19/6 only plus 5/- P. & P.

GLYNE RADIO LTD.

WIRELESS WORLD

JULY, 1960
DEPENDABLE RADIO SUPPLIES LTD.

12a TOTTENHAM STREET, LONDON, W.I. (Guaranteed Goodbye Street Station. Op. Healt in Tottenham Court Road)

Phone LN/Na/n/3 791/2. Hours of Business 9-6. (Mon. to Fri.)

Callers welcome.

Terms: Cash with order or C.O.D.

POST OFFICE RELAYS TYPE 3,000

BUILT UP TO YOUR REQUIREMENTS

Type 606 also available

COMPONENT PARTS ALL PLATED

Yokes, 3/each, Top plates, 3d. each, Fixing Screws (with Armatures, 8d. each, Bottom Plates, 3d. each, insulators), 2d. each.

Adjustable, 1/3 each, Spindles, 1/3 each.

Build Ups, contact to order.

COIL VALUES

Build Ups Contacts

Silver Plating

Single Twin

1. C/O 1/3 4/3 Up to 100 Ohms 3/- 5/-

2. C/O 2/6 5/6 500 ohms 6/- 9/-

3. C/O 3/12 8/12 1,000 ohms 7/- 10/-

4. C/O 4/- 16/- 2,000 ohms 9/- 15/-

5. C/O 5/- 24/- 5,000 ohms 11/- 18/-

6. C/O 6/- 32/- 10,000 ohms 13/- 20/-

Other build ups to order; all types of relays built to order specification.

*Slugged coils extra.

SIEMENS HIGH SPEED C/O RELAYS

250-1,000 ohm Twin Coils 6/6 1,000-1,500ohm Twin Coils 10/6

850-1,550 6/6 1,700-1,900 17/6

G.E.C. MINIATURE SEALED RELAYS

No. Other Build Ups Voltage Price

Z300001 3 10 1/3 4 C/O 4/3 24 6/6 17

Z300005 10 10 1/3 2 C/O 2/6 24 6/6 17

Z300006 20 1/3 2 C/O 2/6 24 6/6 17

Z300008 670 1/3 2 C/O 2/6 24 6/6 17

Z300010 10 1/3 2 C/O 2/6 24 6/6 17

Z300014 12 1/3 2 C/O 2/6 24 6/6 17

Z300015 20 1/3 2 C/O 2/6 24 6/6 17

Z300016 10 1/3 2 C/O 2/6 24 6/6 17

Z300018 250 1/3 2 C/O 2/6 24 6/6 17

Z300019 1 1/3 2 C/O 2/6 24 6/6 17

Z300020 2 1/3 2 C/O 2/6 24 6/6 17

Z300021 3 1/3 2 C/O 2/6 24 6/6 17

Z300022 4 1/3 2 C/O 2/6 24 6/6 17

Z300023 2 1/3 2 B/M 2/6 24 6/6 17

Z300024 1 1/3 2 B/M 2/6 24 6/6 17

Z300025 1/3 2 B/M 2/6 24 6/6 17

Z300026 2/6 2 B/M 2/6 24 6/6 17

Z300027 4/6 4 B/M 2/6 24 6/6 17

Z300028 6/6 6 B/M 2/6 24 6/6 17

Z300029 18 6/6 6 B/M 2/6 24 6/6 17

Z300030 24 6/6 6 B/M 2/6 24 6/6 17

Z300031 10 1/3 2 B/M 2/6 24 6/6 17

Z300032 12 1/3 2 B/M 2/6 24 6/6 17

Z300033 20 1/3 2 B/M 2/6 24 6/6 17

Z300034 24 1/3 2 B/M 2/6 24 6/6 17

Z300035 50 1/3 2 B/M 2/6 24 6/6 17

Z300036 75 1/3 2 B/M 2/6 24 6/6 17

Z300037 1,000 1/3 2 B/M 2/6 24 6/6 17

Z300038 1,500 1/3 2 B/M 2/6 24 6/6 17

Z300039 2,000 1/3 2 B/M 2/6 24 6/6 17

Z300040 3,000 1/3 2 B/M 2/6 24 6/6 17

Z300041 4,000 1/3 2 B/M 2/6 24 6/6 17

Z300042 5,000 1/3 2 B/M 2/6 24 6/6 17

Z300043 6,000 1/3 2 B/M 2/6 24 6/6 17

Z300044 7,000 1/3 2 B/M 2/6 24 6/6 17

Z300045 8,000 1/3 2 B/M 2/6 24 6/6 17

Z300046 9,000 1/3 2 B/M 2/6 24 6/6 17

Z300047 10,000 1/3 2 B/M 2/6 24 6/6 17

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141-414D 700 24 17/6 19

4114C 170 24 17/6 19

1/6 Post & Packing on all relays.

Send for lists.

ROTARY TRANSFORMERS

Delivery ex stock. Quotations on application.

As supplied to Government Departments and leading manufacturers. NEW AND BOXED.

Type 2, 12 v. input 375 v. 110 mA, output 500 v., 26 mA, output.

Type 2, 12 v. input 375 v. 110 mA, output 500 v., 50 mA.

Both types dual output. Made in U.S.A.

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July, 1960

WIRELESS WORLD
REMOTE VIEWING UNIT

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. Outerplate with tinted screen and gridplate. Ideal for convenient positioning of monitor screen when bench space is limited. 3 FP7 CRT (Long Persistence green-yellow trace, 0.3 v. heaters) and valves worth the price. £1 carriage paid.

VARIABLE SPEED HYDRAULIC GEARBOX

This specially made oil-filled casing houses a hydraulic torque converter version unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. This specially made oil-filled casing houses a hydraulic torque converter. High quality materials completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.

BATTERY POWER PACK

Three modern low-consumption miniature valves in a very sensitive hi-fidelity circuit that only requires the addition of a single tuned input circuit and a crystal diode to bring your favourite programme in clear and clean. Pre-wound aerial coil on h.p. ferrite rod. Converter 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 a spare for conversion to radio. Kit of parts sold separately—Defal Aid 40/-, Conversion parts 15/-, batteries 5/-, post free.

ETCH YOUR OWN PRINTED CIRCUIT KITS

A few with superficial damage offered unpreserved and less cables, etc. for £12.10.0 plus 15/- carriage.

A modern laboratory standard instrument still in current use

FEATURES

- Vernier tuned, Triple screened, 6-Band coil turret covering 8.9 to 300 Mc/s with 72 ohm output from 100 mV to 1 kW.
- Precision decade ladder and slide wire attenuator calibrated in voltage and power.
- 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 modulating input: 100 V. AC for pilot light.
- Three 40 V. actuated VU meters.
- Tuff 100 V. AC for pilot light.
- Ten 100 V. AC output fused and three 250 mA output fuses. Full wave metal rectifiers. Circuit diagram inside.

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.
Just right for a day's outing! "CONTINENTAL-6" COMBINED PORTABLE CAR RADIO

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.

**TOTAL COST OF ALL COMPONENTS**
- £11 10 0 P.P. 3/6
- Including Cabinet, Battery, Transistors, Car Radio, A.V.C and all necessary items.

**WHEREVER YOU ARE**
"FIRST CLASS IN EVERY WAY"

**NEW FREE ILLUSTRATED LEAFLET AND PRICES**

**MAJOR-3** (Transistor Pocket Radio)
- 5-stage Reflex Circuit
- No Aerial or Separate Antenna Required
- Min. Volume Control
- 2 Ediswan Transistors
- Medium Wave Tuning
- Size 4 1/2 x 3 x 1 1/2 inches
- Personal phone included
- All parts sold separately.
- TOTAL 69/- POSTBOOKLET FREE
- NO AERIAL—NO EARTH
- RESULTS GUARANTEED ANYWHERE

**MAJOR-2** (Transistor Pocket Radio)
- 4-stage reflex, Medium wave; Tunable
- Very sensitive, No aerial or ear required.
- Complete illustrated layout.
- Over 6 months on one battery. 4 1/2 x 3 x 1 1/2 inches
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- ALL COMPONENTS AVAILABLE SEPARATELY.
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**PYE "SCALAMP" GALVANOMETER**
Limited Quantity of these Brand New Guaranteed Instruments.

- Only £15 P.P. 5/-
- SPECIFICATION:
  - 200/250 volt 50 cis. supply or 4 volt 1 amp. dry cell.
  - SENSITIVITY (Typical) 32.5 mm./mA;
  - 1.45 umV/meter for 2 sec.; 150 ohms damping.
- Complete details supplied with each unit.

**VHF TRANS/RECEIVER** TYPE 196C
- 10-CHANNEL CRYSTAL CONTROLLED
- 124.5 to 156 Mc/s COVERAGE
- 9.72 Mc/s IF; BAND WIDTH 23 Kc/s COMPLETE UNIT WITH 21 VALVES
- 14 Volt POWER UNIT BUILT IN. INCLUDES CIRCUIT DIAGRAM. GOOD NEW CONDITION. LIMITED QUANTITY. ONLY £45/- / 6/- CARRIAGE 10/6.

**TRANSMITTER/RECEIVER**
Army Type 17 Mk. II Complete with Valves, Headphone, Headmike and instruction book and circuit. Frequency Range 440 to 61 Mc/s. Tuning approximately 3 to 8 miles. Power requirements: Standard 120 v. H.T. and 3 v. L.T. Ideal for Civil Defence and communications. BRAND NEW.

**CRYSTAL MICROPHONES**
Acos 39-1 Stick Mic. with stand 39/-, P.P. 1/6
Acos 40 Desk Mic. 25/-, P.P. 1/6

**PAKISTAN VALVES, TUBES, VALVES, TUBES AND MINIATURE COMPONENTS**

**HENRY'S (Radio) LTD.**
Opposite Edgware Road Tube Station. PADdington 1008/9.

S HARROW ROAD, EDGWARE ROAD, PADdington, LONDON, W.2
OPEN MONDAY to SAT. 9-6, THURS. 1 o'clock.

FREE LISTS BY RETURN OF VALVES, TUBES, VALVES, TUBES AND MINIATURE COMPONENTS
VOLTAGE REGULATOR—115v.

Relay and motorized Variac control. Suitable for hand or automatic control. Main Input Range 0/120 v. Separate meters for 24 v. d.c. and output reading 0/30 v. 100amps. Contains complete overload cut-out (switch type) and sensitive 4in. moving coil (meter reading type). Handling capacity 9 amps. $25. Delivered Free.

HEAVY DUTY

20 AMP. L.T. SUPPLY UNIT

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 12v/130/700 ampere hours.

Input: A.C. 100/260 volts 45/65 cycles.

Size: 16 x 24 x 32in. high.

In attractive Grey Cabinet. ex Warehouse.

(Circ. diags. and instr. loaned for 10/- deposit).

by S.T.C.

WORLD TELEPHONES

"F" TYPE IN ATTRACTIVE CASE

The best portable telephone ever made. With a range of up to a mile, 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, $6.60/- each. Carr. 12/6.

D) 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: 90 volts 10 amps. D.C.

Input: 900/550 volts A.C.

New and in original cases.

$13.10.0 Carr. 9/6.

AUTO TRANSFORMERS

3kVA. Air Cooled (100%) under-rated. GUARANTEED 230/250 tapped, 12 amps.

5 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.

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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/–.

SUPER POWER AMPLIFIER

Multiple Speaker System

Output: 20 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.

AERIAL MASTS

IMPROVED TYPE 50 MK.II

36ft. HIGH

Kit complete—u/s. 2½in. dia. Tubular steel sections of 6ft. length, top-section and base Plates, guys, and fittings. YOU can purchase this normally expensive MAST for a fraction of the cost. Ideal for temporary or permanent wood carrying mast.

The MAST is easily suitable to take aerials for TV, P.M. and TV, separately COMMISSIONED and has many other uses. Extra 6ft. sections can be supplied at 10/- per section.

$8.10/0 only Carr. 12/6

U.S.A. Type 45ft. TELECOM AERIAL MAST (7 sections, 6ft. 8in. x 2½in., guys, etc.). This entirely complete aerial mast including case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only.

Limited Quantity

36ft TELESCOPIC MASTS


Winds down to 9½.

$35 Carr. 1½/0

ATTRACTION INSTRUMENT CABINET

LIMITED QUANTITY

ONLY

7ft. x 2ft. grey enamel finish.

For housing and protecting equipment. Standard 12in. rock mounting (heavy angle side channels). Sliding half-bearing runners. 2 door (front and back) picture action locking chrome handles.

$26.10.0

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/-.

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ROTARY CONVERTORS.

12 x D.C. input. 230 volts A.C., 150 watts, 20 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, 2½/16 each. P. & P. 1½/-.

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GREATER-THAN-EVER VALUES

268 RECTIFIER UNITS. $10 each. Carr. 17/6.

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Get Finest Value from IRONGATE—England's Leading Equipment Wholesalers

Bulk Buying means LOWEST PRICES. All Equipment is in TIP-TOP condition
STILL NO DEPOSIT ON OUR CREDIT SALES
STereo RECORD PLAYER CABINET
WITH EXTENSION SPEAKER CAbINET
at the amazing offer of
99/6
Portable 1000 Show Model in two-tone colours. Extension speaker cabinet secured in lid. Size 18 x 14 x 8½ in. high. This stereophonic player complete, retails at 35 gns. in the shops today. Ins. & carr. (with order), 6/6, or initial payment plus ins. & carr. of 6/1 and 19 weekly payments of 4/11.

T.V. CHASSIS FOR SPARES
ALL THIS FOR ONLY 9/6
56 resistances including 7 variable controls. 54 condensers including electrolytics. Coils 7 I.F. and R.F. transformers. 15 valve holders (8-B8A, 2-BYV and 3-ocat), 4 transformers- Mains-Output Valve-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. 1½ 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.

RECORD PLAYER CABINET R.P.8.
Balance at 3/11 a week for 20 weeks. This contemporary cabinet in two-tone grey realine is ideal for the modern home. Added attraction is the cream plastic speaker front. Press button lid; lock. Fittings for screw-in legs. External measurements 14 x 18 x 8½ in. deep. Taken a Garrard 121 Mk. 2 or B.S.R. 1A.12. (6½ x 4½ in.) elliptical speaker; our Mk. D.2 portable amplifier. Carr. & ins. 6/0.

REPLACEMENT, REBUILT T.V. TUBES. 12 months guarantee.
17" TUBE £8.10.0 £2 allowed on old tube.
12" 14½ 15" TUBES £5.10.0 £1 allowed on old tube.

DE LUXE TAPE RECORDER CAbINET 29/9

ELLIPSEThICAL SPEAKERS 9½ x 4½ 19/6
SUPER CHASSIS
3/11 per week
Five-valve superhet chassis including: Sin. P.M. speaker and valves. Four control knobs (tone, volume, tuning, switch). Four wavebands with position for gram. P.U. and extension speaker. A.C. Ins. & carr. 7/6. Cash price 79/6

SUMMER SALE! BARGAIN! 17" T.V.'s complete. 19 gns.
Cash, or terms over 20 weeks. (No interest charged). Initial payment 5/1/7 and 19 weekly payments of 15/11. Carr. & Ins. 30/-. 17TV/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.

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A.M. or NATIONAL A.C. or Universal Mains. Five valve ootupal superhet. 3 waveband receiver. P.U. in attractive wooden cabinet. 9½ x 11½ in. Ins. and carr. 4/6.

SALVAGED VALVES. 3 MONTHS GUARANTEE
8d each. 6A7, 6S47, 6S57, 6S77, 12B6E6, EP36, EF37, EF50, EF90, EF101, SP81, T31. 2/9 each. 6F1, 6F12, 6P13, 6F14, 6F15, 6K7, 6L20, 10E1, PEN45, PEN66, T299, UF41. 7/9 each. 6U4, 5Y3, 6AS, 6K8, 9Q7, 9U6, EABC80, EBC88, ECC81, EL38, EZ40, KT36, EZ80.
Post, packing and insurance, 1 valve 7d., 6 valves 1½d., 12 valves 2/6.

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8d each. 6A7, 6S47, 6S57, 6S77, 12B6E6, EP36, EF37, EF50, EF90, EF101, SP81, T31. 2/9 each. 6F1, 6F12, 6P13, 6F14, 6F15, 6K7, 6L20, 10E1, PEN45, PEN66, T299, UF41. 7/9 each. 6U4, 5Y3, 6AS, 6K8, 9Q7, 9U6, EABC80, EBC88, ECC81, EL38, EZ40, KT36, EZ80.
Post, packing and insurance, 1 valve 7d., 6 valves 1½d., 12 valves 2/6.

AMPLIFIERS ALL PORTABLE
12 MONTHS GUARANTEE
MK. D.1.
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8d each. 6A7, 6S47, 6S57, 6S77, 12B6E6, EP36, EF37, EF50, EF90, EF101, SP81, T31. 2/9 each. 6F1, 6F12, 6P13, 6F14, 6F15, 6K7, 6L20, 10E1, PEN45, PEN66, T299, UF41. 7/9 each. 6U4, 5Y3, 6AS, 6K8, 9Q7, 9U6, EABC80, EBC88, ECC81, EL38, EZ40, KT36, EZ80.
Post, packing and insurance, 1 valve 7d., 6 valves 1½d., 12 valves 2/6.

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output leads, 0-270 volts, 2.5 amps. 50 for TERMINAL BLOCKS.

500 Millimeters, 2". MCF/F. SW 12/6, post 3/6.

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### MULTYMETRE

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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 incorporate internal A.C. mains power unit (100-250 v. A.C.) and 12 volts D.C. Vibrator pack. Size 24 x 13 x 17 in. These sets are extensively tested prior to despatch.

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### COMMUNICATION RECEIVER


### LEAD ACID ACCUMULATORS

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### AMERICAN LIGHTWEIGHT HEAD SET

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I.F. 34-38 Mc/s complete with valves PC939 and FC994. Removed from chassis but in working order. 15/- (C & F. P.) knobs 2d. extra. Some tuners less valves 7/6.

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<td>8.8 Me/e.</td>
<td>£10.60</td>
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**Absolutely Complete**

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<tr>
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<td>12&quot;</td>
<td>£3.19</td>
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<td>14&quot;</td>
<td>£6.19</td>
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<td>17&quot;</td>
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**Also 12 5 CH. TV's 55/-**

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Any six valves marked in black type are sold at 80% of List Value.

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Large stocks of special purpose and industrial types available ex stock.

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**New Low Prices**

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<tr>
<th>Model</th>
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<tr>
<td>CVB150</td>
<td>£12.50</td>
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<tr>
<td>CVL150</td>
<td>£15.00</td>
</tr>
<tr>
<td>CVL150</td>
<td>£18.00</td>
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**Free Transit Insurance**

All valves are new or of reconditioned type, and are guaranteed for six months from date of purchase.

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Any six valves marked in black type are sold at 80% of List Value.

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We can offer the following Hi-Fi Amplifiers brand new in sealed cartons.

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RADIO CLEARANCE LTD
Min. Twin Gang .0005 MFG. 251n. x liin. x liin. Spindle Twin Gang 20 pF.
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3. Control System Designers having primarily an Electrical Engineering background, but capable of adapting established circuit designs to suit specific applications.

Positions are available at Junior and Senior levels and your application should state the preferred category together with details of education and previous experience.

All applications will be treated in strict confidence and should be addressed for the attention of the Chief Designer.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED,
Rugby, Staffs.
Interesting vacancies exist at the Feltham Laboratories of E.M.I. Electronics Ltd., for the following:

**TECHNICAL SPECIFICATION WRITER**
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:

Personnel Manager
E.M.I. ELECTRONICS LTD.
HAYES, MIDDLESEX

**ARE YOU A SKILLED AND EXPERIENCED ELECTRONICS TECHNICIAN?**
**DO YOU HAVE GOOD TECHNICAL QUALIFICATIONS BUT LACK INDUSTRIAL EXPERIENCE?**

If you can answer "YES" to at least one of these questions then we should like to hear from you.

We need new test and calibration engineers to help us increase the output of our very wide range of telecommunications measuring instruments. The work requires the understanding of the most modern and varied circuit techniques and embraces all frequencies up to 10,000 M.c.

The posts are permanent and pensionable and will prove attractive to men who believe strongly that there is a real career for them in production.

Call and talk it over if you live close to us at St. Albans. Alternatively, write to Dept. C.P.R. Marconi House, 23/7 Strand, London, W.C.2, giving full details of your education and experience and quoting reference WW 57/395.

MARCONI INSTRUMENTS LIMITED,
Longacres, Hatfield Road, St. Albans.

**RESEARCH LABORATORY**

**TECHNICAL ASSISTANTS**
required by Electronics Section for developing, servicing and maintenance of varied range of electronic apparatus connected with nuclear and thermomuclear research. O.N.C. or equivalent required, but people with adequate experience but not so qualified would be considered. The Laboratory is situated in pleasant rural surroundings near Reading, with fast train service to London.

Apply in writing, quoting Reference No. BL/1/1, to the Personnel Officer, Research Laboratory.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED
Aldermaston Court, Aldermaston, Berks.
ARE YOU A YOUNG AND PROGRESSIVE ELECTRONICS ENGINEER

with these qualifications

O.N.C. Electrical
Experience in the use of digital techniques for counting and data processing.
Have some years of industrial experience, both development and production.
There is a unique position for such an engineer in a new and expanding electronics division which a progressive Company has brought into being to handle a large number of problems involved in the handing of paper and associated documents. This Company is the leading manufacturer of paper handling equipment and can offer a young engineer a bright and secure future.
Write, giving details including age, qualifications, experience and salary required to the Personnel Manager, Vacuumatic Limited, Harwich, Essex.
Housing or accommodation assistance given where possible.

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IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

Opportunities in Radio Engineering and allied professions await the ICS trained man. ICS Courses open a new world to the keen student.

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Build your own 4-valve TRF and 5-valve superhet radio receiver, Signal Generator and High-quality Multi-tester.

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...A WHOLE WORLD OF KNOWLEDGE for the KEEN STUDENT

THE M.O. VALVE COMPANY LTD.
Invites applications from suitably qualified staff for the following:

● CIRCUIT ENGINEERS & PHYSICISTS
  for work on
  ★ MICROWAVE DEVICES
  ★ CIRCUIT APPLICATIONS ENGINEERING

● DRAUGHTSMEN & DESIGNERS
  for work on
  ★ JIGS AND TOOLS
  ★ PLANT DESIGN

Candidates should possess, or be working towards, an H.N.C. Elec., Mech., or Applied Physics, or similar qualification.

Please write, with reference to the position which interests you to:-
G/EC, PERSONNEL OFFICER, M.O. VALVE COMPANY LTD., BROOK GREEN, HAMMERSMITH, W.6.

TRANSISTOR RADIO & T.V. DEVELOPMENT
PERDIO LTD.
invite applications from Engineers

SENIOR age 28-40 to lead T.V. Development Projects. B.Sc. or A.M.I.E.E. and practical experience in current receiver techniques in a senior position. Knowledge of transistor applications an advantage.

SENIORS age 28-40 to control and progress radio development projects. B.Sc. or A.M.I.E.E. and preferably experienced in transistor equipment design.

SENIORS AND JUNIORS to work with minimum supervision on transistor circuit design in the above and other fields. H.N.C. level and experience are essential.

Write stating age, qualifications, experience (in detail) and salary required to:-
A. V. ROE & CO. LIMITED have vacancies for RADIO ENGINEERS in the FLIGHT DEVELOPMENT SECTION AT WOODFORD, CHESHIRE.

Position 1
Applicants should have a recognised Engineering Training—a minimum of 5 years' experience in installation and maintenance of aircraft radio and radar systems—sufficient aircraft experience an advantage, (and ex-Service radio/radar technical training would be suitable).

Position 2
Applicants to assist in aerial development work—a minimum of 3 years' experience of R.F. measurement techniques preferably associated with aerial systems—suitably academically qualified.

Applications should be made quoting Ref. RI33/W, and giving full particulars of age, training and experience to:

The Personnel Manager,
A. V. ROE & CO. LIMITED,
Greengate, Middleton, Manchester

COSSOR RADAR AND ELECTRONICS LIMITED require

RADAR AND NAV. AID SYSTEMS ENGINEERS:
To undertake the initial systems design of new projects and to co-ordinate the design work through to the production stage.

SENIOR DESIGN ENGINEERS:
To be responsible for sections concerned with the design of major items of electronic equipment.

DESIGN ENGINEERS:
To be responsible for the design of electronic equipment, especially in the following fields:

- 3.1 Radar Displays
- 3.2 Microwave components and receiver/transmitters
- 3.3 Data processing

MECHANICAL ENGINEERS:
Experience in the design of electronic equipment for use by the Services is essential.

Engineers with the necessary experience and qualifications are invited to write to:

The Personnel Manager,
Cossor Radar & Electronics Limited,
Elizabeth Way,
Harlow, Essex.

Housing arrangements can be made for selected applicants.


NATIONAL CERTIFICATES IN APPLIED PHYSICS Ordinary National Certificate. Course available to students of 16 and over.
Higher National Certificate. Course available to students with O.N.C., or with suitable passes in G.C.E. Students taking the H.N.C. course at the Northern Polytechnic can proceed to complete the College Diploma course and qualify in this way for Grad. Inst. P.

Enquiries should be addressed to The Head of the Department of Physics.

CENTRAL ELECTRICITY GENERATING BOARD RESEARCH AND DEVELOPMENT DEPARTMENT APPLICATIONS BRANCH (MECHANICAL)

ELECTRONICS DESIGN ENGINEER required in the Rig Design Section to be located at Guildford Power Station. A knowledge of electronics circuitry is of advantage, but it is essential that the engineer appointed be fully competent to carry out the engineering design of electronic equipment to given circuit designs and provide detailed information to draughtsmen preparing manufacturing drawings. The equipment to be designed includes that required for electronic instrumentation of experimental apparatus of many kinds, but the principal responsibility will be for equipment to be developed for automatic control applied to power stations and the grid distribution system. This equipment must be designed to the high standards appropriate to power station practice. Applicants should have several years of relevant experience and proof of capability for independent work, with qualifications of at least H.N.C. or membership of a recognised institution.

The starting salary will be within the range £1,195–£1,775 p.a., or £1,090–£1,300 p.a., according to duties and responsibilities. Applications stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24-30, Holborn, London, E.C.I, as soon as possible. Envelopes should be marked "Confidential Ref. WW/196."
Applications are invited for the post of Senior Superintendent Engineer (Television). The successful applicant will be responsible to the Chief Engineer and will be required to give advice on and 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.

The F.B.C. is inaugurating this service in November 1960 in conjunction with Rhodesia Television (Private) Ltd. who will be responsible for studio engineering and programmes production side.

Applications should have technical qualifications of a high standard and appropriate recent and extensive practical television engineering experience.

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.

There is a contributory pension scheme, medical aid and leave is at rate of three days for each month of service. Free air passage provided for the successful applicant, and assisted passages for his family. The scale of the post will be £2,000 x £60 rising to £2,900 per annum, and entry point, which may be the maximum, will be according to qualifications and experience.

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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Wholesalers and Distributors of Electrical and Electronic Appliances, Household, Etc.
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MALVYN ENGINEERING WORKS
Manufacturers of: Chassis, Small Pressings, Machined Components, Wiring and Mechanical Assemblies, to specification.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
PRODUCTION GROUP
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Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable Instrumentation background.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:
Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland
or
Works Labour Manager, Chapelcross Works, Annan, Dumfrieshire, Scotland.

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CENTRAL ELECTRICITY
GENERATING BOARD
SOUTH EASTERN DIVISION

VACANCY No. 39D/60
ELECTRICIAN (TELEPHONES)
BRIGHTON DISTRICT

Duties consist of installation and maintenance of communications and remote control apparatus together with V.H.F. radio equipment. Applicants must have basic knowledge and experience of automatic telephone exchange apparatus with the G.P.O. or a telephone equipment manufacturer. A knowledge of radio work would be an advantage but is not essential. Rate of pay 5/1d. per hour.

VACANCY No. 9311/60
ELECTRICIAN (TELEPHONES)
NORTHFLEET DISTRICT

Duties as above, the rate of pay 5/5d. per hour including London Allowance.

Both positions are for a 42-hour 5-day week. Sick pay and voluntary superannuation schemes in operation. Applications giving age, details of training, experience, present position, etc., and quoting Vacancy No. should be sent to the Personnel Officer, Central Electricity House, Lower Ham Road, Kingston, Surrey, to arrive by 7th July, 1960.

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Holloway, N.7
North 1666
DEPARTMENT OF PHYSICS
SESSION 1960-61
ADVANCED PART-TIME COURSES IN
ELECTRONICS AND MICROWAVE PHYSICS
ELECTRICAL DISCHARGES IN GASES
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Selected students, with suitable degrees in Physics, following certain of these courses, accompanied by practical work, may be allowed to proceed to the M.Sc. degree of the University of London.

The lectures are not confined to such students, but are open to any working in appropriate fields.

Enquiries should be addressed to:
The Head of the Department of Physics.
NEW ZEALAND—AIR DEPARTMENT

RADAR TECHNICIANS—N.Z. CIVIL AVIATION ADMINISTRATION

Salary: Up to £910 a year depending on qualifications and experience with further prospects of advancement to established positions.

Location: Wellington Airport or Dunedin Airport.

Qualifications Desired: Recent experience in the maintenance of S. and X band ground radar equipment together with 1st Class P.M.G. Certificate or City and Guilds Radio 2 and Tels 2 Certificates or equivalent qualifications.

Duties: Operation and maintenance of Precision Approach and Surveillance Radar installations.

Training: Appointees will be required to undergo approximately three months' training in the United Kingdom on full salary, in the operation and maintenance of radar equipment of the type installed in New Zealand.

Sea passages to New Zealand for the appointees and their families, if any, will be arranged and paid for by the Department. In addition, an allowance will be made towards the cost of transporting personal effects.

Enquiries, mentioning this publication and quoting Reference No. B1I/8/6, 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.
A CIRCUIT ENGINEER
is required by
THE ENGLISH ELECTRIC VALVE CO. LIMITED,
Chelmsford, Essex,
to be fully responsible for the manufacture, maintenance and calibration of test equipment for the gas-filled valve division. It is essential that the successful applicant has a wide experience of pulse techniques, particularly as applied to line discharge modulators. A knowledge of valve manufacture is not required but should be conversant with high voltage power supply systems. The nature of the work demands constant liaison with production sections.

Applications should be sent to:
C.P.S. Marconi House, Strand, London W.C.2, quoting reference WW1590B.

LEO
TRAINING TO BE COMPUTER ENGINEERS
Young men with G.C.E. "A" level in Physics and Mathematics (or equivalent) are offered training to become Electronic Computer Engineers in one of the Maintenance teams of a young and rapidly expanding organisation. This is an excellent opportunity, for men between 18 and 25, to train from scratch to reach positions of responsibility in a rapidly expanding field.

Vacancies exist on the next training course which begins in September. Applicants should write giving personal and education details, and an outline of any experience to—Personnel Manager, LEO Computers Limited, Hartree House, 151a-159a, Queensway, W.2.

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AND
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A leading Company in the Electronics field has a number of openings for Senior Authors to take their place in a substantial team of writers covering all aspects of major Electronic equipment. Vacancies occur particularly in the radar field, but there are openings for those with other experience.

Good salaries are offered for experienced Authors; in the case of those with good technical qualifications salaries will be exceptional.

Please write, giving full details of qualifications, experience and present salary to Box WW 1037, Romano House, 399/401, Strand, London, W.C.2. All applications will be treated in strictest confidence.

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BOLTON TECHNICAL COLLEGE
FULL-TIME ELECTRONIC ENGINEERING COURSE
A three year course in Electronic Engineering is available. Candidates should be at least 16 years of age and have taken, or be taking, General Certificate of Education courses, which include Mathematics and Physics at the Ordinary and/or Advanced level, or equivalent courses in Technical Institutions.

The Institution of Electrical Engineers accepts the College Diploma for exemption from Parts I and II of the Institution Examination. This rapidly developing industry offers new and attractive openings to qualified men, and students who have passed through the course are readily absorbed by industry.

Further particulars may be obtained from the Principal.

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SAUNDERS-ROW LIMITED
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Leaders in Automation and Process Control, invite applications from Instrument Engineers with an Electronic background and experience in any of the following industries,
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for their Technical Sales Department. Successful applicants will specialise in new range of electronic instruments and will investigate future requirements for this new equipment in the Process Industries.
Excellent prospects and salary offered.
Applications to:—
The Sales Director,
Taylor Controls Ltd.,
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NUCLEAR ELECTRONICS
Opportunities exist for aspiring young Electronic Engineers, in the development of nuclear electronic equipment. A thorough basic training in electronic theory is required, but previous experience in this particular field is not essential.
Please apply in confidence to:—
The Regional Personnel Manager
Plessey Nucleonics Limited,
Weedon Road, NORTHAMPTON

ELECTRONICS TECHNICAL WRITERS
Interesting posts available in London to men with sound knowledge of one or more branches of electronics and experience of technical writing.
Holiday arrangements respected.
Full details to Box 110, Mercury House, 20 St. Bride St., E.C.4.

ULTRA
HAVE YOU CONSIDERED TECHNICAL WRITING?
This is addressed, particularly, to young electronic engineers (although age is not a limiting factor) who, for one reason or another, may have decided that they do not wish to continue a laboratory career.
Ultra Electronics Limited have staff vacancies in their Technical Publications Department which include part-time training in technical writing. The course covers all aspects of technical authorship, fitting those who benefit for positions carrying four-figure salaries. Competent technical authors find many openings in the field of publicity.

There are two essential qualifications:
(a) A theoretical electrical/electronic training, although not necessarily to an advanced level. Laboratory experience highly desirable.
(b) A genuine interest in this occupation. It is emphasised that technical authorship does not call for literary elegance or creative imagination. It does require conscientious application to the writing of clear and concise, factual information.
Salaries paid will be in accordance with present abilities but in any case will not be less than corresponding rates for laboratory assistants.
A vacancy exists at present for a
SENIOR TECHNICAL AUTHOR
(section leader)
Electronic background essential.
Applications, which will be treated confidentially, should give details of experience, qualifications, age, and salary desired, and be addressed to the Personnel Manager.
ULTRA ELECTRONICS LIMITED
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International Business Machines, the largest company of its kind in the world, requires Customer Engineers to take responsibility for the installation, maintenance and efficient working of IBM's whole range of electronic computers and calculators and electro-mechanical accounting machines.
Applications are invited to fill the following vacancies:—
COMPUTER ENGINEERS
Applicants (aged 21-30) should be of H.N.C. (Electronics) standard or have a sound background in general electronics, with emphasis on pulse circuitry. A knowledge of computer or calculator techniques would be an advantage but is not essential. Engineers must be prepared to spend a training period in the United Kingdom, France or the United States.
Excellent starting salaries are offered based on qualifications and experience. Prospects of promotion are amongst the best in the United Kingdom.
Preliminary interviews will be conducted at the IBM offices which are located throughout the United Kingdom. Applications should be made in writing to the:
Personnel Manager,
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101, Wigmore Street,
Quoting Ref.: 60/36-60/37.
MARCONI TYPE TF-88A VIDEO OSCILLATORS
Frequency Range 25 Hz to 4000 Hz for sine wave output and 50 Hz to 100 kHz for square wave output, covered in two bands, max. output 2 V. D.C. at 50 Hz, at 20 V. peak square wave. Distortion better than 0.5% at full power. Fully calibrated. Guaranteed. £100 0 0

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Range 1 to 10 mc/s. on fundamentals, extendable to at least 20 mc/s. by using harmonics. Accuracy better than 0.05%. Crystal reference oscillator giving check points every 20 and 200 mc/s. Fully calibrated. PRICED, fully overhauled and guaranteed £75 0 0

CINETELEC R-C OSCILLATOR AND AUTOMATIC FREQUENCY MONITOR
Oscillator output from 10 mc/s to 150 mc/s. with variable accuracy of ±0.5%. Automatic Frequency Monitor will cover the oscillator output from 10 mc/s to 150 mc/s. with a variable accuracy of ±0.1% of the displayed value. Variations of ±0.1, ±1, or ±10 sec. displaying the result on face. Full calibration service. Meets factory specifications. £220 0 0

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MAGNETRONS
420/0, 3,438-9,405 mw; better than 7.3 V; Peak output voltage 22 kV. Peak output power 222 KW. Forced air cooling. £500 0 0

TRANSMITTING TUBES FOR ALL MULLARD AMPLIFIERS
_S S BAND AND_ X _BAND SIGNAL GENERATORS
TR-11, 3,200-3,720 mc/s: Power Measuring Range 20-100,000 mc/s. Accuracy to 5%. Additional variable width, phase and repetition rate. Fully overhauled and guaranteed £150 0 0

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1,000 c/s. Impedance Bridge giving the following ranges: Rms. to 10 k; Rms. to 100 k; D.C. 100 k. Accuracy ±1% except extreme ranges for C & R. Power Supply: 200-250 V. 40-100 c/s. PRICED, fully overhauled and guaranteed £15 0 0

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1 megohm; Power 250 mc/s; Frequency Range 40 to 2,000 mc/s. £55 0 0

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Frequency Range 10 to 10,000 mc/s, extendable to at least 100 mc/s. 15.6 dB. above 1 mV. Output Impedance 7245. Internal Square wave modulation. Frequency Modulation. £90 0 0

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Cables: ELELiow, BIRMINGHAM Supplies of American Wireless Communication Equipment for Aircraft such as BENDIX V.O.R. Type MN-85 VHF 280 crystal-controlled channels radio system incorporating both navigation and communication facilities operating in the frequency range of 100, 0 to 150, 0 mc/s.

RCA Type 710A Signal Generator. Frequency range 370 to 5,000 mc/s. Direct calibration, with accuracy of ±0.5%. Automatic Frequency Monitor will cover the oscillator output from 10 mc/s to 150 mc/s. with a variable accuracy of ±0.1% of the displayed value. Variations of ±0.1, ±1, or ±10 sec. displaying the result on face. Full calibration service. Meets factory specifications. £220 0 0

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AMERICAN FLIGHT INSTRUMENTS such as Air speed, Climb, Fuel, Temperature, Pressure, Horizon, Turn & Slip Indicators, AIRMEN FLIGHT AMPLIFIERS, CONTROL DIRECTIONAL GYROS, etc., etc.
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**RATCHET MOTORS, 12 v.**

1 Amp. (Unisport Motors) 0/9.

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DI41008. Enclosed polarized relay, red type permanently armature. 1 CO. 500 mA maximum. Two 4000 G coils and one 09000 Damping winding. 

**EXTRA SENSITIVE RELAYS**

SIGMA 401 (for equi-split), high speed, 1B 400mA. contact, 2 Amps. 750 coil: operating current 0.05 Amps. Type 3000, 10000 Coil, 6 CO. 

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Type Goli Volts Contacts Price

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321021 3131 3 V. 3 CO. 5 Amps. 1/6 1/6
421012 4131 4 V. 4 CO. 6 Amps. 1/6 1/6
521021 5131 5 V. 5 CO. 7 Amps. 1/6 1/6

**AMERICAN TELEPHONE RELAYS**

**STANDARD TYPE**

Clare A-1012A, 12 V. 200mA. 1 CO. 1 Amps. Contacts, slow release. 

Ditto secondary.

Clare B-1013B, 2500V 11013M 1 Amps.

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