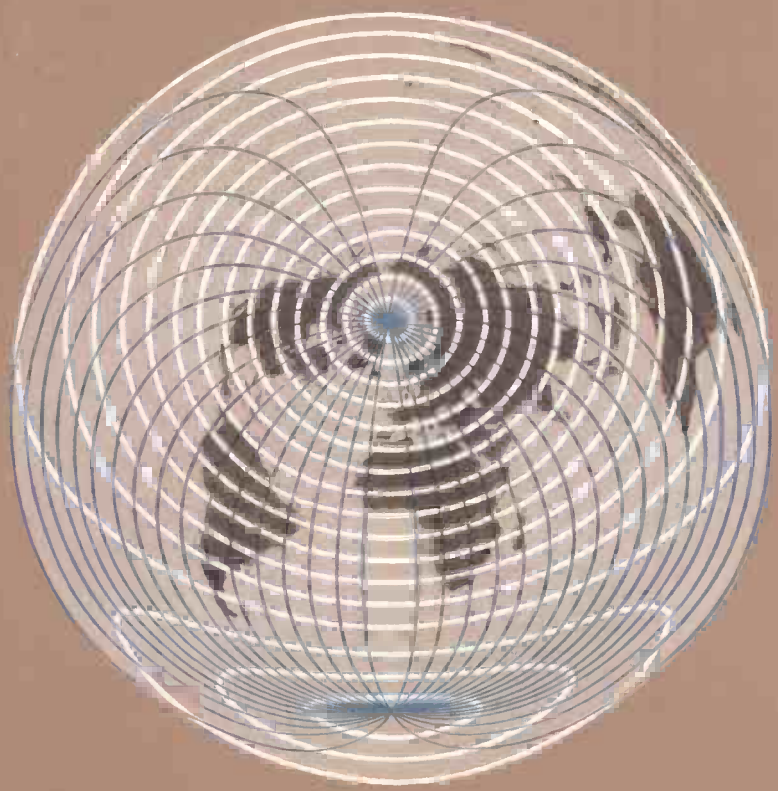
MAY 1958

TWO SHILLINGS

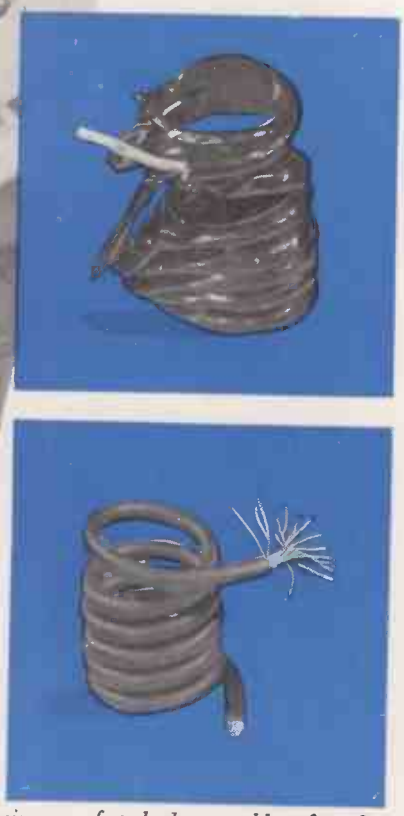
Wireless World

ELECTRONICS
Radio · Television



FORTY-EIGHTH YEAR OF PUBLICATION

Setting up polythene core ready for irradiation.



Specimens of polythene cable after heating at 200°C. Top: Normal sample. Bottom: Irradiated sample.

How we make good cables — better

Take polythene for instance, already noted for its excellent electrical characteristics and widely used in the cable industry.

Then make it stronger, more elastic and improve its temperature characteristics. The result, a better material still.

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Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: F. L. DEVEREUX, B.Sc.

MAY 1958

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MAY 1958

Vol. 64 No. 5

Wireless World

The Status of Electronics

EVER since the term electronics was admitted by common usage to the language attempts have been made to define and circumscribe it—with conspicuous lack of success.

The early American definition as "that branch of science and technology which relates to the conduction of electricity through gases or in vacuo" is now generally acknowledged to have been proved abortive by the advent of the transistor and other semiconductor devices which have resulted from advances in our knowledge of solid state physics. The photojunction transistor is as much a part of "electronics" as the photo-electric cell.

When the Institution of Electronics was incorporated in 1935 the "science of electronics" was referred to as "the study of the electron at rest or in motion, and other kindred subjects"—a definition which is broad enough to have stood the test of time, but is inadequate as a description of electronics as it is tacitly accepted to-day. The only kindred subject specifically mentioned in the memorandum of association of this body is "radio science," and this reflects the view long held by this journal that electronics started as the application of radio-like devices and methods in fields other than those of communication. This view is no doubt shared by the British Institution of Radio Engineers, which devotes a considerable proportion of its time to electronic matters. The Institution of Electrical Engineers cuts the Gordian knot by proclaiming both radio communication and electronics as examples of light-current electrical engineering, and adds considerably to its stature and membership by catering for both. The Institute of Physics recognizes at least one course in the physics and technology of electronics as leading to qualification for graduate membership.

But there are indications that electronics may not be so easily confined within the older technological disciplines. For instance, one sees many advertisements of appointments and situations vacant for electronic(s) engineers; almost as many as for electrical engineers. Even more significant are the advertisements of some of the larger firms, particularly those in the aircraft industry, which invite applications for both these types of post. Presumably the hard-headed business men who pay for these advertisements know what they want, and have good reasons for making a distinction.

Then again there was the shock to our own *amour propre* when we read in a recent book the chapter heading "Electronics in Communication"—the tail wagging the dog with a vengeance!

Which brings us to the point, which we have so far evaded, of saying what we mean by electronics and what entitles a man to call himself an electronics engineer. Any precise definition must be doomed to be as short-lived as a police description of a growing youth, so we will content ourselves with the figurative and say that electronics is a bag of tricks culled from radio, radar and electrical engineering, to which are added from time to time any likely new items from research in pure and applied physics. An electronics engineer is a man who knows instinctively what to pop into the bag for future use, and what to pull out for any given occasion.

One of the most useful assortment of oddments came from wartime radar activities, and with them came that attitude of mind which was unabashed by seemingly insuperable difficulties. There is not one but a hundred "electronics", and as many varieties of "electronics engineers". The good electronics engineer is one who is always willing to shift his ground. While readily acknowledging his debt to the older sciences and technologies, he does not feel himself bound by the rules of any one discipline. He is, in fact, a sort of stateless person, a citizen of the world, who can adapt himself to any industry that has the wit to appreciate his qualities and the courage to give him a free hand.

As to his qualifications, he can be safely left to choose for himself, from the wide range offered, those which he feels will best reflect his own particular bias, or which he thinks will carry most weight with his potential employers.

Asymmetry in Long-distance

IT is not uncommon to find that there is a pronounced seasonal asymmetry in performance on certain long-distance radiotelegraph circuits even when the transmitting and receiving equipment at the terminal stations is substantially identical.

Knowledge of such phenomena is of importance in regard to: (*a*) the general understanding of the factors which determine the proportion of time for which a circuit is of commercial grade; (*b*) the assessment of the performance of new equipment introduced in one direction of a circuit when based on a comparison with the performance in the other direction, in which the terminal conditions have remained unchanged; (*c*) the choice of radio relay sites required to ensure maximum efficiency of communications under peak traffic loading.

In two recent studies [1, 2] of the performance of circuits operating from London to South Africa, Ceylon, Malaya and Australia (short route), seasonal asymmetry in performance has been explained in terms of atmospheric interference. In particular, reference has been made to the decrease in the signal/noise ratio for transmission in one direction which can occur when a distant thunderstorm area, lying in the direction of the main beam of the receiving aerial, reaches its diurnal activity maximum.

The principal thunderstorm areas are known to be associated with tropical or semi-tropical, land masses; and it is to be expected, therefore, that the performance of trans-equatorial circuits, like those mentioned, should be affected by atmospheric noise originating in such areas, particularly at a time of day and season when activity is at a maximum, i.e., during afternoon and early evening of local summer.

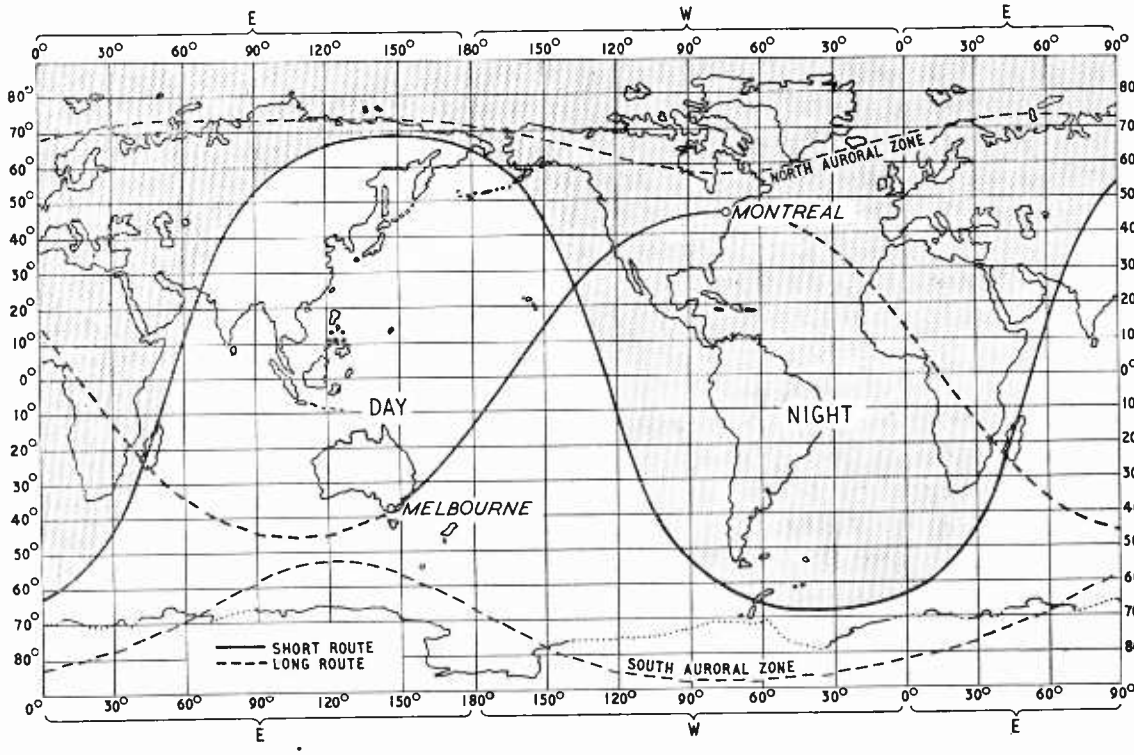
The main purpose of the present article is to examine the performance of trans-equatorial circuits which (in contrast to those previously reported on) are mainly over sea, convenient examples, being those from Montreal to Melbourne (short and long paths). Between these two terminals the short route is over sea in the proportion of 72%, and the long route over sea in the proportion of 64%. The analysis covers the 21-year period 1935 to 1955 inclusive, and the performance data is derived from reports prepared hourly by the operating personnel.

Montreal-Melbourne Circuit Characteristics.—*Use of Short and Long Routes.*—Due to the contrasting conditions of daylight and season associated with this route, the proportion of time for which frequencies in either the upper or lower part of the h.f. spectrum can be successfully used is small, and in consequence extensive use has to be made of intermediate frequencies, for example, those between 9 and 13Mc/s.

Even on such frequencies, however, absorption of the signal under conditions of excessive daylight along the path may be such as seriously to limit the speed of telegraph operation, despite the use of first-class equipment.

Thus difficulties in communication arise in December at about 0230G.M.T., i.e., local noon at Melbourne (see Fig. 1), and in June at about 1700G.M.T.,

Fig. 1 Alternative path conditions between Montreal and Melbourne at 0230G.M.T. (noon, Melbourne) during December.



W/T Circuits

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

Seasonal Variations in Performance on Trans-equatorial Paths Mainly Over Sea

i.e., local noon at Montreal (see Fig. 2), since the amount of daylight encountered is extensive irrespective of whether transmission is directed over the short or long route. The diurnal variation of absorption for the short and long routes for the months of December and June is shown in Figs. 3(a) and 3(b) respectively, from which it will be seen that absorption can be restricted to a minimum by the use of the short route from approximately 0300 to 1630G.M.T., and the long route from approximately 1630 to 0300G.M.T. The above periods conform very closely to the average periods for which each route is in fact used in practice; the actual time of change of route on any particular day is, of necessity, dependent to a large extent on the immediate signal/noise ratio.

Diurnal and Seasonal Changes in Performance.— The diurnal and seasonal performance is shown in Figs. 4(a) and 4(b), from which it will be seen that serious difficulties arose around 0300G.M.T. in December, January and February, and around 1700 G.M.T. in June, July and August. Among other factors contributory to difficulty of communication are the relatively low ionic densities encountered at each terminal of the circuit around local sunrise, necessitating the use of lower frequencies with consequent higher absorption effects. Such periods are approximately as follows:—

Montreal Terminal, 1230G.M.T. December
0900G.M.T. June.
Melbourne Terminal, 1900G.M.T. December.
2130G.M.T. June.

See Figs. 4(a) and 4(b).

* Royal Naval Scientific Service.

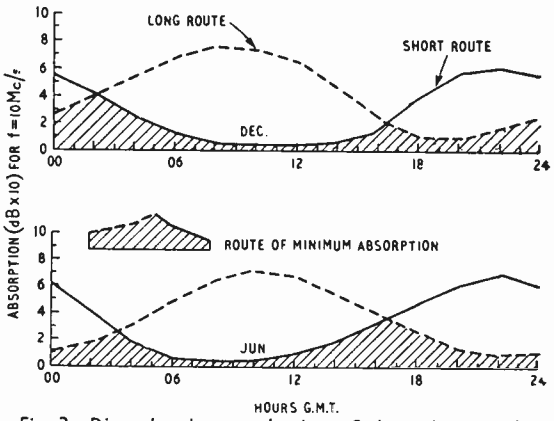
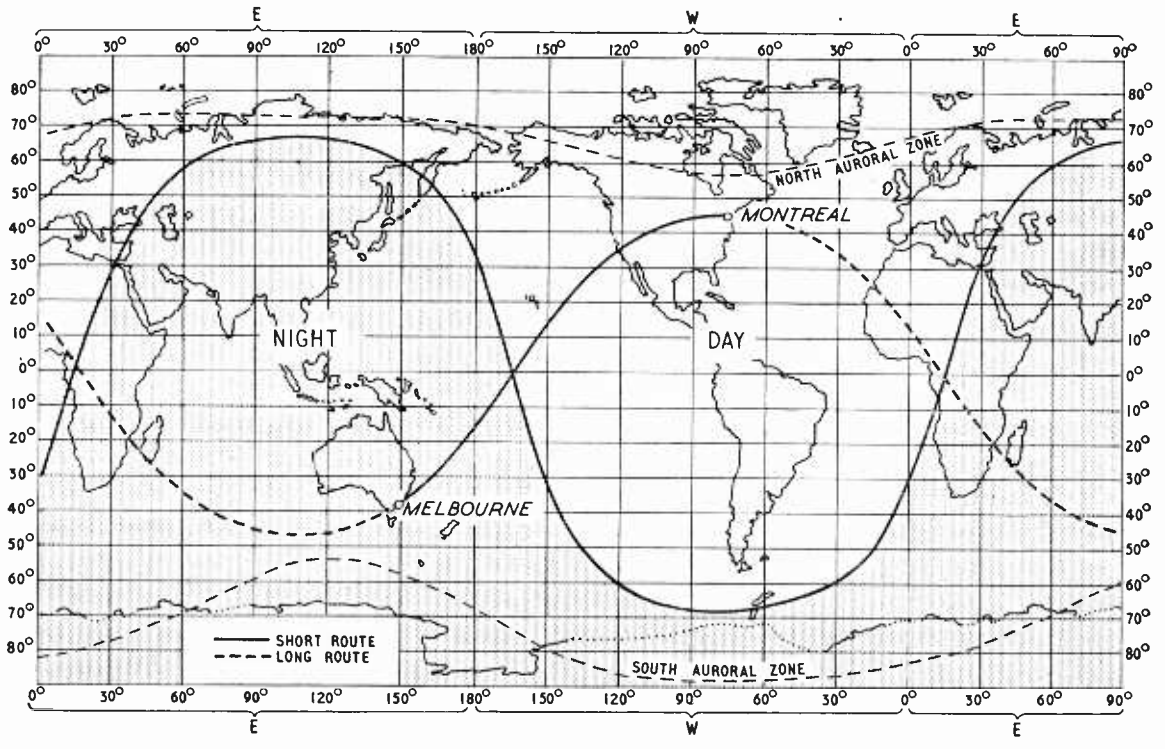


Fig. 3 Diurnal and seasonal values of absorption over the Montreal-Melbourne path.

Fig. 2 Alternative path conditions between Montreal and Melbourne at 1700G.M.T. (noon, Montreal) during June.



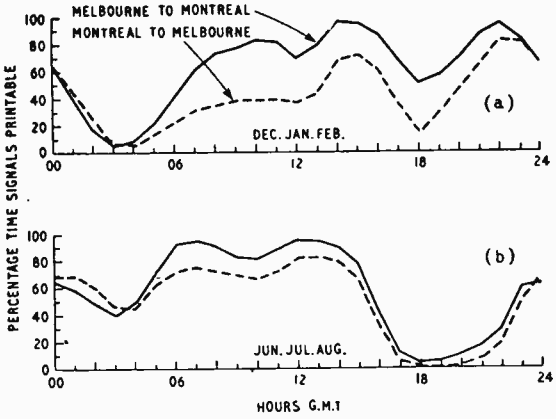


Fig. 4 Diurnal variations in performance over the Montreal-Melbourne path during 1941 to 1955 inclusive.

Asymmetry of Circuit Performance.—*Seasonal Effects.*—The seasonal changes in performance of the Montreal-Melbourne circuit for the period 1935-53 inclusive are shown in Fig. 5, from which it is clear that there is a marked deterioration in the reception of the Melbourne signals at Montreal in the months of June, July and August and a corresponding deterioration in the reception of the Montreal signals at Melbourne in the months of December, January and February.

This deterioration in circuit performance for the direction in which reception is taking place in local summer is in conformity with the local seasonal changes in thunderstorm activity. It is evident from Fig. 4, however, that unlike trans-equatorial circuits mainly over land [1, 2] (see Fig. 6) there is no sharply defined period of the day when such deterioration sets in. Thus there is here confirmation that for paths mainly over sea the absence of any sharply defined period of the deterioration during the day is associated with an absence of active thunderstorms in the direction of the main lobe of the receiving aerial.

In making this interpretation of the data, it may be desirable for the reader to note that the only case where the receiving aerial is pointing landwards is that at Montreal when use is made of the short route to Melbourne. As stated previously, the period concerned is from approximately 0300 to 1630 G.M.T., or late night to forenoon at Montreal, i.e., a period during which not much thunderstorm activity is expected in that region.

Conclusions.—A study has been made of the performance, over a 20-year period, of a Montreal-Melbourne high-frequency radiotelegraph circuit, both the short and long routes of which are predominantly over sea. In so far as the performance of these two routes may be typical of that of other long-distance trans-equatorial radiotelegraph circuits, the routes of which are substantially over *sea*, it may be concluded that such circuits are:—(*a*) subject to a seasonal asymmetry of performance, resulting in a significant fall in the performance in the direction which entails reception in local summer; but (*b*) exhibit no sharply defined hour of onset of such asymmetry, as has been reported for trans-equatorial *land* routes when the main lobe of the receiving aerial is "looking into" an area of land in which atmospherics are generated, and at a time of day when the source of atmospherics (thunderstorms) is most active..

Note.—Asymmetry of circuit performance for both land and sea routes has been less marked during the recent exceptionally high degree of solar activity. One reason for this may be the ability economically to obtain improved aerial polar diagrams at the higher frequencies necessitated by ionospheric considerations. Thus the old-time radio operator's

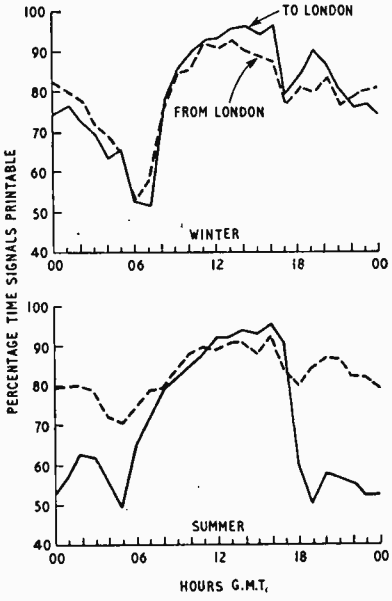


Fig. 6 Diurnal variations in performance of the Capetown-London path during 1951 to 1954 inclusive.
(Reproduced from Proc. I.E.E. July 1956 Part B.)

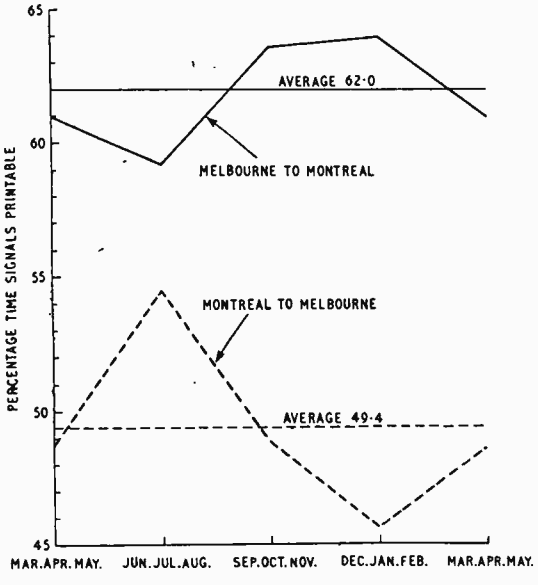


Fig. 5 Seasonal variations in performance over the Montreal-Melbourne path during 1935 to 1953 inclusive.

simple rule that, "if I can hear him, he can hear me" may be more applicable to years of high, than of low, solar activity[3].

Acknowledgements.—The author wishes to thank the Canadian Overseas Telecommunications Corporation for permission to use information relating to its circuits. He also wishes to thank Mr. K. S. W. Maunder of the Royal Naval Scientific Service for his assistance in the preparation of this article, which is published by permission of the Admiralty.

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[1] Humby, A. M., Minnis, C. M., and Hitchcock, R. J.: "Performance Characteristics of High-Frequency Radiotelegraph Circuits." *Proc.I.E.E.* Paper No. 1787R, January, 1955 (Vol. 102, Part B p. 513).

[2] Humby, A. M., and Minnis, C. M.: "Asymmetry in the performance of High-Frequency Radiotelegraph Circuits." *Proc.I.E.E.* Paper No. 2118R, July, 1956 (Vol. 103, Part B p. 553).

[3] Bennington, T. W.: "Is Radio Propagation Always Two-Way?" *Wireless World*, January, 1957, p. 20.

B.B.C.'s VIDEO MAGNETIC TAPE RECORDER

STANDARD grade ½-inch magnetic tape running at 200 inches per second is used in the B.B.C.'s new Vision Electronic Recording Apparatus (called "VERA") which television viewers have recently seen in operation. The method of recording is the straightforward longitudinal one, and 15 minutes of programme can be accommodated in a 20½-inch spool of tape. A complete video recording channel consists of two of the machines controlled from a central desk.

Actually the method of recording is not quite straightforward, in that the incoming 3-Mc/s video signal is split into two frequency bands of 0-100kc/s and 100kc/s-3Mc/s, which are recorded in separate tracks. The high-frequency band is recorded directly, but the low band is used to frequency modulate a 1-Mc/s carrier signal, and it is the frequency deviations of this signal which are carried in the other track. The modulation is only in one direction, so that 1Mc/s corresponds to minimum video amplitude at the bottom of the sync waveform and 400kc/s to peak white.

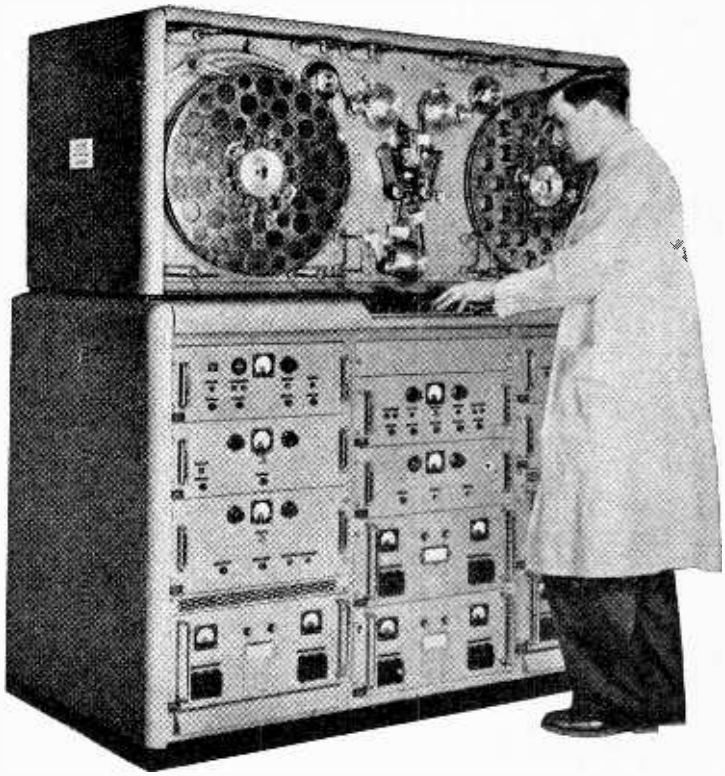
This f.m. carrier system has been adopted mainly to avoid the effects of tape imperfections and spurious amplitude modulation, which experience has shown to be more noticeable in the low-frequency components of the television picture (for example, as fluctuations in large-area brightness). It also avoids the fall-off in low-frequency response which occurs during playback as a result of the slower rate-of-change of flux at low frequencies and the increase of wavelength at the high tape speed. A limiter is used in the f.m. channel just as in f.m. receiving technique. Unwanted amplitude variations also occur in the 100kc/s-3Mc/s video band but these do not noticeably degrade the picture.

The television sound signal is recorded in a third track, and the opportunity has been taken of again using an f.m. carrier system, which simplifies the problem of recording and reproducing the low frequencies at the high tape speed.

Extreme precautions have been taken to maintain constant tape speed past the recording and reproducing heads, since very small fluctuations can cause noticeable horizontal displacements in the reproduced picture similar to line tearing. The initial tape drive is on the spools themselves, with automatic adjustment for the amount of tape they carry. The final drive is from a capstan which operates inside a loop of tape, providing drive for both oppositely moving sides of the loop at once. This system effectively isolates the tape loop from speed fluctations in the spool drive. During recording the capstan drive is synchronized with the 50-c/s mains. On playback its speed is controlled by a servo system which compares the reproduced sync pulses with the station sync pulses and applies appropriate correction signals. A tape speed accuracy of 0.04 per cent is said to be obtained.

The three-channel recording and reproducing heads, which are independent and situated in the tape loop mentioned above, use ferrite cores for efficient operation at the high frequencies. They are surfaced with Mumetal where the tape passes over them and have gap widths of the order of 2×10^{-5} inch. The gap width, of course, in conjunction with the tape speed, is the thing which determines the maximum resolution of the recording system. In terms of frequency response, the equipment is flat to 2Mc/s and falls 3dB at 2.5Mc/s.

For marking editing points on the tape a 30-kc/s burst of signal is switched on to the sound track. This becomes audible on playing back at slow speed.



One of the two machines in a complete video recording channel.

Fourth International Instrument Show

EXHIBITS BY SEVENTY FIRMS FROM TEN COUNTRIES

THIS year's London exhibition, organized by B. & K. Laboratories, Ltd., was substantially larger than last year's. The report must again be confined to apparatus not previously shown; and the nationality of the makers, where not stated, is American.

As in the Physical Society's Exhibition, held concurrently, much of the equipment was intended for applications outside the scope of this journal, but it goes without saying that nowadays many of the techniques are common to all scientific and industrial fields.

Beginning with real "wireless," however, there was a demonstration of the Racal (U.K.) RA.17 communications receiver described in detail in the August 1957 issue. It will be remembered that by virtue of an ingenious tuning system a crystal-controlled frequency range of 0.5 to 30 Mc/s is covered continuously without band switching.

Interference-measuring sets designed by the Post Office, enabling tests to be made in accordance with British Standards, are offered by Union Radio (U.K.). Set No. 1, covering 150 to 400 kc/s and 0.55 to 30 Mc/s, is now supplemented by No. 2 covering 30 to 220 Mc/s, in which piston attenuators are used.

A.f. equipment included a wow meter by Furst Electronics, consisting essentially of an electronic frequency meter. Working from a constant-frequency signal recorded on the appropriate medium, it accepts any amplitude from 0.1 to 250 V and gives direct readings of wow in three ranges: 0.2%, 0.5% and 2% full-scale.

The Peekel (Holland) Type 013.V a.f. RC oscillator is unusual in covering frequencies from 18 kc/s down to 0.14 c/s, in 10 ranges. Both sine and square waveforms, and the choice of balanced or unbalanced output, are provided. The Type 10.V Function Generator (10 c/s to 100 kc/s) uses a back-coupled Schmitt circuit to generate square waves and (by integration) accurate triangular waves. The same firm showed an interesting portable Sound Spectrum Meter, reading sound or vibration levels either flat over the a.f. band or in eight octave bands.

Bruel & Kjaer (Denmark) again showed a very wide range of equipment for determining a.f. characteristics, much of it automatically operated. New instruments included Microphone Amplifier Type 2603, incorporating a number of standard weighting networks for sound level measurements. It was demonstrated as part of a vibration-test set-up A feature is that peak, mean and true r.m.s. values can be read. Roughness Meter Type 6100 was demonstrated measuring the roughness of machined surfaces. A stylus is moved over the surface at constant speed and the irregularity is indicated directly in μmetres and μinches.

To the Advance Electronics phase detector shown last year is now added "Vectorlyzer" Type 202, a useful instrument for measuring vector relations of alternating voltages over the wide range 8 c/s to 500 Mc/s. An accuracy of better than 0.05° is claimed. Besides phase angles, impedances can be measured.

Danbridge (Denmark) showed a 1 kc/s universal bridge, and a pocket-size capacitor tester with a range of 0 to 0.01 μF. This tester works on the tuned-circuit principle in the 0.3 to 1.0 Mc/s range, and enables capacitances to be read *in situ* even when shunted by low resistances.

How far the tendency for digital displays to supersede pointer indication is now going is shown when even a valve voltmeter is included—Kay Electric Model 615. Twelve ranges of direct and alternating voltage and resistance are provided, and the readings are displayed in bold figures, with illuminated decimal point.

Microwave equipment was again very much to the fore. The comprehensive Sivers (Sweden) range of equipment has been extended to include a number of hand and motor operated waveguide switches, for frequencies from 2.6 to 18 kMc/s. Fast action, low voltage standing-wave ratio, and variety of circuit arrangement are notable features. For v.s.w.r. measurements, either manual or automatic, Indicating Amplifier Type SL.5400/3 has been introduced. The ratio is directly and continually shown on the meter.

R.C.A. showed their R.F. Power Meter Type LP-91, consisting of a r.f. power bridge and set of calibrated accessories for frequencies from 1 to 10 kMc/s. It is direct reading over the power range 5 μW to 5 W within 5%.

One of the most useful facilities, especially at microwave frequencies, is a swept-frequency signal generator or "wobbulator." The new Polarad Model ESG is an impressive instrument in this field, covering the wide frequency range of 1 to 15 kMc/s in seven octave bands by means of plug-in units. The electronic frequency deviation is adjustable up to the full width of the unit in use. Maximum signal power available is substantial—up to nearly a watt at the low-frequency end. Frequency, deviation and power are all indicated directly by meters. The oscillator valve is of the backward-wave or carcinotron type.

Some fine examples of microwave "plumbing" were to be seen on the Sivers, G. & E. Bradley (U.K.), Sperry and Demornay Bonardi stands. The last-named display was again notable for the high frequencies covered, now up to 140 kMc/s (2.15 mm wavelength)! The section of some of the waveguides was only $1 \times 2\frac{1}{2}$ mm.

The emphasis in valve displays was also largely on microwave types. Huggins continue to specialize in travelling-wave types, of which a considerable variety were shown. Sperry high-power klystrons are now obtainable for frequencies up to 6 kMc/s. The Raytheon range included carcinotrons, and a new type of crossed-field valve called the platinotron, which can be used as a broad-band amplifier or an oscillator.

One thinks nowadays of oscillographs only in terms of the c.r.t. variety, but a reminder that this

is not the only or original sort appeared in the Brush Type BL-274 Four-Channel Portable Oscillograph, which has four pens for simultaneous recording. Another new data recorder was the Varian Graphic Recorder Model G-10. Although small in size, this instrument records on a large scale, the pen being motor-driven in a servo system.

Although at first glance an orthodox high-performance c.r.t. oscilloscope, the Disa (Denmark) Universal Indicator 51.B00 is unusual in that the deflection is produced by the output of what in effect is an f.m. receiver, driven from an oscillator frequency-modulated by a capacitive or inductive transducer. It is therefore especially suitable for mechanical investigations. The frequency range is 0 to 0.5 Mc/s.

Besides the microwave equipment already mentioned, G. & E. Bradley showed a number of instruments designed for the fighting services, including a crystal-impedance meter (UE.24) for measuring the resistance of overtone quartz crystal units in the frequency range 10 to 140 Mc/s, and an electrolytic capacitor reforming unit (UE.23).

New types of germanium and (especially) silicon diodes and transistors were shown. Sperry miniature (about 2×7 mm) silicon diodes have remarkably high current ratings, for temperatures from $-55°$ to $+200°$C. Two transistor testers were to be seen: one, by Norden-Ketay (BCT-300), is a curve tracer for use with an oscilloscope; the other, by Electronic Research Associates (TT.11A), is for acceptance tests, in which the transistor under test is compared with a standard, the particular test required being put into operation by one of a number of spring-loaded keys.

Some interesting examples of circuit printing were shown by Lares S.R.L. (Italy), notably tuners for multi-channel television and f.m. receivers, which include wafer switches and printed inductors. An entire circuit-etching machine, for rapid automatic production, was exhibited.

Considerable interest, too, was shown in samples of multi-conductor (up to 50) flat cable by the Tape Cable Corporation. The conductors, of rectangular-section copper rated at 1 A, are embedded in transparent polyester tape. In spite of its thinness, the "cable" is rated at 300 V. The capacitance between adjacent conductors is only 5 pF/ft.

BOOKS RECEIVED

Rádio Technology, by Ernest J. Vogt. Course of study designed to equip students for the Federal Communication Commission licence examination for radio operators. Treats radio as an extension of electrical engineering principles and covers telegraphy, telephony, television transcription and facsimile. Pp. 556; Figs. 325. Price 45s. Sir Isaac Pitman & Sons, Ltd., 39, Parker Street, London, W.C.2.

High Fidelity Sound Reproduction. Collection of ten essays: "Subjective and Objective Judgment of Performance," by Graham Higgs; "Acoustics of Sound Reproduction," by James Moir; "Multiple Channel Systems," by M. B. Martin; "Amplifiers and Preamplifiers," by G. W. Tillett; "Dynamic Loudspeakers," by P. D. Collings-Wells; "Loudspeaker Enclosures," by E. T. Jordan; "Electrostatic Loudspeakers," by R. L. West; "Record Reproduction," by S. Kelly; "Tape Recordings," by M. B. Martin; "Radio Reproduction," by R. S. Roberts. Pp. 200; Figs. 151. Price 20s. George Newnes, Ltd., Southampton Street, London, W.C.2.

High Quality Sound Reproduction, by James Moir, M.I.E.E. Treatise on the characteristics of music and speech and the human hearing mechanism leading to an assessment of the requirements of a sound reproducing system and detailed analysis of microphones, amplifiers, disc and magnetic recording systems, loudspeakers, stereophonic systems and the acoustics of rooms. The book is one of a series of Advanced Engineering Textbooks sponsored by the B.T.H. Company and published by Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Pp. 591; Figs. 343. Price 70s.

Gasentladungsröhren in der Nachrichtentechnik. Supplement No. 9 (1957) to *NTZ*. A collection of twelve papers on the use of gas discharge tubes in telecommunications. Pp. 62; Figs. 95. Price DM. 8.50. Friedrich Vieweg & Sohn, Burgplatz 1, Braunschweig, Germany.

Worked Radio Calculations, by A. T. Witts, A.M.I.E.E. Revised second edition with adaptations where necessary to bring into use the M.K.S. system of units. Pp. 155; Figs. 77. Price 12s 6d. Sir Isaac Pitman & Sons, Ltd., Parker Street, London, W.C.2.

Television Interference, Its causes and Cures, by Phil Rand. Illustrated American treatise giving photographs of typical forms of interference distortion and circuit diagrams indicating possible methods of amelioration. Pp. 56; Figs. 91. Price $2. Nelson Publishing Company, P.O. Box 36, Redding Ridge, Conn., U.S.A.

British Standards Yearbook 1958, gives lists and synopses of British Standards specifications, codes of practice, etc., complete to 31st December, 1957. Pp. 515. Price 15s. British Standards Institution, 2, Park Street, London, W.1.

Telecommunications Principles, by R. N. Renton, C.G.I.A., M.I.E.E. Second edition revised to use rationalized M.K.S. units throughout and designed to cover the syllabuses of the City and Guilds examinations Telecommunications (Principles) Grades I, II and III. Pp. 446; Figs. 641. Price 45s. Sir Isaac Pitman & Sons, Ltd., 39, Parker Street, London, W.C.2.

The Economic Development of Radio, by S. G. Sturmey. One of a series of studies prepared by members of the Department of Political Economy of University College, London, showing the factors which have determined the growth of the industry, with special reference to marine radio, point-to-point communications and broadcasting. Pp. 284. Price 30s. Gerald Duckworth & Co., Ltd., 3, Henrietta Street, London, W.C.2.

International Electronic Tube Handbook. Third edition gives principal data on many European and American receiving valves, thyratrons, transistors and cathode ray tubes in semi-pictorial form. Equivalents and near equivalents (including British and American service types) are also given. Introduction is in nine languages. Pp. 334. Price Fl.7.50 (Dutch). De Muiderkring, Postbox 10, Bussum, Netherlands.

Tabellen und Kurven zur Berechnung von Spulen und Übertragern, by Richard Feldtkeller. Third edition gives magnetic data at various audio frequencies for laminations of typical high-permeability materials; and also the inductance and d.c. resistance of coils wound on cores of various sizes and any permeability. Pp. 69. Price 10DM. S. Hirzel Verlag, Stuttgart N., Birkenwaldstrasse 185.

Radio Navigational Aids

DIGEST OF PAPERS PRESENTED AT THE I.E.E. NAVAID CONVENTION

A SYMPOSIUM of aeronautical and marine radio aids to navigation was held at the Institution of Electrical Engineers in London on March 27th and 28th last when eighteen papers were presented dealing with the many contributions radio and radar are making to speedier and safer travel by air and by sea. The Convention was inaugurated by an address by Marshal of the Royal Air Force Lord Douglas of Kirtleside, whose knowledge of both service and civilian aeronautical requirements is probably unrivalled to-day.

The Convention was divided into five sessions, two on the first day and three on the second, the inauguration address being followed by a general review of aeronautical and marine navaids, while the second session dealt with medium- and long-range systems. The three sessions on the second day dealt with range and bearing systems, generally referred to as rho-theta systems; airfield and harbour approach aids with which was included radio altimeters, marine and ground radars. Thus every aspect of the subject was adequately covered.

In this review of the Convention the established and well-known systems such as Decca, radio beacons, radio direction finding (including radio compasses) and surveillance, ship and airborne radars have been omitted in order that the lesser-known systems can be more fully described.

Three papers were devoted to Doppler navigation and although it is one of the latest systems for use in aircraft it was apparently first suggested as far back as 1930. Owing to the scarcity of suitable radio equipment at that time for the very high radio frequencies involved nothing came of it until about 1952 when a prototype equipment was produced for the Royal Air Force.

The basic principles were explained in *Wireless World* (May, 1957) and a description was given of a civilian version of the military model in the August 1957 issue of this journal. Both equipments are pulse modulated and operate in the 8,500 to 9,800Mc/s, or "X," band. Details were given in one of the papers of a new c.w. Doppler system which has been developed in Australia. It is restricted to low power owing to the unavailability at present of high-power klystrons suitable for airborne use. Two fixed pencil beams are radiated downward and to the rear of the aircraft and the high concentration of the available radiated power, coupled with the use of high-sensitivity receivers, enables satisfactory operation up to 10,000ft altitude, and up to speeds of 250 knots, to be effected over water, for which purpose it was evolved. In the subsequent discussion mention was made of an f.m. Doppler c.w. navigation system being experimented with in Canada. With an effective radiated power of 2 watts operation up to an altitude of 60,000ft is possible and the equipment is said to be smaller, lighter and more economical than current pulsed systems.

One of the papers on Doppler navigation gave a table of the failures of components experienced in this equipment and the opinion was expressed that for civil applications considerable improvement in reliability would be required before the system becomes a serious competitor of the simpler types of radio navaid in current service on the world's airlines.

A new navaid for aircraft is "Inertial Navigation." It employs no external reference apart from a departure "fix" and no radio transmission or reception is involved. Although it is not a radio aid it was included in the Convention because it relies extensively on electronic equipment and in its present form is combined with a radio aid of one kind or another. In operation it relies on the measurement of forces constraining a body of known mass when the speed or direction of the aircraft is changed. By means of integrators and computers this data is converted into velocity and position. The basic instruments employed are gyroscopes and accelerometers. Its principal characteristic is that good short-term accuracy at a high rate of information is supplied, but it needs external references for long-term accuracy and for this reliance is generally placed on one of the existing forms of radio navaid, but an alternative independent reference could be used.

A new system of long-range navigation based on the Decca Navigator is under evaluation over the North Atlantic between Newfoundland and the British Isles. Known as Dectra it employs two stations at each end of the 2,000 or so miles of sea route and these lay down a hyperbolic pattern of radiation. Each pair of stations operates alternatively on a single frequency in the 70-kc/s band, the signals being switched from master to slave stations of each pair in time sequence. A local oscillator in the aircraft receiver is held in phase with the master station's signal and acts as a phase reference when the slave station is transmitting. The nearest pair of stations to the aircraft provides the hyperbolic pattern for navigating to the mid-point of the route whence the receiver is retuned to the stations at the opposite end of the route.

Time sharing a frequency between master and slave stations is adopted in preference to frequency diversity as it ensures better correlation in the propagation where ionospheric reflections have to be relied on, as is necessary in the case of Dectra. The two radio frequencies at each end of the route are interrelated so as to provide a further hyperbolic pattern for determination of distance. As signals propagated via the ionosphere are always liable to interruptions the local oscillator in the aircraft receiver must have exceedingly high stability, long-term accuracy and memory and can replace when necessary signals which may fade out for an hour or more. It was said that this is believed to be the first example of a high-stability frequency reference employed in airborne equipment for distance measurements. Mention was also made of a related long-range c.w. system known as Delrac using radio frequencies of the order of

12kc/s and master and slave stations operating in pairs with very long base lines up to 1,000 miles.

Of the various new medium-range navigational systems Tacan seems to be the most advanced in development. It operates from a single site and is a beacon of the interrogator-responder type giving range and bearing to an aircraft provided the site of the beacon is known. It operates in the 962 to 1,213-Mc/s band and allows for 126 clear radio channels to be employed and immediately selected on the aircraft receiver. Up to 100 interrogating aircraft signals can be handled simultaneously by a single Tacan beacon and coded interrogation pulses are employed for identification purposes.

For bearing information a Tacan beacon radiates two signals, one for coarse bearings taking the form of a cardioid pattern of radiation produced by using a vertical stack of dipoles with a cylinder revolving around it carrying a parasitic element in the form of a vertical metal strip. The cylinder, and hence the cardioid, revolves at 900 r.p.m. and in the aircraft receiver this is resolved into a sinusoidal amplitude of modulation at 15c/s. As the rotating cylinder passes through a fixed point, generally true north, a pulse of modulation is superimposed on the cardioid and in the aircraft receiver this is used for comparing the phase of the modulated signal at maximum amplitude with that of the true north marker pulse. From this the bearing is approximately fixed.

Also superimposed on the rotating cardioid pattern is a 135-c/s modulation produced by an outer glass-fibre cylinder rotating about the aerial and having nine vertical parasitic elements. Further marker pulses are radiated every 40° of this cylinder's rotation. The rotating cardioid pattern locates the bearing in one of nine 40° sectors and phase comparison between the peaks of the subsidiary 135-c/s modulation and the second set of marker pulses accurately fixes the bearing within the appropriate 40° sector. Bearings are displayed on an instrument dial.

Distance from the beacon is determined by the well-known interrogator-transponder (D.M.E.) principle by measuring the time interval of a round-trip pulse, allowing for the delay in the beacon's response. In the U.S.A. a compromise version of Tacan is being adopted. This is to enable the existing chain of v.h.f. omni-range beacons (V.O.R.) to be utilized and the common military-civil system is known as V.O.R.T.A.C. This consists of ground installations comprising co-sited or correlated Tacan and V.O.R. beacons. Civil aircraft use V.O.R. for bearings and determine distance by additional equipment compatible with Tacan and known as D.M.E.T. Military aircraft use Tacan for both distance and bearing.

The integration of military and civil requirements has brought in its train a further facility described as "data links." It is a method of passing information from air to ground and ground to air and requires only limited additional equipment in the aircraft and some additions on the ground to transmit and receive a certain number of pre-selected types of message and send quantitative data in both directions. For ground-to-air service additional groups of code pulses are inserted in the normal signal and these carry information in binary group form and by pulse-time modulation. For air-to-ground messages a number of pulse-time modulated groups convey such information as aircraft identity, bearing, distance and speed.

The attempt to reach some sort of compatibility between closely related systems is sound common sense and should in the long run lead to a reduction in the number of radio aids to navigation which differ only just sufficiently to render them non-compatible.

An example of this might be said to be a British system very similar to Tacan and which is known as V.O.R.A.C. being based on the V.O.R. type of beacon and which operates in conjunction with the existing v.h.f. radio telephone equipment in aircraft. Like Tacan bearings are obtained by the rotating cardioid principle with a superimposed star-shaped sinusoidal modulation, but in V.O.R.A.C. the star or "daisy" pattern is supplied by a sub-carrier offset about 50kc/s from the main carrier. Limited distance measuring facilities (D.M.E.) are incorporated by using a two-tone modulation on the cardioid pattern and these are superimposed on the aircraft R/T transmission and returned to the ground beacon where the tones are separated out and used for measuring distance by comparing the phases of the transmitted and received tones. The fundamental difference between V.O.R.A.C. and Tacan is that in the former system distance is measured on the ground and in the latter in the aircraft.

The only significant development in the orthodox form of radio direction finding in recent years would appear to be the commutated aerial system (C.A.D.F.) in which a ring of vertical aerials is used and sequentially connected to the receiver. It is a ground system, of course, and exploratory investigation has been made on the h.f., v.h.f. and u.h.f. bands. One system for use on the 100- to 156-Mc/s band employs 18 unipole aerials spaced round the circumference of a circle 4 metres in diameter and mounted on a wire-mesh "earth" some 14 metres in diameter. Electronic switching incorporating germanium diodes is used to commutate the aerial system. Switching is effected at 50c/s which in effect phase-modulates the received signal at this frequency. The diameter of the ring of aerials, also the signal frequency, plays a part. In effect the commutated aerial system can be likened to a pair of vertical dipoles mounted on a rotating horizontal arm about a half-wavelength long. The phase difference of the signals in the aerials is extracted by splitting the i.f. output in the receiver into two channels, one passing through a delay network with a delay equal to the commutation time between adjacent aerials. By demodulating the two signals in a single stage a sinusoidal output voltage is obtained having a phase dependent on the direction of arrival of the signal. Comparing this with a reference voltage derived from the commutating oscillator provides bearing information.

A commutated aerial u.h.f. direction finder has been developed, similar in basic principles to the v.h.f. one, for use on the 225 to 400-Mc/s band. In this installation the aerial consists of a fixed vertical dipole surrounded by a fibre-glass cylinder carrying several vertical metal strips, the cylinder revolving at 2,400 r.p.m. and thus imparting a 40-c/s sinusoidal modulation to the received signal. Comparing the phase of the demodulated signal with that of a 40-c/s reference voltage derived from an alternator coupled to the revolving cylinder gives bearing information. This is displayed as a radial line on a c.r. tube. Provision is made for receiving R/T simultaneously on the same equipment.

Flip-Flop Stability

EFFECT OF CHANGING VALVES

By T. G. CLARK,* A.M.Brit.I.R.E.

THE article, "Cathode-Coupled Flip-Flop," published in *Wireless World* for January 1958 averred that this circuit, frequently considered to be unpredictable, was in fact predictable. It is the object of this note to offer further experimental justification in support of this statement.

For the purposes of the experiment the circuit of Fig. 1 was used, and the design was based upon the published characteristics of the E88CC. A number of E88CC's were tried in the circuit, both pulse duration and amplitude being observed. Without changing any circuit constants, a number of ECC81/12AT7's were similarly tried. These two valves are quite dissimilar as is indicated by the published parameters shown in Table 1.

Table 1

	E88CC	ECC81
V_a (V)	90	100
I_a (mA)	15	3
V_g (V)	−1.2	−1
μ	33	62
g_m (mA/V)	12.5	3.75
r_a (kΩ)	2.65	16.5

From equation (6) of the original article, reproduced here as equation (1), it may be argued that for stability of pulse duration the logarithmic term should be dominated by stable quantities.

$$t_o = K C R$$

$$\text{where } K = \log_e \left\{ \frac{i_3 + i_1 R_3/R_5 - i_2}{i_3 - i_1} \right\} \qquad (1)$$

$$\text{and } i_3 = E_g/R_5$$

Considering the terms contained in the numerator of equation (1): i_3 is not dependent upon the valve, i_1 is dependent upon the valve but is subjected to control by negative feedback, and i_2 is wholly dependent upon the valve although, by using a diode clamp, this term may also be stabilized. Design considerations require that i_2 should be greater than i_1 and therefore the ratio R_3/R_5 should be made large in order that i_2 should not unduly influence equation (1). In the denominator, there is a stable term, i_3, that can be large with respect to i_1, a feedback controlled term.

As discussed in the original article, i_3 should not be made large by excessive reduction of R_5. Moreover, R_5 has a minimum value dictated by the maximum anode dissipation of the normally-on stage. It was therefore decided to accept a minimum cathode load of 2.7 kΩ and to reduce the anode voltage of V_2 to a suitable value for the E88CC. Keeping E_g at +250V produces a value $i_3 = 92.5$mA. Considering now the ratio R_3/R_5, it was decided initially to try $R_3 = 82$kΩ, thus giving a ratio of 30.4. The value of i_2 was not stabilized for this investigation since the object was to swamp this term if possible.

The following circuit parameters now exist:—

$V_{a1} = +250$V, $V_{a2} = +100$V, $E_g = +250$V,
$R_5 = 2.7$KΩ, $R_3 = 82$ kΩ, $R_3/R_5 = 30.4$
and $i_3 = 92.5$mA

From the published characteristics of the E88CC the following data were obtained:—

$i_1 = 2.6$mA at −1V bias
$i_2 = 16.6$mA at zero bias

$$\text{hence, } K = \log_e \left\{ \frac{92.5 + 2.6 \times 30.4 - 16.6}{92.5 - 2.6} \right\}$$

$$= \log_e (1.72)$$
$$= 0.542$$

Let $t_a = 100$ μs, and C = 180 pF
Then R = 1 MΩ

Since $i_1 = 2.6$mA, this will produce +7V across R_5. Thus the potentiometer formed by R_1 and R_2 must be such as to produce +6V at V_1's grid. Actually the preferred values selected gave a value of +5.7V. A slightly narrow pulse was thus anticipated but this was not of consequence since it was pulse stability that was being investigated.

The results for nine E88CC's, taken at random, are shown in Table 2.

Table 2

Valve No.	Pulse Amplitude (V)	Pulse Duration (μs)
1	50	80
2	50	80
3	50	82
4	50	82
5	50	83
6	52	82
7	51	81
8	52	80
9	50	81

*Decca Radar Ltd.

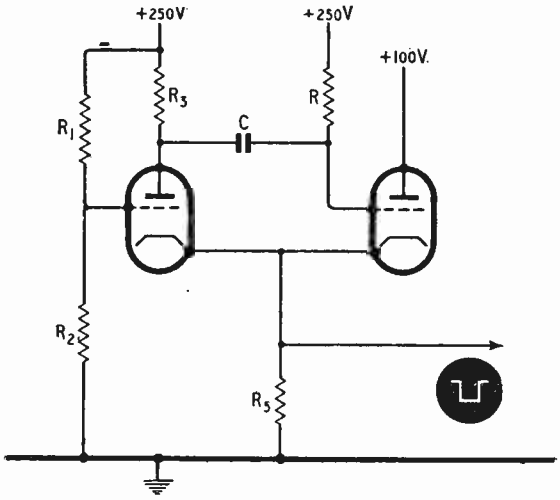


Fig. 1. Basic flip-flop circuit used.

A number of ECC81/12AT7's were then put into the circuit. The results are shown in Table 3.

Table 3

Valve No.	Pulse Amplitude (V)	Pulse Duration (μs)
1	15	95
2	19	95
3	25	90
4	18	91
5	16	95
6	13	95
7	18	91
8	14	95
9	14	90
10	15	91

It is seen that a substantial change of valve parameters caused a change in the mean pulse duration of only 11 μs.

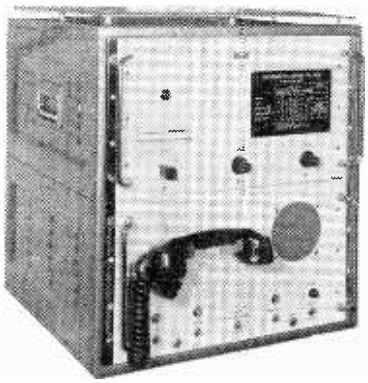
A further test was completed in which the circuit was modified by increasing R_3 to 470 kΩ and modifying R_2 appropriately, other circuit components being left unchanged. Thus R_3/R_5 became 174. It may be noted that for such a value of R_3 the valve V_1 becomes virtually a constant current device for small changes of grid potential.

As before, nine E88CC's and ten 12AT7's were tried. The mean duration for both cases was 125 μs compared with the calculated value of 124 μs; and the maximum spread was ± 5 μs except for two "rogues" giving 112 μs pulses.

The foregoing results adequately demonstrate the original contention. However, it should be appreciated that for the purposes of this exercise the stability of the pulse duration only was the consideration. It may be that other requirements, for example, a high duty ratio, would preclude the use of these methods.

Single-Sideband Radiotelephone

IT is most unusual to find the single-sideband (s.s.b.) system of radiotelephony employed in the smaller kind of commercial transportable communications equipment, but this system is used, with fully suppressed carrier, in the Racal Type TRA55 radiotelephone set. The principal advantages of s.s.b. are that a narrower channel than normally required for double-sideband systems can be used and interference is considerably reduced; but perhaps the most important of them all is that considerably more r.f. power is radiated for a given input power than with orthodox systems. Alternatively the set is smaller for a given power output.



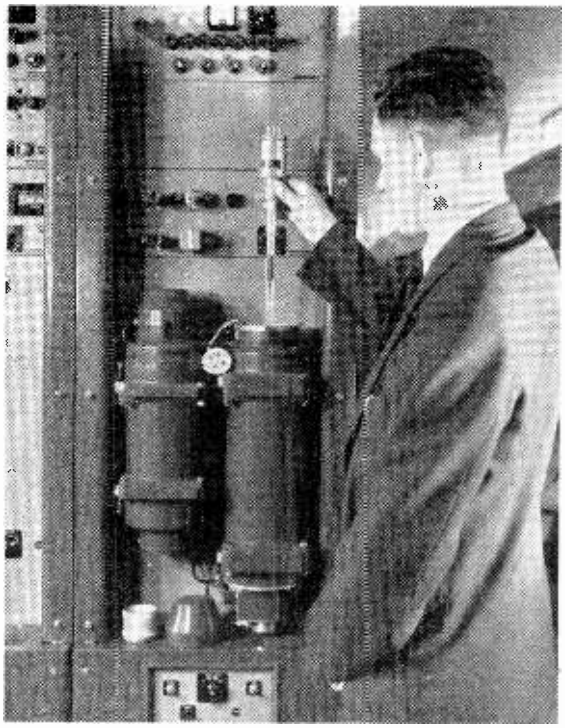
Racal Type TRA55, single-sideband radiotelephone.

The TRA55 is rated at 60 watts output and operates on four crystal-controlled channels, two in the 3 to 6-Mc/s band and two in the 6 to 12-Mc/s band. It is simple to operate, having been designed for use by unskilled personnel, and a single switch simultaneously adjusts both transmitter and receiver to the required channel and leaves the set ready for reception. For transmission a switch in the handle of the telephone-microphone handset has to be depressed. A built-in loudspeaker can be used, if required, in place of the telephone earpiece.

A metal cabinet measuring 20½in × 20½in × 24½in high houses the equipment, which complete weighs 160lb. It is designed for operation on a.c. supplies of 100 to 125V or 200 to 250V, 40 to 60 c/s and the power consumption is 95W on reception and 300W on transmission. It is fully tropicalized and costs £495, less crystals, in the U.K.

The makers are, Racal Engineering Ltd., Western Road, Bracknell, Berkshire.

NEW LINK FOR I.T.A.



Intermediate and output stage travelling-wave tubes in the Marconi Type HM 200 u.h.f. terminal transmitter.

WHEN the I.T.A. East Anglian television service begins in the summer of 1959 it will be connected to London by a u.h.f. link operated by the G.P.O. in the range 1.75-2.3 kMc/s. The terminal equipment chosen is the Marconi Type HM 200, which uses travelling-wave tubes throughout and has a power output of 10 to 15 watts. Intermediate repeaters (Type HM 250) will be used at Ongar Sibleys and Ousden, and the terminals will be at the Museum Exchange in London and at a station between Norwich and Ipswich. The link is designed to carry one television signal of 405, 525, or 625 lines (black and white or N.T.S.C. colour); alternatively it can be used for 600 telephone channels.

WORLD OF WIRELESS

B.B.C. 625-line Tests

EXPERIMENTAL transmissions in Band V, using the 625-line standard with f.m. sound are to begin from the Crystal Palace station on May 5th. It will be recalled that last November the B.B.C. started a series of u.h.f. tests initially using the 405-line standard with a.m. sound. The E.M.I. transmitters installed for this series of tests have now been modified for 625 lines with negative modulation and f.m. sound (±50 kc/s), using a bandwidth of 7 Mc/s. Vision signals will continue on 654.25 Mc/s, but the sound carrier will be changed to 659.75 Mc/s.

The material transmitted during the 405-line tests has been the same as that radiated by the London Band I transmitter, but for the 625-line tests pictures will be produced at the Lime Grove studios by Cintel flying-spot film-scanning equipment and sent by coaxial cable to the Crystal Palace.

The date on which the tests begin was announced by Sir Harold Bishop during an I.E.E. discussion on u.h.f. test transmissions on April 9th. During the discussion several speakers expressed the view that u.h.f. transmitters will need an e.r.p. of 1 or 2 MW in order to provide an adequate signal/noise ratio. One speaker said that it would be possible to cover about 50% of the population with five stations, each of one megawatt e.r.p. Reports from various speakers indicated that low signal/noise ratio and pronounced local variations in signal strength were the main problems in reception.

7,000,000 Components a Day

COMPONENT production in the U.K. is increasing at a rate in excess of 20% per annum, and it is estimated that current production is approximately 7M components every working day.

It is not possible to give an accurate statistical breakdown of component distribution throughout the radio and electronics industry, but the table, compiled from the annual report of the Radio and Electronic Component Manufacturers' Federation, gives a rough guide to the number and value of the components supplied to the major sections.

Industrial Group	Components (M) 1956	Components (M) 1957	Value (£M) 1956	Value (£M) 1957
Domestic equipment	600	725	21.5	25.5
Professional equipment ...	450	525	25.0	28.5
Direct export	275	300	16.0	19.0
Sound reproducing equipment	100	125	6.0	7.0
Other*	75	75	12.5	13.0
	1500	1750	81.0	93.0

* Defence, Replacements and Retail Sales.

The principal overseas market for components is still Australia, but the United States is by far the biggest market for sound reproducing equipment—over £3M worth last year. The second largest purchaser of S.R.E. was Canada (£875,000).

The presentation of the 1957/58 report of the R.E.C.M.F. marks the 25th anniversary of the founding of the Federation with 38 member firms. Output was then approximately 100M components a year, valued at £5M. The output of the present 201 member firms is some 1,750M components a year, valued at over £90M.

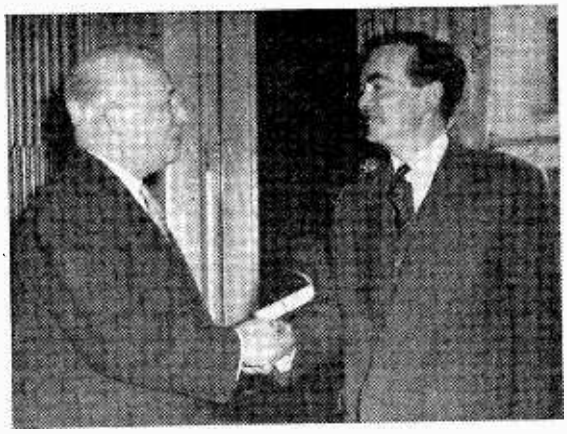
S.E. Coast TV

THE difficulty of providing a television service in the south-east corner of England is being overcome by the B.B.C. by installing two transmitters—one to serve the Dover area and the other Folkestone.

In order to provide a service in the Dover area without delay a temporary station has been installed at Swingate, where the permanent station will be built. Test transmissions in Channel 2 began on April 8th and the station came into service on April 21st. The permanent transmitter will use a vertically-polarized directional aerial, giving an e.r.p. of between 0.25 and 1 kW.

Folkestone will be served by a satellite transmitter, which will re-broadcast signals picked up from another station. It will operate in Channel 4 with horizontal polarization and will have an e.r.p. of 10 watts.

Exhibitions and Conferences.—Since preparing the list of exhibitions and conferences, which will be found on page 249, we have received details of the following: International Swedish Industries Fair, Gothenburg, May 10th-18th, at which emphasis is being placed on sound radio and television (U.K. representatives John E. Buck & Co., 47, Brewer Street, London, W.1); Radio Hobbies Exhibition, Royal Horticultural Society's Old Hall, London, S.W.1, November 26th-29th, organized by P. A. Thorogood, 35, Gibbs Green, Edgware, Middlesex; Industrial Electronics Exhibition, Rutherford College of Technology, Newcastle-upon-Tyne, May 20th-23rd, organized by Farnell Instruments, Ltd., York Road, Wetherby, Yorks.



WRITING PRIZE—E. J. Gargini, A.M.Brit. I.R.E., (right) being congratulated by F. W. Perks (chairman of B.R.E.M.A.) on winning one of the 25-guinea premiums presented annually by the Radio Industry Council. Full details of the awards were given in the preceding issue. Mr. Gargini, who is in the research division of E.M.I. Electronics, Ltd., contributed the article on "An Alternative Colour TV System" which appeared in Wireless World *for August 1957.*

V.H.F./U.H.F. Convention.—The 4th International V.H.F./U.H.F. Convention organized by the R.S.G.B. and the London U.H.F. Group will be held on May 17th at the Prince of Wales Hotel, Kensington, London. The convention and exhibition opens at 10.0. During the afternoon session (from 2.0) three papers will be delivered: "Auroral propagation at v.h.f." by T. R. Kaiser (Sheffield University), "Some problems in u.h.f. broadcasting" by Dr. A. J. Saxton (D.S.I.R.), and "V.H.F./U.H.F. radio-frequency amplifiers and aerials" by C. de Leeuw (Netherlands Govt. station PE1PL). The convention dinner is at 7.0. Tickets, price 3s 6d for the exhibition and convention or 22s 6d including the dinner, are obtainable from F. Lambeth, 21, Bridge Way, Whitton, Twickenham, Middlesex.

Test transmissions, with an e.r.p. of 1 kW, from the site of the I.T.A.'s Chillerton Down, Isle of Wight, transmitter begin on April 28th. They will be radiated in Channel 11 (vision 204.75 Mc/s, sound 201.25 Mc/s) from 10.0 to 12.30 (Mon. to Sat.) and from 2.0 to 5.30 (Mon. to Fri.). These vertically polarized pilot transmissions will continue until early in August when it is expected full-power tests (100 kW e.r.p.) will begin.

I.T.A. In East Anglia.—A site at Mendlesham, near Stowmarket, East Suffolk, has been approved for the I.T.A. East Anglian station. It will serve practically the whole of Norfolk and Suffolk, and by using a directional aerial with maximum radiation (about 200 kW) to the N.W., will have Peterborough on its western boundary. The station is planned to be brought into service in the autumn of 1959.

I.T.A.'s North-Eastern transmitter being built at Burnhope, about five miles south-east of Consett, Durham, is to operate in Channel 8. Its carriers are slightly off-set, the actual frequencies being 189.75675 Mc/s vision and 186.270 Mc/s sound. It will use a directional aerial giving a vision e.r.p. of from 7.5 to 100 kW.

R.E.C.M.F. Council.—The following representatives of member firms of the Radio and Electronic Component Manufacturers' Federation have been elected to the council of the Federation for 1958/59: K. G. Smith (N.S.F.), chairman; Hector V. Slade (Garrard), vice-chairman; C. M. Benham (Painton), E. E. Bivand (S.T.C.), S. H. Brewell (Hunt), P. D. Canning (Plessey), E. M. Lee (Belling & Lee), H. J. Mildren (Colvern), Dr. G. A. V. Sowter (Telcon), G. J. Taylor (Bakelite), W. F. Taylor (T.C.C.) and J. Thomson (Morganite Resistors).

Television-sound licences in the U.K. increased during February by 96,476 bringing the total to 7,994,723, and sound-only licences decreased by 80,714 to 6,662,313 (including 330,238 for car radio). The overall February increase in broadcast receiving licences was, therefore, 15,762, making 14,657,036 at the end of the month.

Presentation of Technical Information.—To encourage the clear presentation of scientific material in a form readily understandable by scientists working in other fields and by laymen, *Research*, the journal of science and its application to industry, is again sponsoring an essay competition. Particulars of the Waverley Gold Medal Essay Competition, as it is called, which offers three prizes (£100 and two of £50) are obtainable from the Editor, *Research*, 4 and 5, Bell Yard, London, W.C.2.

B.R.E.M.A.—The British Radio Equipment Manufacturers' Association, the domestic receiving equipment makers' organization, has moved from 59 to 49, Russell Square, London, W.C.1. The new telephone number is Langham 3586.

British Radio Cabinet Manufacturers' Association recently moved to Audrey House, 5-7, Houndsditch, London, E.C.3. The telephone number is unchanged (Avenue 2707).

Computer Programming.—A summer school in programme design for automatic digital computers will be held in the University Mathematical Laboratory at Cambridge, September 15th-26th. The course will give a basic training in the mathematical use of digital computers, dealing with the processes involved and their embodiment in programmes which specify the operation in detail. Lectures and practical classes will be held in the design of programmes for EDSAC 2. A detailed syllabus and form of application for admission may be obtained from the Board of Extra-Mural Studies, Stuart House, Cambridge. Completed application forms must be returned by June 16th.

Summer schools in instrumentation and automatic control are again being organized by the department of science of the City of Gloucester Technical College. There will be a five-day course on process control (June 30th-July 4th) followed by a five-day course on servo-mechanisms (July 7th-11th). The fee for each course is 9gns.

The first recipient of the Baird Memorial Prize introduced by the Royal College of Science and Technology, Glasgow, in 1955, is D. T. A. Blair, who, having gained a first-class honours degree, is now undertaking a three-year research course at the College. It is announced that the first biennial lecture introduced under the Baird memorial scheme will be given in 1959 by T. H. Bridgewater, superintendent engineer, Television Outside Broadcasts, B.B.C.

Two Fellowships, each worth £1,000 p.a., one at the University of Birmingham and the other at the College of Technology, Birmingham, are being sponsored by the Wilmot Breeden group of companies whose manufacturing interests include electronics as well as motor vehicle and gas turbine components and hydraulics. Particulars are obtainable from the secretary, Wilmot Breeden (Holdings), Ltd., Amington Road, Birmingham, 25.

Patents Information Service.—Instead of the annual publication of the "List of Patents in Force" the Patent Office has introduced a service whereby information will be supplied as to whether any particular patent is in force on payment of 1s for the first patent and 6d for each succeeding one. This is one of the changes introduced under the Patents Rules, 1958 (S.I. 1958 No. 73).

Symposium on R.F. Transistors.—Some 80 engineers and physicists from about 30 firms and other organizations attended the third annual symposium on transistors held at the Borough Polytechnic, South East London, from March 31st to April 2nd. The theme of this year's symposium was the manufacture, design, performance and application of transistors in r.f. and v.h.f. circuits.

More Forward Scatter.—Supreme Headquarters Allied Powers Europe (SHAPE), has called for tenders for the supply and installation of 168 aerials for tropospheric scatter transmission. The approximate value of the contracts will be £3.4M. The installations are to be completed by mid-1960.

Hungary's new 30-kW television station built on a hill overlooking Budapest, is now transmitting daily. Hungarians now have to pay for a television receiving licence costing about 30s a month (about 3 per cent of a factory worker's monthly earnings). A combined television-sound licence costs about 37s.

I.R.E. (Aust.).—Last year the Institution of Radio Engineers, Australia, celebrated the 25th anniversary of its foundation and the December issue of its *Proceedings* is a silver jubilee number. At the end of its first year of operation the Institution's membership was 108, today it is nearly 1,900.

V.H.F. broadcasting is to begin in Hungary this year. Test transmissions have been radiated by a 1-kW transmitter for some time and a new 3-kW station is to be built this year.

Personalities

Sir George Barnes, M.A., D.C.L., has become president of the Television Society in succession to **Sir Vincent de Ferranti,** who retired at his own request in December. Sir George, who was from 1950-1957 B.B.C. director of television, is now principal of the University College of North Staffordshire. He joined the B.B.C. in 1935 and was for two years in charge of the Third Programme.

Hugh Townsend, C.B., B.A., has retired from the International Telecommunication Union which he joined in 1950 as assistant secretary-general. He is 67. For six years prior to going to Geneva he was director of telecommunications in the Post Office, which he joined in 1914, and was for some years a member of the Government's Television Advisory Committee.

K. G. Smith, technical and sales director of N.S.F., Ltd., is the new chairman of the Radio and Electronic Component Manufacturers' Federation in succession to **Richard Arbib.** Mr. Smith, who is also a director of British Centralab, Ltd., and the Motor and Electronics Corp., Ltd., is a native of South Africa but came to this country over 30 years ago. **Hector V. Slade,** M.B.E., managing director of Garrard Engineering, is this year's vice-chairman.

H. F. Wilson, B.Sc., Comp.I.E.E., and **C. L. G. Fairfield,** M.A., M.I.E.E., have been appointed to the board of the Telegraph Construction and Maintenance Co. Mr. Wilson, who will be managing director of the Telcon cables group, joined the company in 1919 and has successively held the positions of chief chemist, technical manager, and works manager of the Greenwich cable factory. Mr. Fairfield, who has been appointed commercial director of T.C.M.C., joined the company in 1953, prior to which he was for six years with Mullard, latterly as manager of the valve division.

Eric Goodhew, M.I.E.E., chief electrical engineer in charge of laboratories at Philips Croydon Works, Ltd., recently completed 25 years' service with the Philips organization. Mr. Goodhew, who joined the service department of Philips at the age of 24, is chairman of the B.R.E.M.A. committee and the B.S.I. sub-committee on safety of sound and television receivers.

C. P. Ginsburg, manager of advanced video-tape development with Ampex Corp., of California, has received the I.R.E. Vladimir Zworykin Television Prize "for pioneering contributions to the development of video magnetic recording." As announced last December, he is also the recipient of the David Sarnoff Gold Medal of the American Society of Motion Picture and Television Engineers.

E. R. Friedlaender, M.Brit.I.R.E., who has been in the radio and electrical industry for the past 20 years, is now in practice as an industrial consultant. For ten years prior to 1955 he was general manager of Trust Accessories, Ltd. (Manchester). Originally the firm produced only h.f. powder cores, on which subject Mr. Friedlaender wrote several papers, but since becoming part of the Hartley-Baird group in 1949 it has made equipment and sub-assemblies for the parent company. Mr. Friedlaender's address is 102, Ealing Road, Wembley, Middlesex.

Dennis G. Packham.—We regret that in the announcement in our last issue of the appointment of the chief engineer of the I.T.A. North East England television station Mr. Packham's name was mis-spelt.

Dr. S. K. Mitra, professor of physics at the University of Calcutta, has been elected a Fellow of the Royal Society. "Distinguished for his researches in many branches of upper atmosphere physics," Professor Mitra, who graduated from the University of Calcutta in 1912 and received his D.Sc. in 1919, has been head of the University's Institute of Radio-physics and Electronics since its formation in 1949. He was for some time (1942-48) chairman of the Government of India's Radio Research Committee and has been chairman of the Calcutta section of the Brit.I.R.E. since its formation in 1952.

Dr. Robert M. Page, the recently appointed director of research at the U.S. Naval Research Laboratory, "carried the bulk of the design work for the first successful [pulse] radar"—a quotation from Guerlac's "Radar in World War II" included in Sir Robert Watson-Watt's "Three Steps to Victory." Dr. Page was formerly director of research for electronics at the Laboratory, which he joined in 1927.

Aubrey Harris, A.M.Brit.I.R.E., recently appointed chief engineer of the Bermuda Radio and Television Company's television station ZBM-TV, was previously for five years with Marconi's, Chelmsford. Whilst at Marconi's he worked on the development of colour television cameras and associated equipment and was in charge of the installation of colour equipment for the B.B.C. at Alexandra Palace. Before joining Marconi's he was for some time at the G.P.O. Research Station, Dollis Hill.

Graham Phillips, Assoc.I.E.E., A.M.Brit.I.R.E., has been seconded by the B.B.C. to the Kenya Government Broadcasting Service as chief broadcasting engineer. He joined the Corporation as a maintenance engineer in 1940 and in 1946 transferred to the overseas section of the Engineering Information Department. In 1952 Mr. Phillips was seconded as chief broadcasting engineer, Uganda, in which capacity he planned and supervised the installation of equipment for the new Uganda Broadcasting Service. Since returning to this country in 1956 he has been attached to the B.B.C.'s Engineering Information Department.

Maurice H. Easy, head of the development laboratories of Decca Radar, Ltd., has been appointed to the company's board of directors. Like many of the original members of the Decca Radar and Navigator companies, he served in No. 60 Group in the R.A.F. during the war, initially in charge of coastal radar stations and later as a specialist radar officer on the headquarters staff. He joined the Decca organization in 1946. **Charles L. Tayler,** marine manager of Decca Radar, is also elected to the board. He has been with the company since its formation in 1950. He was the first post-war Adjutant of the R.A.F. College, Cranwell.

M. H. EASY

C. L. TAYLER

W. H. Grinsted, O.B.E., F.C.G.I., M.I.E.E., director of engineering of Siemens Edison Swan, has retired. After some years with the National Telephone Co. he joined Siemens in 1911 and in 1945 became chief engineer of the telecommunications department. He served on the Telecommunications Advisory Comm.t-tee of the City and Guilds of London Institute for many years and in 1950 was elected a Fellow.

G. G. ROBERTS

G. G. Roberts, technical director of Smiths Aircraft Instruments, Ltd., and **J. E. N. Hooper,** of the Ministry of Supply, were presented with the Musick Memorial Trophy by the New Zealand Acting High Commissioner on March 27th. The trophy, which commemorates Capt. Edwin Musick and his companions who were lost in 1938 on the first commercial flight between New Zealand and America, is awarded annually to the person or group making the most practical contribution to the safety of aircraft, especially in trans-oceanic flights. Mr. Roberts and Mr. Hooper share the award for the work they did on cloud and collision warning radar at the Royal Radar Establishment, Malvern. Mr. Roberts left R.R.E. in 1947 and joined the newly formed guided weapons department of the Royal Aircraft Establishment, Farnborough. He joined Smiths in 1954.

J. H. Mitchell, B.Sc., Ph.D., M.I.E.E., head of research at Ericsson Telephones, Ltd., since 1947, and **F. Limb,** factory manager, have been appointed to the board of the company. Dr. Mitchell was a member of the Bawdsey radar research team in 1936, later transferring to the R.A.E., Farnborough, where he took charge of research on radio aids to navigation. For his contribution to the development of radar installations—particularly beam techniques and Yagi aerials—he received an award from the Royal Commission on Awards to Inventors. Mr. Limb has been with Ericsson since 1925. **Col. J. Reading,** who joined the company as export director on leaving the Post Office (where he was assistant engineer-in-chief) in 1955, has been appointed sales director.

C. L. McAllister, Assoc.I.E.E., newly appointed head of Airmec's sales promotion department, was for 16 years in the Air Ministry where he was concerned with the development of air traffic control systems and navigational aids. During the war he was in the R.A.F. and was for some time on Combined Staffs planning navaid systems in Africa and the Near East. In 1955 he went to English Electric's guided weapons division.

A. D. Zemenides, B.Sc.(Eng.), has been appointed technical manager of G. A. Stanley Palmer, Ltd., agents for the German Resista high-stability carbon and wire-wound resistors and Deac hermetically sealed nickel-cadmium accumulators. Since obtaining his degree at Northampton Engineering College, London, in 1955, he has been a computer programmer at the G.E.C. Coventry Works.

E. W. Durant, technical director of Telerection, Ltd., is on an eight-weeks tour of the United States and Canada. He is making a survey of the North American markets.

H. Fuller, appointed assistant service manager of E. K. Cole, Ltd., has been in the company's service department for 20 years. His industrial career began in 1926 when he joined the Sterling Telephone Co.

T. W. Chalmers has resigned from the B.B.C., which he joined in 1936, to become director of the Tanganyika Broadcasting Corporation. He is 44. From 1950-56 he was seconded from the B.B.C. to the Nigerian Broadcasting Service, of which he was director. Since returning to this country he has been controller, North Region, where he is succeeded by **Robert Stead.**

D. Lindley-Philip, who for the past nine years has been in Ferranti's Edinburgh laboratories, has joined the recently formed Mann Egerton Electronics, Ltd., as manager. The new company is a subsidiary of Mann Egerton & Co., Ltd., of Norwich and London. Whilst at Ferranti's, Mr. Lindley-Philip was responsible for experimental project co-ordination in the radar navigational aid division.

OUR AUTHORS

A. M. Humby, M.I.E.E., who is well known in the field of radio propagation, writes on asymmetry in long-distance W/T circuits in this issue. Since January, 1951, he has been a member of the British Joint Communications Electronics Board (successor to the original Wireless Telegraphy Board). He entered Marconi's in 1920 after war service during which he was appointed battalion signals officer. In 1929 he joined Cable & Wireless as manager and engineer-in-charge of the Bridgwater W/T station and was subsequently for four years on research and development work. Mr. Humby, who is 62, was seconded to the Admiralty in 1941—subsequently joining the Royal Naval Scientific Service—and was for some time officer in charge of the Inter-Services Ionosphere Bureau.

H. N. Gant, A.M.Brit.I.R.E., who describes a Band V receiver on page 244, is engaged on problems of v.h.f. and u.h.f. communication and on the development of equipment for mobile communications and telemetry with E.M.I. which he joined in 1947. He received his technical education in the Royal Navy and at Manchester Technical College and passed the Brit.I.R.E. graduate exam.—gaining the Institute's S. R. Walker prize—in 1943. He is 47.

David A. G. Tait, author of "Direct-coupled Transistor Amplifier," joined the R.A.F. as an apprentice at Cranwell in 1940. He served in various signal establishments until his release in 1953, when he joined the weapons division of Fairey Aviation Co. He is now senior development engineer in the electronic development division of R. B. Pullin & Co.

L. F. Shaw, at present training as an air radar fitter at the R.A.F. establishment at Yatesbury, contributes an article in this issue on a transistorized transmitter. Born in Australia, he travelled extensively before entering on a four-year engagement in the R.A.F. He has been employed by R.C.A. and English Electric in America, A.W.A. and Philips in Australia and Decca and Tannoy in this country.

OBITUARY

Sir James Swinburne, F.R.S., who celebrated his 100th birthday on February 28th, died on March 30th. As mentioned in our centenary notice last month, Sir James was an electrical engineer by profession, but about 50 years ago entered the chemical field, becoming a pioneer in plastics.

William Davies, M.B.E., the first official radio officer appointed by the Marconi Marine Co., has died at the age of 79. A native of Holyhead, he began his career as a G.P.O. telegraphist and joined Marconi's in 1902. He went to sea in the Allan liner *Parisian* in 1903 and can be said to have inaugurated the regular marine radio service. "Billy" Davies served through both world wars and was off Arromanches on D-Day.

News from the Industry

Decca.—In his report on the financial year ended March, 1957, E. R. Lewis, chairman of the Decca group, announced a profit of £1,402,514; an increase of £370,321 on the previous year. After allowing for taxation the net profit was £581,206. The turnover was over £17M, some £4M more than in the previous year. Reviewing the current year he stated that the cumulative total of hire and sale contracts for the Navigator at January 31st was 4,500 units, of which some 1,600 are in fishing trawlers.

Marconi.—The annual reports of both Marconi's W/T Co. and the Marconi Marine Co. show increased profits on the previous year. After deducting all charges, but before allowing for taxation, the group profit was £1,075,938, an increase of £130,020 on the previous year. The turnover of the Marine Co. was a record resulting in a profit of £622,892—before allowing for taxation.

Amphenol (Great Britain) Ltd., formed jointly a few months ago by Gas Purification & Chemical Co. and Amphenol Electronics Corp., of Chicago, has become a wholly owned subsidiary of the American company. On May 1st the company will be moving to a new factory and office premises at Burgess Hill Industrial Estate, Victoria Road, Burgess Hill, Sussex.

British Communications Corp.—"With a view to effecting changes in the organization as a preliminary to the expansion of the company's activities" D. D. Prenn, the chairman, has assumed executive control. He is also chairman of Rola-Celestion and Truvox. J. A. D. Timms and F. P. Nurdin have been appointed to the board of directors. K. Jones, formerly general manager, has left the company.

IBM United Kingdom, Ltd., has appointed Frederick Baillie as works manager of its Scottish plant, where, among other equipment, the IBM 650 computer is manufactured. Mr. Baillie joined IBM in 1955 becoming technical manager last year.

A correction.—In a note on page 172 of the April issue mention was made of a signal tracer and transistorized d.c. voltmeter made by Amos of Exeter. This equipment is handled by Soundrite, Ltd. (83, New Bond Street, London, W.1) and not by RGA Sound Services. It should also be pointed out that the title of RGA Sound Services was changed some months ago to CQ Audio, Ltd.

20th Century Electronics, Ltd., of New Addington, Surrey, recently signed a long-term agreement with Edgerton, Germeshausen and Grier, of Boston, Mass. It provides for the manufacture in Great Britain, under licence, of the E.G. & G. travelling-wave cathode-ray tube and the interchange of technical advice and "know-how." 20th Century is granted exclusive sales rights in the United Kingdom for the tube. Examples of the British manufactured tube were on show at the Physical Society Exhibition.

Rosite, Ltd., recently formed jointly by the Plessey Co. and Rostone Corp., of Indiana, has appointed B. W. Hymass as manager and J. G. Selby as sales manager. Mr. Hymass has been with Plessey's components division for 11 years and Mr. Selby was formerly sales manager of Insulators, Ltd. The company, which is operating from Cheney Manor, Swindon, is to manufacture a wide range of cold moulded plastics based on "Rosite," an inorganic plastic which has high heat resistance, arc resistance and dimensional stability at high temperatures.

Semiconductors, Ltd.—The transistor production equipment having been installed in the recently completed factory at Swindon, the sales and administrative staffs of Semiconductors Ltd. (a Plessey subsidiary) have moved from Ilford to the West Country. The new address is Cheney Manor, Swindon, Wilts. (Tel.: Swindon 6421.)

Ericsson-Solartron Agreement.—Under an agreement signed by the Solartron Electronic Group and Ericsson Telephones, Ltd., the distribution throughout the world of Ericsson electronic products will be handled by Solartron.

Garrard.—Within three days of the fire which destroyed Garrard's Swindon factory the first record changer came off the temporary assembly line erected in buildings put at their disposal by local industry.

Siemens Edison Swan installed radio-communication equipment and a direction finder in the 10,000-ton cargo vessel *North Devon* which was launched within 11½ weeks of the keel-laying and completed in about 24 weeks.

Antiference has introduced a free insurance scheme for owners of its aerials. It provides 12 months full cover against damage to property and/or aerial and third-party liability.

EXPORTS

An electronic digital computer has been ordered from Standard Telephones and Cables by the National Physical Research Laboratory of the South African Council for Scientific and Industrial Research. The "Stantec Zebra," as it is called, will be used to carry out calculations for pure and applied research problems in a variety of fields including nuclear physics and telecommunications.

Airport Radar.—Since their introduction, three years ago, of the world's first all-crystal-controlled 50-cm radar, Marconi's have received orders valued at well over £1M. Contracts have been placed for installations in many overseas countries and orders are in hand for installations at the Southern Air Traffic Control Centre (for London Airport), Gatwick, Elmdon and Jersey airports, and for Royal Aircraft Establishments.

Harbour Radar.—The Hamburg Harbour Commission has ordered Decca Radar for equipping Hamburg Harbour and the adjacent stretch of the River Elbe with four land-based radar stations. The contract has been awarded to Telefunken, G.m.b.H., in collaboration with Decca Radar, Ltd. The equipment to be used is of the same type as that recently installed by Decca at the Port of Southampton (see March issue) and shortly to be fitted at the Port of Liverpool.

Multichannel R/T Equipment.—A further order—making three in all—for multichannel radio-telephone equipment for the Azores inter-island communication system has been placed with Marconi's by the Portuguese Postal and Telegraph Authorities. Twelve sets of terminal equipment for the radio paths will be used in conjunction with carrier equipment manufactured by the Telephone Manufacturing Co.

Nigeria.—A report on the market for domestic receivers, radio-gramophones and tape recorders prepared by the U.K. Trade Commissioner in Lagos, shows that the U.K.'s exports to Nigeria of sound receivers rose from £47,000 in 1954 to £218,000 in 1956 (the latest figures available). The total value of Nigeria's receiver imports for the years 1954 to 1956 was £141,000, £265,000 and £623,000 respectively. The Netherlands did not export receivers to Nigeria in 1954, but in 1955 the figure was £67,000 and in 1956 £253,000. Western Germany's figures were £70,000 (1954) and £146,000 (1956).

Ghana's imports of domestic receivers and the potentialities of the market are reviewed in a report prepared by the U.K. Trade Commission in Accra. The U.K.'s share of the country's £158,000-worth of imported receivers in 1955 was £61,000, Western Germany's was £54,000 and the Netherlands £39,000. Their figures for the first seven months of 1957, during which £230,000 worth was imported, are respectively £57,000, £47,000 and £109,000.

Physical Society's Exhibition

DEVELOPMENTS IN ELECTRONIC DEVICES AND TECHNIQUES

ONE of the chief attractions of the Physical Society's annual exhibition is its variety. Practically every known application of the electronic arts is represented, not only in commercially available measuring instruments but in research into such divergent interests as communications and agriculture, computation and medicine.

In the following pages a selection has been made of items which we think will interest our readers and also indicate the directions in which developments are moving.

Printed Circuit Techniques. The use of printed circuit techniques is becoming the rule rather than the exception. This trend is leading to some items with surprising performances—for instance G. V. Planer Ltd. were exhibiting printed potentiometer elements. Photographically reproduced with a meandered track of metal or oxide film, these potentiometers can have values up to 5MΩ, but with the characteristics of a wire-wound component.

A conventional multivibrator circuit on a printed panel was shown by the Morgan Crucible Co. (Morganite)—what was unconventional was that the board was operating in an oven at an ambient temperature of 150°C!

Another stand (Johnson, Matthey and Co. Ltd.) featured protective electroplating on printed circuit boards. Rhodium plating is used for switch contacts because it is extremely hard (Vickers' Penetration Number 800). Hard gold (V.P.N. 115) is used for less arduous duty on plug contact surfaces.

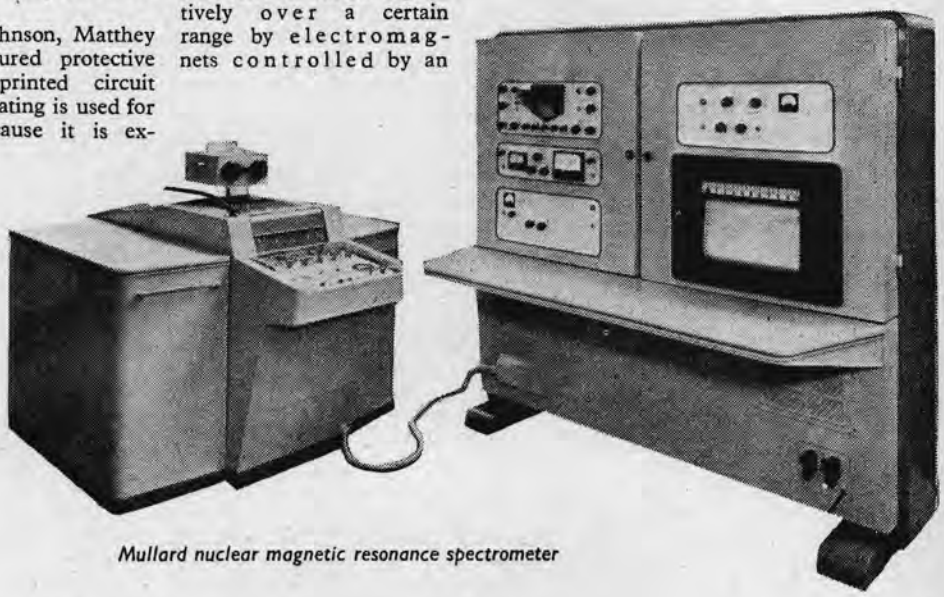
Magnetic Materials. The magnetic properties of the platinum-cobalt series have been known for some years, but the high cost has not made the use of these alloys an economic proposition. Now, as equipment shrinks even further, the limiting factors on miniaturization are often the basic physical properties of materials, and not cost.

Johnson, Matthey have developed a platinum-cobalt alloy giving a BH (max.) value of nearly twice and a coercive force of four times the values for Ticonal or Alnico V. The untreated material is completely malleable and ductile before heat treatment and can be worked by any suitable process.

Among the many ferrites at the exhibition were some samples made by an electrolytic precipitation process (G. V. Planer). It is claimed that the composition of the ferrite can be varied at will by altering the current to the precipitating electrodes, and that no milling or mixing of the precipitated material is necessary before sintering.

Nuclear Magnetic Resonance, in which spinning nuclei can be made to precess at characteristic frequencies by the application of magnetic fields, is the basis of a recording spectrometer for molecular structure analysis shown in commercial form by Mullard. The specimen for analysis is placed between the poles of a large permanent magnet (7,500 gauss) and the field is varied repetitively over a certain range by electromagnets controlled by an electronic sweep system. The resulting precession of the nuclei is observed by the absorption of energy at resonance in a small coil surrounding the sample which is energized at the precession frequency by a crystal-controlled r.f. oscillator. This absorption is detected by an r.f. bridge and the resulting signal passes eventually to a c.r.t. display whose timebase is locked to the sweep system varying the magnetic field.

Semiconductor Devices on view this year included several new junction diodes and transistors with interesting properties. G.E.C., for example, had a silicon p-n junction diode, type EW76, which exhibits a wide variation of junction capacitance with reverse voltage and can, therefore, be used as a variable reactance element. A change of 2-13pF can be obtained with a reverse bias range of 0-20 volts. A non-linear voltage/current characteristic is given by the SX640 silicon junction diode from the same firm. The voltage across the device is proportional to the logarithm of the current over five decades. In the switching and computing field, the 2N293 micro-alloy transistor exhibited by Semiconductors, offers great possibilities



Mullard nuclear magnetic resonance spectrometer

for high-speed operation. As an example, two of the transistors were shown working in an astable multivibrator at a p.r.f. of 10Mc/s, with rise and fall times of only 10 millimicroseconds (see April, 1958, issue, p. 189).

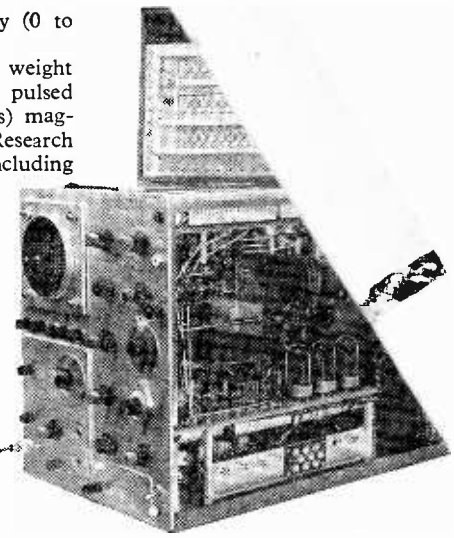
Semiconductor Transducers of indium antinomide for converting magnetic fields and infra-red radiation into electrical voltages were shown in commercial form by Plessey. The magnetic field detectors are based on the Hall effect and magneto-resistance effect respectively. They are particularly advantageous in applications where the detector has to be kept stationary relative to the field. The infra-red radiation detector is based on the photoelectromagnetic effect and was demonstrated in an apparatus for detecting low-temperature radiation like heat from the hand.

Semiconductor Multiplier based on the Hall effect in a plate of indium arsenide was demonstrated by B.T.H. The semiconductor is mounted in the gap of a ferrite pot core and the electrical signals to be multiplied are applied to an energizing coil in the pot core and to the polarizing electrodes on the indium arsenide plate. The open circuit output voltage across the Hall electrodes on the plate is the linear product of the two driving currents. Less than 1 per cent distortion is said to be obtained under maximum drive conditions. An interesting possible application of the multiplier is as a double-sideband carrier-suppressed modulator.

Microwave Components.—A probe carriage which can be quickly adapted for standing-wave measurement using slotted lines in any waveguide size from 12 to 20 (4 to 26kMc/s) was shown by Sanders. The high cost of a number of standing wave meters may thus be reduced to that of one such carriage and the slotted lines. Broadband coaxial mixers using a modification of the hybrid ring ("rat-race") with a potential 3 to 1 frequency bandwidth were shown by Mullard Research Laboratories.

A variety of facilities are available in a transistor battery standing-wave-ratio meter shown by Sanders. Crystal outputs from 1μV to 0.4V r.m.s. may be compared. The difference between two such signals may also be observed, this latter facility being useful in measuring small standing wave ratios using one fixed and one movable probe. Narrow band measurements may be made around 1 or 3kc/s. A bolometer input with built-in bias supply (0 to 10mA) is also available.

Microwave Valves.—The weight of an experimental miniature pulsed 200-watt S-band (2850 Mc/s) magnetron shown by Mullard Research Laboratories was only 3½oz including the associated magnet. The 2-kV, 1-A pulse input was obtained from a transistor modulator. A 500-c/s square-wave oscillator feeds a transformer to give an output of 2 kV. This is voltage doubled, rectified, and fed to a five-section line whose other end is matched to the magnetron. The 500 c/s oscillator also triggers a spark gap at the input end of the line so as to produce a discharge pulse which travels down the line, and whose voltage is shared between the magnetron and the line.



E.M.I. W.M.7 oscilloscope with signal delay line (above).

Frequency shifting of a microwave signal was illustrated by Mullard Research Laboratories. Phase modulation of the output of an LA9-3 X-Band (9000Mc/s) travelling wave tube by sawtooth or sine-wave modulation of the helix voltage was shown. With sine-wave modulation a number of sidebands are produced, at least 6dB down on the unmodulated signal. With sawtooth modulation, if the amplitude is such as to produce a maximum phase change of 2π, the fundamental and all sidebands but the lower first are almost entirely suppressed, as described by Cummings in *Proc. I.R.E.* for February 1957. Thus an almost pure shift in the frequency by an amount equal to the sawtooth frequency is obtained. Moreover, almost the full gain of the t.w.t. is still realized.

Oscillograph Tubes.—The general trend of development in instrument c.r. tubes is towards higher writing speeds and greater resolution. Tubes capable of displaying frequencies up to 500Mc/s are becoming almost commonplace nowadays and spot sizes of less than 0.001in are not unusual. Above 500Mc/s the transit time of the electron beam through the deflection plates is the limiting factor on frequency response, and it becomes necessary to use special techniques like the travelling-wave deflection system mentioned last year (June, 1957, issue, p. 283). A tube with a similar deflection system has been developed by 20th Century Electronics for photographic recording of millimicrosecond transients, and its travelling-wave system has an upper frequency limit of 3,000Mc/s. Whereas the tube described last year had just a single helix for the travelling wave, the 20th Century tube is distinguished by a balanced pair of helices between which the electron beam passes. This gives greater deflection sensitivity and less defocusing of the spot by the deflection system.

Among the more conventional oscillograph tubes, the Ferranti type 5/63 is particularly interesting because of its high deflection sensitivity of 2.5 volts/cm (with 10kV on the anode) and a so-called "beam lever" electrode which can be used to vary the sensitivity over a 2:1 range by application of voltages between zero and a few hundred volts. Electronic Tubes were showing a low-consumption 3-inch tube for battery-operated portable oscilloscopes. The h.t. voltage required is only 1,000 volts, which can be obtained from a transistor d.c. converter, and the heater consumption has been reduced to 1 watt.

Transparent-Screen C.R.T. shown in experimental form by Ferranti has been developed for high-definition work in radar or television. The fluorescent screen is not applied to the face plate in powder form but evaporated on to it. Calcium tungstate is used as the phosphor because it enables the baking process necessary to diffuse the activator to be done at a lower temperature than with other materials. Apart from giving higher resolution (because of the finer grain of the evaporated phosphor) the transparent material makes it possible to apply a black backing to the screen. This does not reflect room illumination like the

usual white powder screens and so the contrast of the picture is greatly improved. The tube has a triode electron gun and operates with 20kV on the anode.

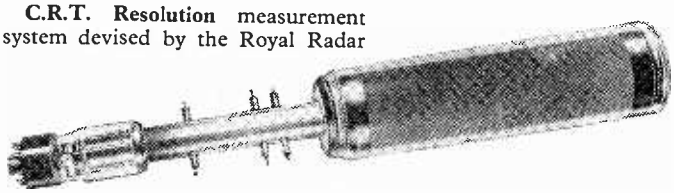
Two-Colour Radar Tube, also exhibited by Ferranti, has two phosphors, one of which lights up blue with relatively few sweeps of the spot while the other lights up magenta after a greater number of sweeps. This makes it possible to distinguish moving objects from fixed objects by colour differentiation. A fixed object produces continuous responses on a given piece of phosphor, which therefore lights up magenta, while a moving object only permits a few sweeps over a given piece of phosphor and, therefore, appears blue. The tube, type 6/61XM, also helps to distinguish between signal and noise by virtue of the repetitive nature of the signal.

Storage Viewing Tube, shown by English Electric, has its screen continuously energized by a "flood" beam passing through a dielectric mesh. A writing beam controls the surface potential of the mesh and so modulates the "flood" beam current reaching any part of the screen. A much higher luminous output can be obtained than from a conventional c.r. tube. The persistence of the trace can be varied from a fraction of a second to several minutes by applying a positive pulse of controlled duration to the metal supporting the mesh.

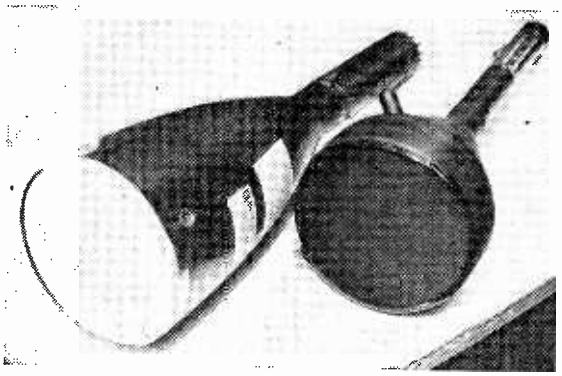
C.R.T. Resolution measurement system devised by the Royal Radar Establishment is based on a new parameter called "spatial frequency response." It avoids the uncertainties resulting from the common practice of specifying resolution in terms of spot size (arising from the spot's lack of sharply defined edges and unknown brightness distribution). The system actually measures the extent to which a tube can reproduce video signals applied as intensity modulation to a timebase. In this respect it is similar to the television practice of stating resolution in terms of so many lines. A 100-kc/s sine wave of constant amplitude is used to modulate the spot brightness, and the timebase speed is varied to give different numbers of intensity cycles along the trace—or different "spatial frequencies" as they are called. At each spatial frequency the amplitude of the light intensity cycles reproduced on the screen is measured by a photoelectric method and the results are plotted to give a curve similar to a frequency response characteristic. At zero and low spatial frequencies the geometry of the spot does not prevent the tube from showing the full amplitude of the light intensity cycles, and this condition is termed 100 per cent modulation. At higher spatial frequencies the spot size becomes significant in relation to the finer displayed patterns and the tube is increasingly unable to reproduce the full amplitude of the light intensity cycles. The amplitudes measured by the photoelectric system are therefore plotted as percentages of the full 100 per cent modulation. Typical curves, showing the effect of defocusing the spot, and details of the measurement apparatus, are given in "Technical Notebook," p. 239.

Oscilloscopes.—An instrument for use at lectures was shown by Rank-Cintel. For the convenience of the demonstrator, the back of the screen of the 12-in c.r.t. is visible through holes in the side of the cabinet, and the controls are placed at the rear. Switching between two inputs (cross-talk less than 0.5%) is possible, and their algebraic sum may also be shown. Full screen deflections are obtained with 8 and 13V peak-to-peak to the Y and X amplifiers respectively; the responses being flat within ±1 dB from 10c/s to 100kc/s. Sweep and trigger time bases are available.

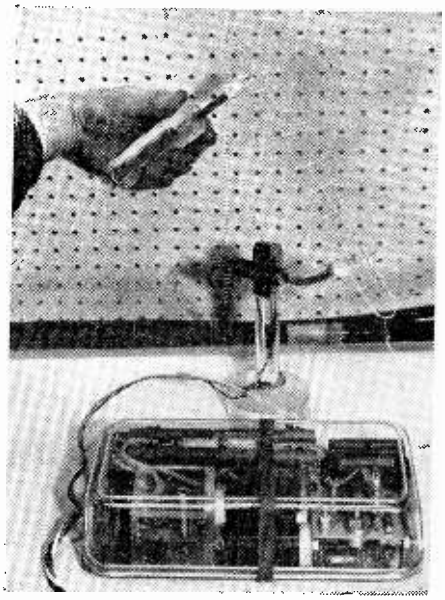
A wide variety of sweep, trigger and measurement facilities are available in the new E.M.I. WM7 prototype. Either a squared graticule or calibrated deflection dials may be used to measure voltages and times to within ±2%. Triggering at frequencies up to 50Mc/s at a variable level is also possible. The X-sweep can be delayed from 1μs to 0.15s, with a jitter of less than one part in 20,000, to allow part of a complex



20th Century travelling-wave deflection c.r. tube.



Ferranti two-colour radar tube (left) and transparent-screen tube with black backing (right).



Mullard miniature S-band magnetron and modulator. The miniature Yagi aerials and neon indicator used for demonstrating transmission and reception are also shown.

waveform to be examined. The response of the d.c. Y-amplifier is 3dB down at 50Mc/s (rise time 8mμs) and its sensitivity is 100mV/cm.

A high d.c. sensitivity of 1mV/cm is a feature of the new Nagard J103 oscilloscope (prototype). The response is 3dB down at 1Mc/s.

Signal Generators.—A random low-frequency noise generator with a constant output down to d.c. was shown by Servomex (Type 77). The patented method uses a source giving a constant noise output in a high-frequency band which is narrow compared with its centre frequency. This band is filtered out, and all signals are limited (clipped) to a very low level. The resulting low-frequency difference intermodulation products give a constant noise output from d.c. to the frequency width of the band.

The full audio-frequency range from 20 c/s to 20 kc/s is covered in the single band of the Dawe 443. The tuning capacitor vanes have been shaped to give a logarithmic calibration, and the shaft extends at the rear for coupling to a motor drive and recorder.

A 13-channel and i.f. television alignment sweep generator (Type E5116) using a sawtooth modulated current to vary the magnetic field in the ferrite core of the oscillator coil was shown by Labgear. The tendency for the oscillator output to vary with the changing L to C ratio is compensated for. Crystal controlled narrow pulses to indicate vision and sound frequencies are also provided.

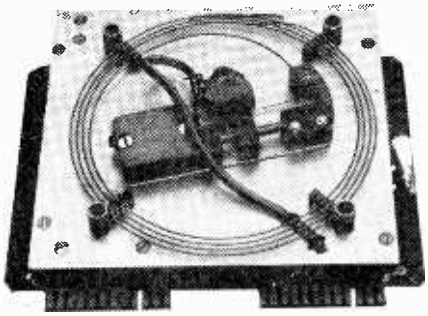
R, C and L Measurement.—Two-way switches in each of the probes allow selection of any of the 4 ranges up to 100 MΩ in the Rank-Cintel prototype resistance and insulation tester. An aural alarm indicates a short circuit between the probes.

Capacitance changes to within 0.05 pF in 200 pF may be measured with the Burndept BE 245 incremental capacity measuring instrument. If a signal is applied to the control grid of a frequency changer valve, and a parallel LC circuit tuned to this frequency connected to the signal grid, then a change in the tuned circuit capacity will cause a change in anode current in the valve. In the BE 245 a push-pull arrangement is used with the LC circuit connected to the signal grids of both valves and tuned to the mean of the two input frequencies of 10 and 10.077 Mc/s. In this way, capacitance changes cause anode current changes in opposite directions in the two valves, a voltmeter connected between their anodes being used to indicate any such changes. With this arrangement, drifts in the valves tend to act in opposition and stability is greatly improved. The voltmeter is actually used as a null indicator, capacity changes being backed off against a standard variable capacity.

Comparison of resistances (from 0.25 Ω to 10 MΩ) capacities (from 2pF to 10μF) and inductances for (2mH to 100H) for component values differing by up to $\pm$25% is possible using the British Physical Laboratories 1000-c/s CZ457 bridge. Phase angles may also be compared. For a 10% mains voltage fluctuation the indicated difference will not vary by more than 2%. The meter cannot be more than 20% overloaded using widely differing components.

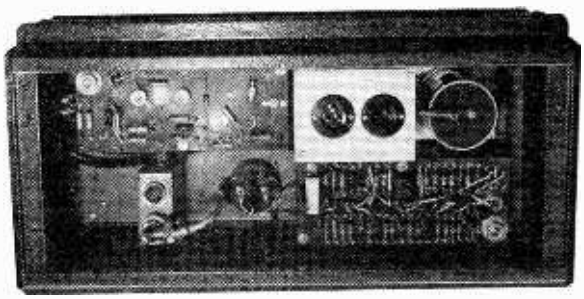
An r.f. multi-ratio transformer arm admittance bridge (Type LE 300) was shown by Hatfield Instruments. Input frequencies from 15 kc/s to 15 Mc/s may be used.

Digital Voltmeters with a directly visible number (and sometimes sign) display were shown by a number of exhibitors. This arrangement gives a more positive and often more accurate indication than a conventional meter, and permits a shorter reading time. One method is to apply a standard voltage across a number of resistors in series of such values that voltages in digital form may be obtained from their junctions. These junctions are connected with the corresponding display numbers so that the digital voltages light up their corresponding

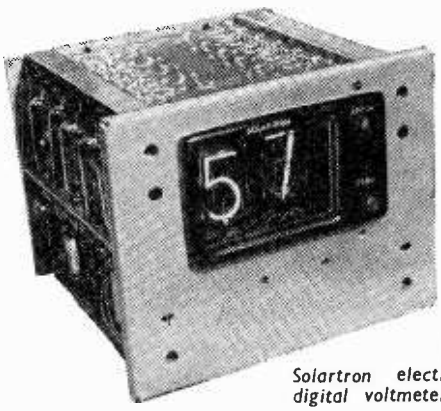


Torsional-wave wire acoustic delay line (Ferranti).

Burndept's new batch counter, showing how the chassis swings out for servicing.



Rear view of the "Langtrol" unit showing the power supply, oscillator, amplifier and range-and-balance sections.



Solartron electronic digital voltmeter.

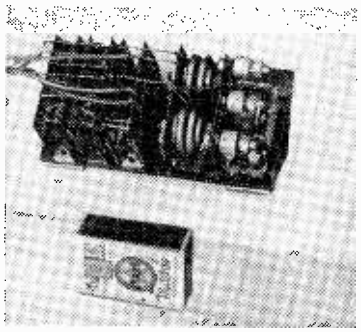
number. The unknown voltage is compared with the digital voltages in a suitable electronic switching sequence until a minimum or zero difference is obtained, the display number set up then being the nearest to the unknown number of volts. This was basically the arrangement used by Ferranti and Metropolitan-Vickers. A variant of this basic scheme is to obtain the digital voltages by switching a constant current into the various resistors as in the Solartron "Digicator."

A quite different system is used by Burndept on the other hand in their BE246. The unknown voltage is used to produce a field in the core of an inductance forming part of an oscillator tuned circuit. The resulting change in oscillator frequency is counted by a crystal counter and displayed on four Dekatron tubes.

Pulse Generators.—Fortiphone showed a miniaturized transistor airborn radar marker giving ten 80.8 kc/s spikes (representing one-mile intervals), followed by five 8.08 kc/s spikes, representing ten-mile intervals), all superimposed on an 800 μs pulse at a p.r.f. of 800/sec. The high output required (60V) was obtained by using silicon transistors. A very flexible two-pulse generator using 22 transistors was shown by Guy's Hospital Medical School. Independent control of the width and voltage of each pulse, the time between pulses, and the repetition period is possible.

In the versatile Rank-Cintel generator a multivibrator variable in frequency from 1 c/s to 1.1 Mc/s gives a fixed width and amplitude synchronizing pulse. This is also taken to a flip-flop to provide delay variable from 0.09 μs to 105 ms, and then to a second flip-flop to give a pulse whose width is also variable from 0.09 μs to 105 ms. This last pulse is used to provide three pulse outputs; rectangular or sawtooth of the same width, or two equal narrow pulses of opposite polarities corresponding to the rectangular leading and trailing edges, and obtained by reflection from a short-circuited cable.

Transistor Computing Circuits for digital operation were very much in evidence—no doubt heralding the appearance of complete transistor machines at subsequent exhibitions. Metropolitan-Vickers were demonstrating a system of logic based on a single-transistor circuit element or "building block" which could be reproduced cheaply in large quantities on printed-circuit boards. These basic elements on their small circuit boards are connected together into

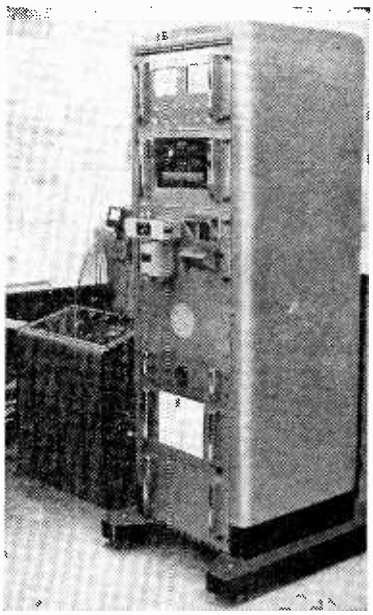


Fortiphone miniature transistor radar marker generator.

computing arrangements by larger printed-circuits, and there are two further stages of connection, giving altogether a four-dimensional printed-circuit system, both electrically and mechanically. A similar system of transistor logic circuits on printed-circuit boards was shown by Mullard as part of an industrial sequence control equipment. A basic circuit provides "and" and "or" gates (according to the phase of the input signal) and can be converted into other logic elements by interconnection and addition of diodes.

Transistors also appeared in two other digital computing exhibits—a fast parallel multiplier shown by the Armament Research and Development Establishment and some torsional-wave acoustic delay lines on the Ferranti stand. In the multiplier the logic is performed by diodes and the transistors are used as interstage amplifiers. Similarly in the delay lines, the transistors provide the current pulses to the acoustic drive transducers (2mA, 1μsec) and amplify the signals from the pick-up transducers. The transducer used is actually a magnetostrictive type. It launches longitudinal stress waves in metal tapes which are coupled to the wire delay line so as to produce torsional waves in it. The particular advantages of torsional waves for this work are their low velocity and ability to preserve the separateness of input pulses at high repetition rates.

Counters and Timers.—Transistor models were shown by Venner and Rank-Cintel. When large numbers of valves or transistors must be used, the smaller heat dissipation and possibly greater reliability of transistors may be valuable. The use of transistors in the switching circuits required presents little difficulty. The cabinets of the Rank-Cintel units are made of fibreglass with slightly curved tops and sides, and an attractive three-toned colour scheme.

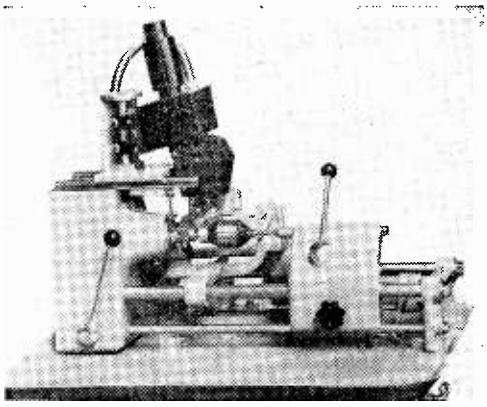


Magnetic recording electromyograph (St. Thomas's Hospital).

New Batch Counter. Burndept had some new and interesting equipment on view including a new batch counter suitable for use with a great variety of transducers. The whole unit is designed for ease of servicing and it provides all the usual facilities—variable paralysis, pre-end-of-batch pulse, end of batch pulse—and it can count at speeds up to 100,000 objects per minute.

Comprehensive Instrumentation. The "Langtrol" (Langham Thompson) transducer carrier system is a fully transistorized instrumentation system using a 3-kc/s carrier. It is made up from a number of units which can be combined to produce a single-or multi-channel equipment. The system will operate from 20 to 28 V, d.c.—rendering it suitable for aircraft use—or from the mains supply via a transistor-stabilized power unit. It produces an output sufficient to operate practically any recording system.

Radiosonde Telemetering System displayed by Rank-Cintel automatically measures and records the transmitted audio frequencies (representing temperature, pressure and humidity in sequence) by a counting and timing method. The a.f. signal from the ground receiver is frequency divided by 100 to give pulses which define time intervals, each containing 100 cycles of the incoming signal. These pulses are used to start and stop an electronic chronometer which measures the time occupied by the 100 cycles of



E.M.I. electronic dividing attachment fitted to a commutator undercutting machine. The light source and pick-up cell are mounted in the black assembly at the top of the picture and the servo amplifiers are located in the pedestal cabinet on which the machine bed is fitted.

audio signal and thereby, indirectly, the frequency. The "decade" information from the chronometer is then translated into the form of a voltage level on a step waveform, which is fed as a deflection voltage to a pen recorder. During one signal period (for a particular meteorological parameter) the counting and timing operation is done four or five times, and this produces a concentration of closely packed marks at a particular place on the recorder chart. The next signal period, for another meteorological parameter, produces a similar concentration elsewhere on the chart, and so on. The three parameters are therefore recorded by a sampling or time-division process on the chart, but the eye is nevertheless able to follow the broken line of each curve.

Medical Electronics. — Developments in recording systems for physiological data were noted in particular this year. An interesting feature of the electromyograph (for muscle potentials) shown by St. Thomas's Hospital, was a magnetic drum store for taking records of transient phenomena which would be too fast for the conventional pen writer. The oxide recording surface is actually on a removable plastic sheet which is wrapped round the drum and can be filed away for reference. It provides 19 tracks for recording, and the information is played back to a c.r. tube display system whose timebase is locked to the drum rotation.

The need for portability, and, in consequence, miniaturization, had obviously influenced the design of several other instruments. A miniature chart recorder on the Medical Research Council stand was small enough to be put in the pocket. The circular chart, driven by clockwork, is only about 2 inches across, and a miniature transistor d.c. amplifier is used in the self-balancing bridge type of servo for driving the recording stylus. The chart paper is of a kind directly sensitive to the contact of the metal stylus. In the Siemens Edison Swan transistorized cardiograph, another portable instrument, a hot-wire stylus records on heat-sensitive paper, which is driven by a battery-operated motor.

Mine Rescue.—When miners are trapped they can guide their rescuers by tapping on a pipe or rail. When these are not available reliance has to be placed on the longitudinal transmission of sound through a stratum, but the maximum range that can be achieved is very limited.

G.E.C., in co-operation with the National Coal Board have produced an underground listening set, consisting of geophones and a highly sensitive amplifier and indicating equipment, covering the frequency range 25 to 250c/s. Hammer taps have been detected up to $\frac{1}{4}$ mile away under very unfavourable conditions, but the range would be much greater if work noises were stopped. One of the main difficulties during development was to find valves of adequately low noise level over the unusual frequency range required.

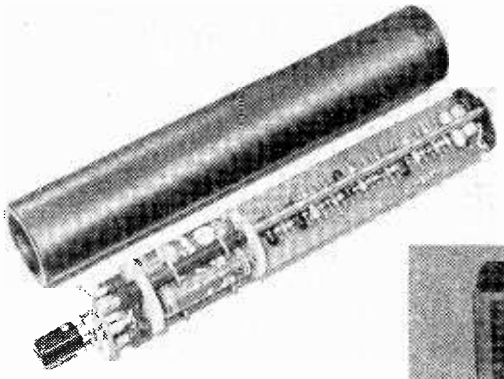
Transistorized Metal Locator.—Particularly notable for neat construction was the Rank-Cintel metal detector and cable route or pipe route tracer.

This small transistorized unit replaces the original valve amplifier/oscillator, and fits on to the search coil head as a handle. Once the pipe or cable has been found, the heavy search coil is discarded and replaced by a light ferrite-cored coil. The internal oscillator is switched off and the pipe is energized by a signal generator. The ferrite coil can then be used to trace the route of the pipe.

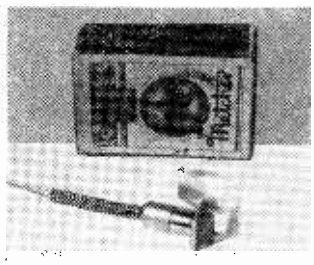
Vibration Measurement. A new application of the three terminal bridge technique was shown by Wayne-Kerr, as a vibration meter. Normal methods of vibration measurement require the attachment of a transducer or a stylus to the object under test. The Wayne-Kerr instrument uses a capacitive probe placed near the vibrating elements to control the feedback in an amplifier fed with a.c. from a high-impedance source. Thus the depth of modulation of the output from the amplifier is proportional to the vibration amplitude and is independent of probe spacing.

Ultrasonics. The Ultrasonoscope Company have produced some small probes for their flaw-detecting equipment primarily for use in situations where space is very limited, e.g., between turbine blades.

Ultrasonic frequencies have many uses in industry, but Mullard have added yet another—cold welding. The two metals to be joined are clamped together with not more than



Below : Miniature ultrasonic flaw detector probe (Ultrasonoscope).



Rank-Cintel transistor oscillator/receiver for the metal detector and cable or pipe route tracer (cover removed).

about 200lb pressure. The top "jaw" of the clamp is then vibrated in the "shear" direction at about 20kc/s by magneto-striction, producing a weld similar to a spot-weld. It is thought that the vibration breaks down the oxide film present on the surface of the metal, and once this has occurred small pressures are sufficient to cause fusion. Shear strength is about 80% of that of a spot weld, but Mullard hope to improve these figures.

Commutator Undercutter. The E.M.I. electronic dividing attachment was shown applied to a commutator undercutting machine. A narrow beam of light vibrates at 50c/s, shining on the commutator of the armature clamped to the machine. If the commutator is not centred properly the output from a photo-cell will be at 50c/s, because the light is shining alternately on to copper and dark mica. This causes a servo system to rotate the armature. When the mica is centred the light will shine on copper at either side, giving a 100c/s output from the cell. This locks the armature in position and starts the cutter. The machine will automatically undercut a 28 segment commutator in 35 seconds.

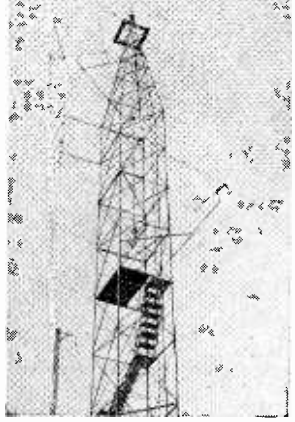
LETTERS TO THE EDITOR

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

TV DX in Australia

I READ with interest the report by "Diallist" in the February issue of a South African's success in receiving the B.B.C. Crystal Palace TV service in his country and felt that my own efforts in long-distance TV may be of interest to your readers.

I have received the B.B.C. Ch. 1 sound on 25 occasions since Dec. 3rd last and the picture (snowy) on three occasions. I have five hours of recorded tape as a permanent record of this reception. Some of the tapes are already in the archives of the B.B.C. and reference to their Research Dept. (Mr. Dennis) will verify my claim to being the first person to see around the world by "looking-in" on the B.B.C., over a distance of some 11,000 miles. My success in seeing the B.B.C. TV film of the S.E. London rail crash on the 5th Dec. was widely reported in the world's press.



The top aerial on Mr. Palmer's tower was used for B.B.C. reception.

It is also reported that from time to time the American Police break through on British receivers. I have two such receivers here and experience the same reception of these Police calls from 42 to 46Mc/s over the 10,000 miles between Melbourne and U.S.

I trust my reports will be of interest to your readers.

Williamstown, Victoria, Australia. GEORGE F. PALMER.

Maritime V.H.F./F.M.

I REFER to the article in the March issue of *Wireless World* giving a report of the radar and v.h.f. control system for the Port of Southampton and to the statement (on p. 102) that it is believed that Southampton is the first port in England to use f.m./v.h.f. on the frequencies agreed at the Hague conference.

The Port of Dover brought into operation listening watches on f.m. 156.3, 156.6, 156.8 Mc/s at the beginning of January this year. These are in addition to the existing watches on a.m. at the same frequencies which have been in operation at this port since early in 1953.

The a.m. services will be continued at Dover until all the vessels normally using these ports have been changed to f.m.

Trusting this information will be of general use and interest.

Dover. B. A. A. SMYE-RUMSBY.

Valve Failures

AS A service engineer, I heartily endorse Mr. J. Spencer's remarks regarding premature valve failures, the replacements in television receivers under 12 months are reaching alarming proportions.

Although some of these failures are with new types of valves, there is one glaring example, a triode-pentode, used as a frame oscillator-cum-output stage, which has given persistent trouble over the last five years. This is one instance where a big improvement in reliability could be made, even if it meant an increase in the price of the receiver.

All service engineers, on behalf of their customers, would commend to manufacturers the slogan, "Reliability before Reductions."

Manchester. E. EVENSON.

Fixed or Free Stereophony

WITH reference to "Free Grid's" note (March issue) on the desirability of headphones for any foolproof stereophonic effect, I wholeheartedly agree. At present, it seems there are two main objections to the stereo systems now available:—

(1) The wretched listener has to sit rooted to the same spot all the time in order to get the full effect; this puts paid to listening to stereophony while doing odd jobs, minding the baby, etc. It is also extremely annoying having one's whole furnishing scheme subordinated to the positions of the two loudspeakers: in any case in the average living room there will be probably only one chair from which it is possible to receive the proper effect—hence there will be no question of all the family listening at once.

(2) "Free Grid's" objection, namely the necessity for each ear to hear only the channel meant for it. He suggests headphones—and this is an excellent idea as it also partly solves objection (1); the whole family can listen while seated in their accustomed chairs. There is still the problem of movement, as it is rather inconvenient doing housework with a long length of wire trailing behind, which headphones would obviously need.

One day, perhaps, it will be possible to have a battery high-fidelity radio receiver no bigger than the average

headphone; one could then buy two of them, clamp one to each ear and listen to the B.B.C.'s stereophonic* service (as doubtless it will be) wherever one liked, in the car, during a walk, or even in the bath (perhaps "Free Grid" will be interested!).

Fulmer, Bucks. J. R. P. BRIDGE.

* Binaural?—Ed.

Tape Speeds

ON considering "Free Grid's" understandable objection to the expression of tape speeds in inches per second and Mr. Davies' explanation of their origin, I agree that just to start with $1\frac{7}{8}$ in/sec as a new unit would not help. Evidently as techniques improve, still slower speeds will be used, when we shall be back to the fractions again.

I feel it would be more logical to use a logarithmic scale, analogous to the measurement of frequency in octaves above and below "middle C." The obvious zero for such a scale is the standard 30 in/sec, any other speed then being reckoned as n units representing 30×2^n in/sec. On this scale $1\frac{7}{8}$ in/sec becomes simply -4 units (the sign could be dropped, if not ambiguous). By definition all standard speeds can thus be represented by a simple integer, which I am sure would be no more puzzling than decibels.

Chelmsford. D. C. JEFFREY.

I HAVE been entertained by the discussion in your columns over the origin of tape speeds. I was particularly attracted to the idea of adjusting tape speed to the length of a possible broadcast programme.

However, whimsy apart, let us have on record a reason that is rather nearer the truth. We must accept that the development engineers who were responsible for the original Magnetophon were aware of the shortest recorded wavelength that the replay heads then available were capable of resolving. Simple sums would then show the tape speed necessary for the reproduction of the highest frequency required. From the known data this would have been in the region of 75 cm/sec.

Turn now to the workshops where the first machines were constructed. Any experimental machine shop carries a stock of steel rods ground to a high degree of accuracy and surface finish—known in this country as "silver steel" and in some other countries as "drill steel." A standard Continental size is 1cm diameter. Another normally available component would be a small induction motor having a shaft speed of about 1,450 r.p.m. on 50-c/s mains. Attach the standard shaft to the standard motor, and the speed is approximately correct for all practical purposes, with the great advantage that readily available materials could be used.*

With the adoption of standard speeds of 30 in/sec and sub-multiples, capstan shaft diameters have become rather more complicated. With the readily available induction motors with a shaft speed of 1,450 r.p.m., 30 in/sec requires a capstan diameter of 0.39514 inches, or if a synchronous motor is used at 1,500 r.p.m., a shaft diameter of 0.38197 inches will be needed.

Naturally, approximations are used, but oh! the complications of simplification and standardization!

NORMAN L. BOLLAND.

Farnham Common, Bucks.

* Easier said than done if the required concentricity is to be achieved without re-grinding the surface of the capstan.—Ed.

Tape Spools

ONE of the annoyances of this hobby is the way the last few turns unwind themselves off stored reels and produce crumpling of the tape. This could be very simply avoided by cutting four equally spaced slots about half an inch deep in each outside edge of the spool, and then placing a rubber band around the reel along the more suitable diameter. In this way any unwrapping beyond a quarter of a turn is prevented. Perhaps the manufacturers could pander to my laziness and make spools with such slots already cut in them.

Edgware. D. J. KIDD.

Forward Projection Television

I READ with interest the article "Forward Projection in the Home" by A. G. Tucker, in the March issue. He states in his first paragraph that he believes all receivers now marketed are rear projection models. My company has manufactured front-projection receivers for several years including suitable home models. The only drawback to the popularity of the latter, using screen sizes less than 4ft × 3ft, is the heavy purchase tax, which makes the price rather prohibitive.

I can endorse Mr. Tucker's remarks regarding the cinema quality picture obtainable using the activated screen with a reasonably low lighting level.

Merrow, Guildford. A. G. BASSETT,
P.A.M., Limited

Optical Noise Filter

THERE seems to be some confusion on this subject arising from the fact that there is not one effect but a number of different effects. The improvements reported in your original note (October, 1957, "Technical Notebook") were reduction of noise, better contrast and better resolution. To these I would like to add a better sense of depth, though not for the same reason as Mr. Lindsley (February issue).

Resolution is fairly certainly due to the improvement in focusing on the retina brought about by the pin-hole camera effect. The eye is "stopped down" so that it has a large depth of focus. The reduction of extra-axial aberrations is not likely to be a significant factor, since the stopping down process limits the resolving power of the eye and you are unlikely to improve this beyond that of a good eye with no stop.

When a television picture lacks contrast it is usually because the blacks are not truly black but are dark grey. Now in order to be visible as grey they must produce an illumination level on the retina which is above the threshold level. When the pinhole is in front of the eye the illumination levels are all reduced proportionately, but now the areas which appeared as dark grey are below the threshold level and once more appear black. Hence the contrast of the picture is improved. A similar argument can be applied to the noise, and so perhaps instead of calling the pin-hole an optical filter we should call it an optical clipper.

There are several effects which contribute to our perception of depth, but one of these is the focusing of the eyes. When viewing a picture normally our eyes remain focused on the plane of the screen. With the increased depth of focus given by the pinhole our focus need no longer remain fixed and this freedom to change our focus helps the illusion of depth. It is true that we get a better impression of depth with one eye, but the use of pin-holes over both eyes does also improve depth, though not so markedly.

Brentwood, Essex. W. D. H. BLACKMAN.

New Book

Long-wave and Medium-wave Propagation, by H. E. Farrow, Grad.I.E.E. Based on a series of lectures to students in the B.B.C. Engineering Training Department specializing in the operation and maintenance of broadcast transmitting stations, this booklet discusses the problems of establishing a service area of adequate field strength, the effects of ionospheric reflection and ground-wave terrain and the use and limitations of synchronized group working. Pp. 39; Figs. 24. Price 4s 6d. Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Conductors and Insulators

Electron Energy Levels in Solids

By "CATHODE RAY"

LAST month we looked at some examples of the fact that the electrons belonging to an atom move around its nucleus in a way which can be represented pictorially only by a haze but which nevertheless follows strict rules. The most important rule is that only certain sizes and shapes of hazes are possible, and in each of these the electron possesses a certain total amount of energy. The amounts of energy are usually reckoned in electron-volts (eV), and are often displayed in diagrams such as Fig. 1, which shows the basic series of energy levels in the hydrogen atom. An electron normally settles into the lowest level possible (in Fig. 1, −13.5 eV), but can be lifted to a higher level by the arrival of the appropriate amount of energy from somewhere. It usually stays at the upper level for only a fraction of a microsecond (there are some exceptions) before dropping back and giving up the extra energy. Such energy is radiated as a "photon", and because the amount of energy in a photon is related to the frequency of the radiation by the quantum law ($E=hf$) in which h is a constant, the frequency f is completely determined by the amount of the energy jump, E. When E is large, the radiation comes into the frequency band of ultra-violet light or even X-rays; when less, visible light; and when very small it may be low enough to come into the radio band.

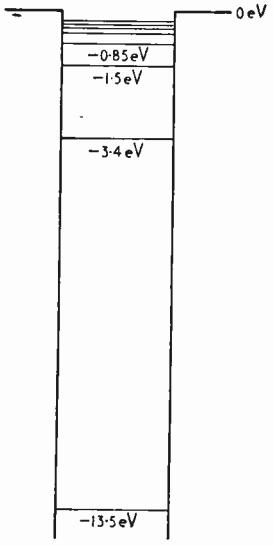


Fig. 1. In this "well" form of diagram are shown the possible energy levels in the "spherical" series of electron states of a hydrogen atom, which are terms in the series $-13.5/n^2$, n being any whole number. The negative sign is used because the most convenient zero level is the energy that parts the electron altogether from the nucleus. The actual energies are of course all positive, but the differences between the levels (which are what matter) are the same either way.

One of our examples was the upper atmosphere, where ultra-violet radiation from the sun imparts so much energy to the electrons that they are jerked entirely clear of their atoms. This process is known as ionization and is responsible for the reflection of waves which makes it possible to send radio signals around the earth. Another example was the energizing of gas molecules in glass tubes by shooting free electrons from end to end. The falling back from higher to lower levels produces the light we see from neon and other gas-discharging electric lighting. Sometimes only one important energy difference involved corresponds to a frequency within the visible band, so such light is concentrated mainly in one colour, depending on the particular gas used. This is all very well for drawing attention to the Palais de Danse, but not at all suitable as a substitute for daylight, which is distributed over the whole of the visible frequency band—roughly 400 to 800 MMc/s.

The elements we considered were chiefly gases, and especially hydrogen, which is by far the simplest because each neutral atom consists of only two components: the nucleus and one electron. Although atoms of gases other than hydrogen have more than one electron each, which makes their haze patterns and energy levels much more difficult to calculate, at least each atom is far enough away from all the others for their influence to be neglected. Consequently the possible energy levels are separate and sharply defined, as shown in Fig. 1; which means that the re-radiated frequencies are also separate and sharply defined and appear on spectrograms as mere lines. This state of affairs is sometimes likened to a single tuned circuit's resonance, which occurs sharply at an isolated frequency. A closer analogy is a cavity, which resonates in one harmonic series of frequencies lengthwise, another breadthwise, and so on.

When two circuits tuned to the same frequency are coupled closely together, their single resonant frequency splits into two, as can be demonstrated by over-coupling an i.f. transformer. In a somewhat similar way, when two atoms come close together so that all the particles in both attract or repel one another, it is found that single energy levels split into two. As with the tuned circuits, the width of separation increases with the closeness of coupling.

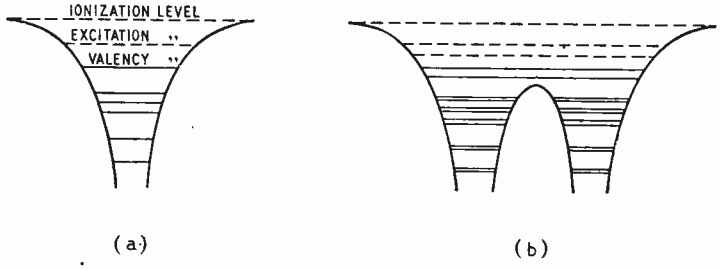


Fig. 2. Showing how the discrete energy levels of a single atom (a) are split into pairs when two atoms are brought close together (b).

This change can be illustrated by a modified form of energy-level diagram, in which the width increases towards the top to represent the greater distance from the nucleus. With this method, a single atom is shown as in Fig. 2(a). Those levels normally occupied by electrons are shown as continuous lines. Their vertical spacing is not to scale; the lower levels, especially, are much deeper down than they look in the diagram, but from now on we shall not be bothering much about those lower than the top occupied (or valency) level. The single excitation level shown stands for a large number of them into which electrons can be temporarily lifted by incoming energy. The ionization level is the point of no return, where an electron gains its freedom from the nucleus. Fig. 2(b) shows how each of the levels (except of course the last) splits into two when two atoms come close enough together to form a single unit—a molecule. The separation is least at the lowest levels, where electrons are influenced least by the component parts of the other atom. Note that at the valency level an electron is so screened off from its own nucleus by the other electrons that it may almost be regarded as belonging to the whole molecule, so this and higher levels are shown extending across both atoms.

Solids consist of vast numbers of atoms close together, so each of the single energy levels divides into a correspondingly vast number of energy levels, so close together that they form practically continuous bands. That is this month's key fact, illustrated in Fig. 3.

Most of the solids in which we are interested are crystalline; that is to say their atoms all line up in regular three-dimensional formation, at equal distances apart. A crystal can, in fact, be regarded as a gigantic molecule. Since it is the closeness with which the atoms are packed (the closeness of coupling, if you like) that decides how widely the single energy levels spread out into bands, the width of these bands depends on the type of crystal structure. Some substances are capable of more than one crystal structure, and these have different energy band patterns. Carbon is an outstanding example, as we shall see later.

Fluorescent Frequencies

One result of this band spreading is to provide a solution to our lighting problem, which was how to cover the visible band of frequencies as completely and uniformly as possible. Gas discharge tubes of the kind I have already described—usually containing mercury vapour, which radiates strongly on isolated frequencies in the visible blue and ultraviolet bands—are modified by lining them with crystalline materials chosen because their bands of radiation frequency cover the visible range with the desired balance (which may be "natural," "warm white," etc., according to taste). Such materials are described as fluorescent.

To go into all the why and wherefore of this broadening of the Fig. 1 line levels into bands would, as our American friends say, get us all snarled up (except those who are mathematically bright, and they can read a few books on the wave mechanics of solids). If you lack a mastery of this you may be puzzled, as I was, by one thing that explanations of fluorescent lighting usually omit to explain. We know that the "exciting" radiation from the gas discharge is at isolated frequencies—"discrete" is the proper word—and since it is in photons having only corresponding discrete quanta of energy it would appear that the fluorescent material could only be excited to levels that are higher by those particular amounts of energy. One cannot have a fraction of a photon left over. When the electrons drop back to their original state, the energy losses and therefore the frequencies of the fluorescence would be the same as those of the original discharge and one would be no better off. What we actually see is as unexpected as if people being pelted with shillings and half-crowns were to throw them back in the form of coins having every possible value from fourpence to ninepence in steps of a microfarthing.

The observed fact that the frequencies of re-radiation from fluorescent *solids* are lower (which means less energetic) than the frequencies exciting them is called Stokes' law.* The reason is very involved, but it seems that when electrons in solids are raised to higher energy levels the general interaction of the atoms leads to a rearrangement of electrons whereby the dropping-back jump is usually less than the jump up, and so the re-radiation frequencies are lower. The difference between the received and emitted energy appears as heat.

An alternative method of exciting fluorescence is by bombarding with electrons, as is done on television tube screens. Unlike a photon, which must give up the whole of its energy and then ceases to exist, a bombarding electron can give up any fraction of its kinetic energy, retaining the remainder in the speed with which it bounces off.

Fluorescence is rather a side issue, however, and we must get down to our main line of inquiry, which concerns solids in their less brilliant states. If you have been reading books about atoms you may have been perplexed by statements in some places that the energy of an electron in an atom depends entirely on the first number (n) in the four-part code indicating its state, whereas elsewhere it is said or implied that every state has a different energy. According to the first theory, the energy levels of the non-spherical states (in which the second code number is not zero) would have to coincide with the spherical-state levels shown in Fig. 1. Also there would be no difference in energy between the two directions of spin, indicated by the fourth number in the code. Yet on the other hand one reads that the electrons in an atom arrange themselves in order of energy, implying distinction between several that may have the same value of n. And most diagrams of the Fig. 1 type clearly show non-spherical levels

* Not the Stokes' law concerned with falling bodies.

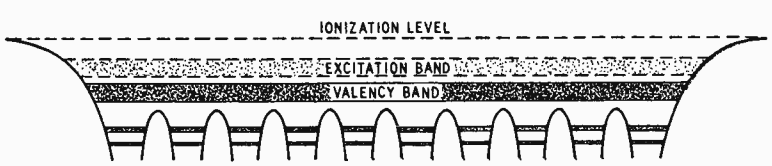


Fig. 3. In solids, enormous numbers of atoms (represented here by a mere ten) are close together, and the single energy levels are multiplied into practically continuous bands, of which those from the valency level upwards can be regarded as common to the whole piece.

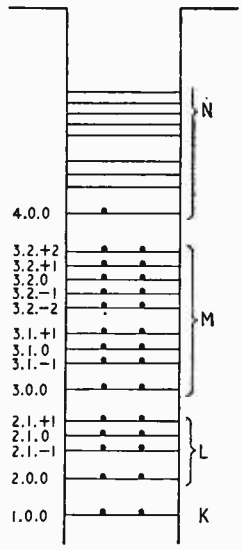


Fig. 4. Occupied energy levels (not to scale) in a single atom of copper at a low temperature. The markings on the left are the quantum numbers; on the right, the "shell" designations.

not coinciding with the spherical. Which is right?

The answer is that both are, but the first applies only where there is a single electron (as in the hydrogen atom), and in the absence of any magnetic field. Just as bringing a number of atoms close together splits up single energy levels, the proximity of a number of electrons in one atom separates out the energy levels of different states having the same n number. Likewise a magnetic field—such as the earth's—discriminates between the plus and minus values of the third code number. As regards electrons in the same state except for direction of spin, they can differ in energy in the presence of a magnetic field, but the difference is extremely small and for most purposes is neglected. So each energy level is usually regarded as capable of holding two oppositely spinning electrons.

It used to be supposed that at absolute zero temperature the electrons in atoms all had zero energy. But we have already noted that even the lowest level in Fig. 1, though negative with respect to the arbitrary zero, is really a positive energy—both potential and kinetic—and the single hydrogen electron can drop no lower, even at absolute zero. And because Pauli's principle invariably applies, there can be no more than two electrons at any one level. The helium atom has two electrons, which occupy practically equal levels lower than the lowest in Fig. 1, but still with some energy. The lithium atom has three electrons, so at its very lowest the third electron has to be up on the next floor (I didn't mention that each table in the atomic restaurant is on a different floor, did I? And that even at a single table some seats are higher than others?). The heavy atoms, with scores of electrons each, have correspondingly large numbers of occupied energy levels, and their restaurants would be quite tall buildings were it not that in order to agree with Fig. 1 we must imagine them to be entirely underground.

When I was introducing transistor theory in the July 1956 issue I simplified the matter by lumping all except the top-floor electrons along with the nucleus as the main body of the atom, in order to concentrate attention on these top electrons. Now, with Pauli's principle before us, we can see why this was possible. Fig. 4 is an energy level diagram (not to scale) of a single copper atom with its 29 electrons. The temperature being low and no other energy coming in, they are all bedded down in the lowest possible levels allowed by Pauli. Consider the position of those near the bottom. There are no vacancies nearer than the level half occupied by the topmost electron, so an extremely large quantum of energy would be needed to force them up past all the others. If such quanta were available—or even much smaller ones—they would find it relatively easy to disturb the much freer electrons near the top. The lone electron, especially, is screened off from nearly all the 29 units of positive attraction to the nucleus by the 28 units of negative repulsion from the other electrons, so its home ties are exceptionally weak. When only small quanta are about, insufficient to shift any of the 28, these 28 can be regarded along with the nucleus as fixed parts of the atom, as I said.

Fig. 4 applies to only a single atom of copper. That is of no practical interest to us, so we must consider a whole crystal of it—for copper has a crystalline structure, though this can usually only be seen by pulling a piece apart. Its energy level diagram should show as many levels for each one of those in Fig. 4 as there are atoms in the crystal. The innumerable "lone" electrons in the whole copper crystal are distributed over this broad band of levels.

In elementary explanations of electrical conductors and insulators we are told that conductors are substances which contain many electrons so loosely bound to their atoms that they can drift freely along in one direction under the influence of an electric field, whereas insulators have all their electrons tethered to their atoms so that no such continuous drift is possible. If you have been following this series through from the beginning you may already be suspecting that this explanation is a trifle over-simplified. For one thing, the voltage depth of the top electron in "well" diagrams does not differ enough as between one kind of atom and another to account for the enormous differences between their conductivities. (Copper conducts about 10^{22} times more than polythene.) If nobody even began to learn the first thing about electricity until he was an accomplished mathematician, the first lesson on electric currents would presumably be on a basis of wave mechanics and would differ considerably from the above. But since it is safer to assume that most people starting electricity not only are not accomplished mathematicians already but never will be at any time, the simpler approach is justified. As far as it goes, it is roughly correct. But if taken literally it fails to square in detail with the facts. So let us see where wave mechanics takes us.

A Different Picture

One of its main results, you will remember, was to replace the billiard-ball electron by a wave-function, and its precise orbit by a haze of probability. Being a haze, it has no clearly defined boundaries but just thins out as the distance from the nucleus increases. When atoms are massed together as in solids, their hazes merge, so that the outermost (valency) electrons, at least, can be regarded as belonging exclusively to no particular atom but free to circulate throughout the whole material, as suggested in Fig. 3. This is not at all the same thing as ionization, which necessitates sufficient energy being given to the electron to take it quite clear of its (or any other) atom. These circulating electrons are still some way "down the well," but the well represents the whole chunk of material. At the

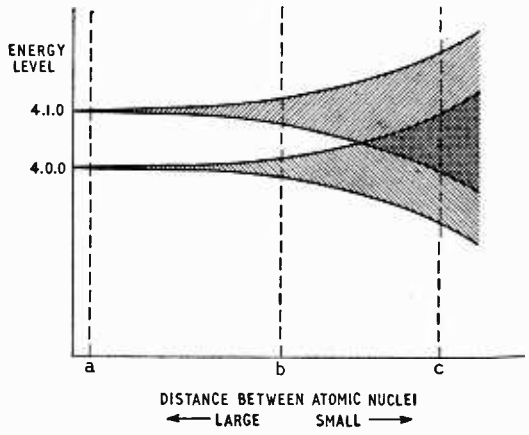


Fig. 5. Another way of showing how bringing very many atoms close together, as in solids, broadens the discrete energy levels (a) of the separate atoms into bands (b). If the spacing is close enough, bands may overlap (c).

low temperature we are assuming, the electrons have insufficient energy to escape from it.

This state of affairs is not an easy thing to visualize, and it will probably be worth while to pause a few minutes to think it out. One must be quite clear that the sort of diagrams we have been looking at refer only to energy levels, and not at all to the physical positions of electrons. Any one electron is visualized as circulating around the nucleus like a gnat, sometimes close to it, sometimes far (relatively!), but unlike the gnat not completely at random, for its energy is tied by the quantum laws to a fixed level. In the crystalline formation the nuclei are close enough together for it to be under the influence of more than one at a time, and it frequently (that is a masterly understatement!) transfers its prime allegiance from one to another. Owing to the "coupling" of all the atoms, all the electrons in any one state have very slightly different energy levels. One cubic centimetre of copper contains about 10^{23} atoms, and its energy diagram would have 10^{23} closely spaced levels, each with one electron, in place of the single 4.0.0 level and electron in Fig. 4.

Now this is the crux of the matter: Pauli's principle still holds; so no more than two electrons can occupy any one level. As we know, current flow through a conductor consists in electrons moving towards the positive pole of a source of e.m.f. For this to happen, the source has to impart energy to each electron. It cannot do so—and this is the thing that is not always realized—unless the electrons are capable of receiving small amounts of energy. Small, because with the voltages that can exist across conductive circuits the proportion available across the diameter of an atom is minute. It would be quite incapable of carrying an electron across gaps between energy levels such as those shown in Fig 4, which are of the order of a volt apart. But it can carry them up the almost imperceptible steps between the levels in an energy band —*provided that the upper step is vacant.*

In copper, only half the levels in the 4.0.0 band are filled; so, on the principle that "there is always room at the top," the electrons in this band are free to accept energy offered by even weak electric fields; which means that they can drift towards the positive pole, thereby creating an electric current.

If you still have the table of elements I gave away free with the last issue, you will no doubt be saying "Hi!" (or any loud cry) "What about zinc?" I take it that you are not referring to the minstrel tradition that this is the substance with which Sambo's mother's teeth were lined, but rather to the fact that its 4.0.0 levels are full up with two electrons each, so there is no vacancy in this band, and therefore according to the theory I have just outlined it ought to be a very good insulator. If such thoughts are indeed beginning to take shape it is time we looked at Fig. 5, which shows diagrammatically how the single energy levels of Fig. 4 (represented at *a*) broaden out into bands as the atoms are brought closer together. At *b* they are bands of some breadth, but still separated by gaps much too great for electrons to cross under the urge of any except enormously strong electric fields. If zinc atoms were so spaced, it would be an insulator, for all the levels in the 4.0.0 band would be full, while all the empty 4.1.0 levels would be out of reach. In fact, however, zinc crystallizes in a formation which spaces its atoms as shown at *c*, with the bands so broad that they overlap. Compared with copper, where bands also overlap, there are more electrons chasing fewer vacancies, a state of affairs which agrees with the fact that zinc is somewhat less conductive than copper.

The next three elements—gallium, germanium and arsenic—would plunge us straight into semiconductors, but before considering them it will be instructive to go back to No. 6, carbon, because it is a particularly interesting example. As you know, it is found fairly plentifully as graphite, which is black, soft, opaque and a fairly good conductor, and much less plentifully as diamonds, which are sparkling, superlatively hard, transparent and non-conductive. All this comes about because carbon crystallizes in two alternative formations; one (diamond) with the atoms so spaced that the nearest unfilled band is beyond the reach of the four outermost electrons; the other (graphite) in which the gap is much smaller. Even so, it is hardly small enough to be crossed by the gentle stimulus of an electric field, and we have to take into account another influence —heat. Since we have been ignoring it until now, we have in effect been assuming that our solids are at absolute zero temperature (−273°C), which isn't very realistic. The effects of heat are so important that we shall have to reserve next month's space for them.

New Edition

Foundations of Wireless by M. G. Scroggie, B.Sc., M.I.E.E. For more than twenty years this book has been the accepted primer for those intending to take a serious interest in radio technology. While assuming no previous technical knowledge on the part of the reader, it nevertheless takes him to a sufficiently high level to appreciate the developments which are taking place day by day in the fields of television and sound broadcasting and radio communications.

To support this growing edifice the foundations must be strengthened and broadened, and this seventh edition has been extensively revised and enlarged with 40 additional pages and 200 new diagrams. Transistor principles are dealt with on an equal footing with valves, and there is new material on transistor circuitry. There is also a new chapter on radiation and aerial systems. Pp. 388; Figs. 278. Price 15s. Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

Transistor Television Circuits

2.—Scan Output Stages, Video and Signal-Frequency Amplifiers

By J. N. BARRY*, M.Sc., and G. W. SECKER*

ALTHOUGH it should be possible to use a suitable power transistor in any one of the three amplifier configurations as a frame output stage in a television receiver, published designs[3] have used the common-collector or common-emitter arrangements. This choice appears to have been influenced by considerations of input impedance or available power gain.

It may be noted that when either of the preferred arrangements is used as a large signal amplifier, distortion may arise due to variation of current gain with emitter current.

In the case of the common-emitter arrangement using a p-n-p transistor, a further consideration in its use as a frame output stage is the polarity of the input sawtooth waveform. If a positive-going sawtooth input is used, the collector waveform will appear as a negative-going sawtooth and the excursion due to the frame flyback voltage will be such as to drive the collector to zero volts. or even to a positive potential. If this last-mentioned condition is reached the collector-base junction is biased in a low-resistance condition and the flyback pulse is clipped and lengthened. The transistor itself could be protected by the use of a " catching " diode, but the lengthening of the flyback pulse would still remain.

Alternatively, if a negative-going input is used, the flyback pulse will tend to drive the collector to a large negative potential (typically of the order of −70V) and the transistor selected must be capable of withstanding this voltage.

If an output transformer is used, any distortion of the output waveform due to variations in incremental permeability with changes in collector current will cause a form of distortion which will add to that produced by the changes in current gain with emitter current already mentioned. The effect of each form of distortion will be to cause cramping of the frame at the end of the scan.

A method of overcoming this form of distortion would be to peak the input sawtooth waveform. Referring back to Fig. 5 in Part I (April issue) it may be seen that the base voltage waveform (V_b) possesses the required characteristics.

It was found that this desired waveshape could be produced only across a high resistance load. In the final design, a common-collector buffer stage was interposed between the blocking oscillator and the output stage. This served to provide a power output sufficient to drive the output stage while at the same time presenting a suitably high value of resistance to the base circuit of the transistor blocking oscillator.

Measurements made on the frame deflection coils of the 17-inch receiver showed that, excluding the flyback pulse, a peak current of approximately 0.55 amps at a peak voltage of approximately 12V was required to scan the tube. Assuming a sawtooth waveform for voltage and current this represents a power input to the frame coils of approximately 2.2 watts[4]. It follows that the d.c. power input to the frame output stage must be of the order of 5 watts (assuming an efficiency of about 50%). In addition the output transistor must be capable of withstanding a collector dissipation of 5 watts should its driving signal fail.

The choice of the h.t. supply voltage applied to the frame output transistor is largely determined by the performance of the transistor itself. In particular, if the common-emitter circuit is used, the collector voltage excursion due to the amplified sawtooth waveform together with the flyback pulse should not exceed the voltage at which collector breakdown occurs.

If it were possible to increase the voltage applied to the output stage it follows that for a given power output the collector current could be reduced. This would have the effect of lessening distortion arising from current gain variations and also from the output transformer. The use of a common-base arrangement would to some extent allow this to be done but with the attendant disadvantages of a much lower input impedance and reduced power gain.

Complete Circuit

Fig. 9 shows the final arrangement of the frame output section together with the line oscillator circuit mentioned in Part I but adapted to work from an h.t. supply of −30V. In addition, a two-stage sync separator has been included to provide a positive-going line sync output and a negative-going frame sync output.

V_1 functions as a common-emitter type of separator with respect to line sync separation (as described in Part I) and positive-going line sync pulses of approximately 28V peak are developed across R_1. These are applied via C_4 to the base of the line oscillator, V_3. Negative-going frame sync pulses are developed across R_2 and C_2 in the emitter circuit of V_1 which is directly coupled to the emitter of V_2. This last-mentioned stage is biased fully on by means of the potentiometer R_4 and R_5 and serves to clip and amplify the frame sync pulses which then appear across R_3. (Since V_2 is used as a common-base amplifier no phase change takes place between input and output.) The frame sync pulses are applied

*Research Laboratories, General Electric Company.

[3] " Transistorized Vertical Deflection for Television Receivers," by M. B. Finkelstein, in " Transistors I " book (RCA Laboratories, 1956) p. 579

[4] " Reference Data for Radio Engineers " (Standard Telephones & Cables, 1948 impression).

to the base of the frame oscillator V_4 via C_5. The frame oscillator stage, while essentially similar to that described in Part I, has been modified to increase the curvature of the rise waveform of the sawtooth voltage appearing at the base. This voltage is approximately 5V peak-to-peak and is applied via C_{13} to the base of the buffer amplifier V_5. Being connected in the common-collector arrangement, V_5 presents a high impedance to the blocking oscillator and also provides sufficient current output to drive V_6, the frame output stage. Variation of the bias point of V_5 and V_6 by means of R_{14} introduces changes in the output waveform and affords a frame linearity control.

It may be mentioned that linearity adjustments tend to vary the voltage across C_{13} and if this component is an electrolytic capacitor some pulling of the frame oscillator can occur. This effect may be lessened considerably by using a tantalum electrolytic, the result then being comparable to that obtained by using a paper capacitor for C_{13}.

Negative feedback is applied to V_6 by means of R_{16} and R_{17}. The last-mentioned, being variable, acts as a gain control, and is used as the height control for the scan.

The h.t. supply voltage (−30V) was chosen as the maximum which could be safely used with available power transistors.

The output transformer T_3 was designed to have a step down ratio of 1.6 to 1 and used No. 4 Stalloy stampings with an air gap of 0.006in. This represents a suitable compromise between performance and physical size.

The total current consumption of the circuit shown in Fig. 9 was approximately 170mA. The consumption of the individual stages is given below, together with brief details of the transistors used.

The output transistor V_6 was mounted on a heat sink consisting of 6in × 6in of No. 18 s.w.g. copper sheet. No thermal run-away effects were noticed under no-signal conditions when the collector dissipation was approximately 4.5 watts. It may be mentioned that the use of negative feedback, i.e. R_{16} and R_{17} will contribute to the thermal stability of this stage*. The performance of the transistorized frame output section was considered subjectively to be comparable with that obtained from the 17-inch receiver in its original condition.

	Mean Collector Voltage	Mean Collector Current	Details
V_1	27V	0.2mA	GET4 p-n-p
V_2	0.5V	2mA	GET4 p-n-p
V_3	26V	0.6mA	2N98 n-p-n
V_4	25V	2mA	EW80 p-n-p
V_5	20V	4mA	Selected GET4† p-n-p high current gain
V_6	28V	160mA	GET9 p-n-p

Linearity measurements were made on Test Card C as described in Part I with the circuit shown in Fig. 9 incorporated in the receiver. The results were: line non-linearity 3%; frame non-linearity 9%. A photograph of the reproduced test card is shown in Fig. 10. The frame non-linearity was such as to produce a maximum height of a rectangle of Test Card C in the middle of the picture which diminished uniformly towards the top and the bottom. The linearity control could be used to extend either the top or the bottom of the picture at the expense of the other. There was a slight tendency towards loss of frame hold during adjustment of the linearity control, but, as

†A value of $\alpha_{cb} = 70$ was used in practice.

For the component values given in Fig. 9 it can be shown by calculation that the circuit will be thermally stable under the most adverse conditions up to an ambient temperature of 50°C provided the intrinsic thermal resistance of the power transistor $\theta \leqslant 18$°C/watt. This condition is fulfilled easily in practice.

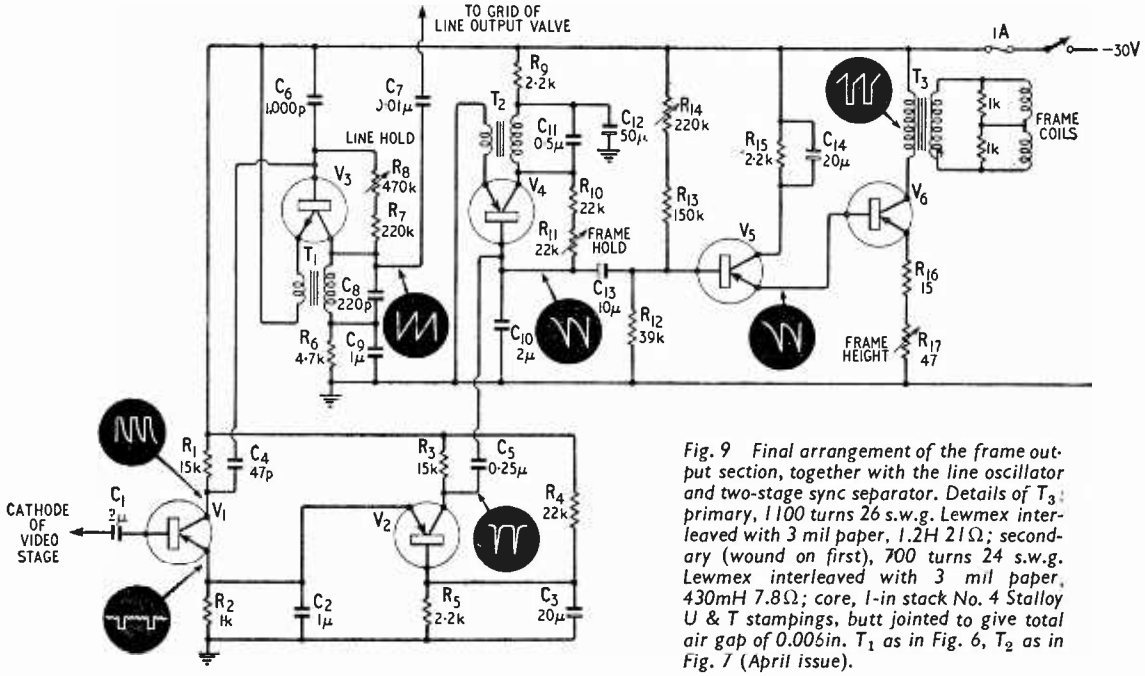


Fig. 9 Final arrangement of the frame output section, together with the line oscillator and two-stage sync separator. Details of T_3: primary, 1100 turns 26 s.w.g. Lewmex interleaved with 3 mil paper, 1.2H 21Ω; secondary (wound on first), 700 turns 24 s.w.g. Lewmex interleaved with 3 mil paper, 430mH 7.8Ω; core, 1-in stack No. 4 Stalloy U & T stampings, butt jointed to give total air gap of 0.006in. T_1 as in Fig. 6, T_2 as in Fig. 7 (April issue).

previously mentioned, this could be overcome by the use of a tantalum electrolytic or paper capacitor for C_{13}. The frame height control permitted a full scan to be obtained under all conditions of contrast and brightness.

In addition to the circuit functions just described, it is of interest to consider other possible uses of transistors in a typical television receiver. Such additional applications can be divided broadly into: (i) line timebase output stages and e.h.t. generators, (ii) video amplifiers, (iii) i.f. amplifiers, and (iv) r.f. amplifiers and local oscillator circuits. (Note: It is considered that the audio circuits have been discussed fully in previous publications, and are therefore not included here.)

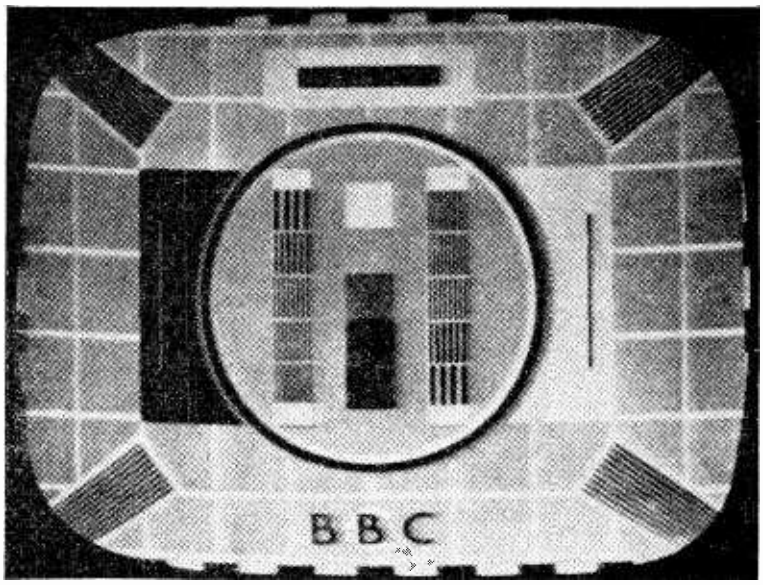


Fig. 10. Picture of Test Card C obtained with the Fig. 9 transistor circuits in the modified 17-inch receiver.

Line Output Stages.—If a conventional output stage is considered it is apparent that a number of circuit problems have to be overcome. A transistor in such a stage would be operating as a large-signal amplifier and would be required to feed the deflector coils via a suitable coupling transformer, i.e., a circuit based on the principles discussed earlier would be required. The transistor requirements in this case, however, would be more rigorous, and a medium-frequency high-power device having a high peak collector voltage rating would be required. The conventional output circuit using a thermionic valve is also used to provide the e.h.t. for the cathode-ray tube. It is doubtful whether the loading imposed by the e.h.t. circuit, together with the increased voltage and frequency requirements, could be supplied by a similar stage using transistors which are likely to be available in the near future.

A more hopeful solution might be in terms of an alternative circuit in which the transistor is in fact used as a switch directly coupled to the scanning coils. Circuits of this type have been described previously by Sziklai *et al.* [6, 7]. Basically the operation of these circuits is to utilize the magnetic energy stored in the scanning coils for part of a cycle to provide the scanning current for the remainder of the cycle. The former circuit[6] has the advantage of only passing part of the peak current through the transistor switch, but does require a large-amplitude initiating pulse. If such a circuit is also required to provide the e.h.t. voltage, a satisfactory solution to the problem again becomes very difficult because of the additional loading on the switch.

The simplest solution is probably in terms of a separate d.c. converter to provide the e.h.t. Such circuits have been discussed in some detail by Light and Hooker[8].

If the above problems could be solved satisfactorily it would mean that the timebase sections of the receiver, together with their associated circuits, could be fully transistorized.

Video Amplifiers.—In this and the following two sections, the operation of transistors in high frequency linear amplifiers is being considered, and the discussion assumes that alloy transistors, or developments of this type of device, are being used.

In order to achieve a video amplifier with satisfactory electrical performance using transistors, a bandwidth of 3 Mc/s is required, and the minimum gain to be provided is usually of the order of 30dB. In addition such an amplifier should provide an output voltage of the order of 50 volts peak-to-peak without distortion. Even if a video load as high as 5 kΩ can be used (this would require the total output capacitance, i.e. transistor collector capacitance plus strays, to be less than 10pF), the mean a.c. power in the load could be as high as 100mW. The transistor required for such an application, in addition to having adequate frequency performance and voltage rating, would thus need to have a minimum power dissipation of the order of 200mW at the highest ambient temperature encountered in the receiver.

It should be noted that the d.c. output power requirements may also need careful consideration.

Much of the original work on transistor wideband amplifiers was carried out by J. M. Early, who gives the relationship between "G_o", the maximum available power gain at low frequency, and "f_G", the frequency where the power gain is 3dB down on G_o, as :

$$G_o \cdot f_G^2 = \frac{f\alpha}{8\pi r_{bb}' \cdot C_c} \quad .. \quad .. \quad .. \quad (1)$$

[6] "Circuit Techniques Associated with Transistor Broadcast Receivers," Part II, by J. N. Barry. *Electronic Engineering*, October 1957, pp. 478-483.

[7] "A Study of Transistor Circuits for Television," by G. C. Sziklai, R. Lohman and G. Hertzog. *Proc. I.R.E.*, Vol. 41, 1953, p. 708.

[8] "Retrace Driven Deflection Circuit," by W. B. Guggi. *I.R.E. Transactions on Broadcast and Television Receivers*, No. 3, October 1956.

"Transistor d.c. Converters," by L. H. Light and Prudence M. Hooker, *Proc. I.E.E.*, Vol. 102, Part B, No. 6, November, 1955.

See also "Transistor Power Supplied," by L. H. Light. *Wireless World*, December 1955.

where $f\alpha$ = alpha cut-off frequency (common-base connection).

$r_{bb'}$ = " extrinsic " or ohmic base resistance.

It can be seen from equation (1) that G_o is dependent on a factor M given by

$$M = \frac{f\alpha}{r_{bb'} \cdot C_c} \quad .. \quad .. \quad .. \quad .. \quad (2)$$

M is frequently referred to as a high frequency figure of merit for the transistor.

A simpler performance parameter is perhaps the maximum frequency at which the transistor will operate as an oscillator, denoted by f_{max}. This can be derived from the equation relating maximum power gain and frequency for the case of a tuned amplifier. This relation, which is valid over a limited frequency range (see next section), is given by:

$$G_{max} = \frac{1}{f^2} \cdot \frac{1}{8\pi} \cdot \frac{f\alpha}{r_{bb'} C_c} \quad .. \quad .. \quad (3)$$

The value of f_{max} is obtained by putting G_{max} equal to unity. Then:

$$f_{max}^2 = \frac{f\alpha}{8\pi r_{bb'} C_c} \quad .. \quad .. \quad .. \quad (4)$$

$$\text{Hence } M = 8\pi f_{max}^2 \quad .. \quad .. \quad .. \quad (5)$$

Substituting in equation (1):

$$G_o = \frac{f_{max}^2}{f_G^2} \quad .. \quad .. \quad .. \quad .. \quad (6)$$

As a general rule the value of f_{max} is found to be appreciably higher than the value of the alpha cut-off frequency $f\alpha$ (see Table I). It can be seen from the above equation (6) that in order to provide a gain of 30dB in a single stage amplifier having a cut-off frequency f_G of 3 Mc/s, a transistor having a value for f_{max} of the order of 95 Mc/s would be required.

Some recent work on cascaded common-emitter stages for use with video amplifiers has been published by Bruun.[9] This paper provides information for the design of an amplifier having an optimum gain-bandwidth product. With currently available transistors a two-stage video amplifier would probably be required for receiver applications, and the best technical solution is therefore not likely to be very economic.

I.F. Amplifiers—In a conventional receiver the i.f. amplifiers are required to operate on a frequency of approximately 34 Mc/s. For the types of transistor being considered, it has been shown by a number of workers that over a limited frequency range the variation of power gain with frequency obeys an inverse square law, according to equation (3). This relation is valid provided that the working frequency lies approximately within the range:

$$0.1 < f/f\alpha < 2 \quad .. \quad .. \quad .. \quad .. \quad (7)$$

By comparing equations (3) and (4), it is also seen that:

$$(G_{max})_f = \frac{f_{max}^2}{f^2} \quad .. \quad .. \quad .. \quad .. \quad (8)$$

From equation (8) it can be shown by way of example that for a power gain of 20dB at 34 Mc/s, f_{max} should be at least 340 Mc/s.

In order to see how far some of the above requirements are met by existing transistors, the typical characteristics of various high frequency types are listed in Table 1.

To meet the arbitrary performance outlined above, a transistor rather better than the 2N384 drift type appears to be required. This conclusion is based on the calculated value of f_{max} for this type.

It will be seen that Table 1 includes some types recently announced in America. It should be borne in mind that the characteristics of some of the devices as given in the table must be considered as tentative only, and may not necessarily appear as the characteristics of a production type in the future.

In addition to exhibiting the required frequency characteristics, transistors suitable for television i.f. amplifier applications should also have as low a value of collector capacitance as possible. If such values are appreciable the design of neutralizing circuits (which are likely to be necessary) may become difficult because of the need to take account of (a) spread in collector capacitance in production devices and (b) variations in h.t. voltage, particularly if battery portable receivers are being considered.

R.F. Amplifiers and Oscillators—Considering first the requirements for the local oscillator, it would appear at first sight that a transistor similar to the one specified for the i.f. amplifier stages ($f_{max} > 340$ Mc/s) would be suitable. However, considering the fact that the oscillator frequency must remain stable with variations in both temperature and supply voltage, it is likely that a transistor having a still higher value of f_{max} may be required. In some ways the problem is similar to that which has already been experienced with sound superhet receivers, but with the frequency range increased by two orders of magnitude.

The solution to the r.f. amplifier problem also requires a transistor having better high frequency characteristics than those specified in the preceding section (excepting possibly the experimental diffused base type), and appears to lie some way into the future, especially if a reasonable power gain is also demanded. In coming to these conclusions it is

TABLE I

Typical High Frequency Transistor Characteristics.

Type	$f\alpha$	$r_{bb'}$	C_c	$M = \frac{f\alpha^*}{r_{bb'}C_c}$	f_{max}‡
	Mc/s	ohms	pF		Mc/s
OC44†	15	110	10.5	13	23
OC45†	6	75	10.5	7.5	17.3
XA102†	8	75	13.5	8	18
EW65/2†	10	90	7.5	14.5	24.5
2N247† (experimental drift type)	35	40	1.7	520	140
2N384 (experimental drift type)	100	50	1.3	1,540	250
Diffused base type (experimental)	400	10	0.5	80,000	1,800

*The value of M is obtained by substituting $f\alpha$ in kc/s, $r_{bb'}$ in ohms and C_c in pF.

†Characteristics measured at $V_c = -6$ volts, $I_e = 1$mA, and are typical values.

‡f_{max} calculated from equation (4).

[9] " Common Emitter Transistor Video Amplifiers," by G. Bruun. *Proc. I.R.E.*, Vol. 44, November, 1956, pp. 1561-1572.

assumed that full coverage on Band III is required.

Future Possibilities.—It will be seen that certain functions in a television receiver, particularly the non-linear circuit applications, can now be solved technically in terms of transistors. However, since in domestic receiving equipment first cost is of paramount importance, it may well be some time before the use of transistors is introduced on the commercial market due to adverse economic considerations.

Another difficulty lies in the provision of suitable power supplies. Thus although some of the circuits described (e.g. sync separators) can be adapted to operate from the h.t. line of a normal mains receiver, other circuits, such as sound output and timebase output circuits, are likely to require the provision of special power supplies.

The use of transistors is likely to be more attractive if developments occur in the field of battery-operated portable television receivers. Should they do so, a situation similar to that existing at the present time with sound radio receivers is likely to arise, whereby the use of transistors is more or less restricted to battery-operated equipment. It also seems likely that, should there be a public demand for portable television receivers, an expanding effort would be devoted to solving the problems surrounding the r.f. and i.f. transistor circuits.

The most likely future development could well be a portable receiver having some of the circuits transistorized. Such a hybrid receiver could incorporate transistors in the timebase section and its associated circuits and use a transistor d.c. converter to provide the h.t. supply for the r.f. and i.f. valves.

In addition to possible uses in television receivers, a limited use of transistors in other types of television apparatus appears likely. Portable camera equipment is a typical example of such an application.

Sensitive Tuning Indicators

SOME PRACTICAL NOTES ON IMPROVING PERFORMANCE

By RICHARD OLIVER

THE well known "magic-eye" is designed to operate with fairly large changes of grid voltage (nine volts for one of the most sensitive—an average figure is about 15 volts). This is the order of voltage which is present on the a.g.c. line of the average radio receiver. A sensitivity of this order can be a disadvantage in situations where adequate control voltage is not available, such as the sound a.g.c. line of a television receiver where the amplifier valves have a grid base of six volts or so, or in an a.m. receiver using valves other than the conventional types, where the a.g.c. line does not become more than a few volts negative. When the "magic-eye" is used as a tuning indicator in an f.m. receiver it is necessary to peak the i.f. transformers at the centre of the passband to ensure an indication of correct tuning—this is an undesirable practice—and even then the change in pattern when first tuning to a station is large compared with the final change caused by the "hump" in the i.f. response curve.

Obviously, some means of increasing the sensitivity of the "magic-eye" is desirable. The practice of adding a cathode resistor, common to the cathode circuits of both the voltage amplifier and target section is well known, but this has its limitations. The control electrode in the display section controls, in the main, the distribution of the electron "beam" over the fluorescent target, but it also affects the current flowing through the display section, tending to reduce the potential difference between the control electrode and the cathode. Also the standing current in the display section backbiases the d.c. amplifier, causing a deflection. Thus there is a practical limit to the gain in sensitivity that can be achieved by this method.*

A moment's consideration will show that there are several points in the average receiver at which an amplified change of voltage of the correct polarity and magnitude for application to the control electrode exists, e.g. the screen grids of the amplifier

* It is suggested that the optimum value for the cathode resistor shown in Fig. 1 be determined experimentally.

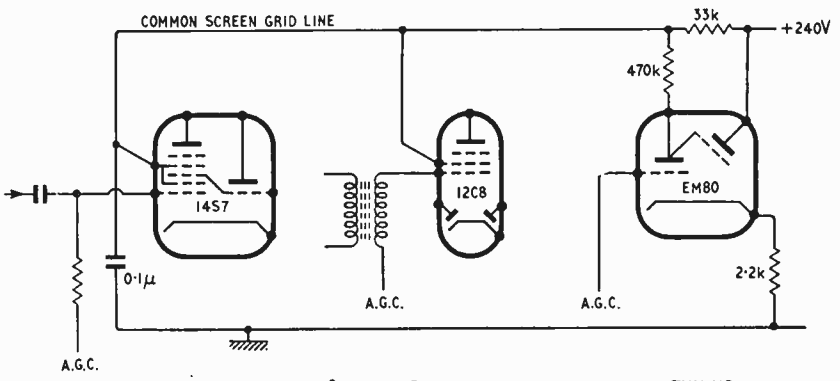


Fig. 1. "Sensitive" connection for the EM80 in an a.m. receiver

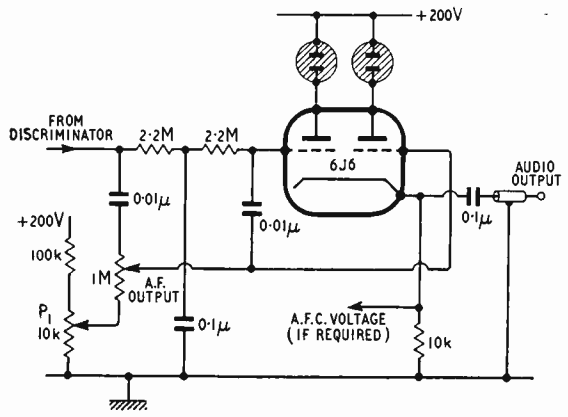


Fig. 2. Combined f.m. tuning indicator and output cathode follower.

or frequency changer (a.m. receiver); the r.f. amplifier screen-grid or the limiter anode (f.m. receiver).

If the voltage amplifier anode is returned, via its load resistor, to one of these points, the change of voltage will be "added" to that caused by the voltage amplifier incorporated in the "magic-eye," resulting in much improved sensitivity. In a particular a.m. receiver made by the writer (Fig. 1) an EM80 fully closes to two dark lines with a maximum of about 12 volts negative on the a.g.c. line. Connected in the conventional way this indicator requires a grid voltage change of 20 volts to produce a shadow angle approaching 0 degrees.

In an f.m. receiver the voltage rise at the anode of the limiter as the signal is tuned in is considerable. If this change is applied to the control electrode the change in shadow angle caused by it should be sufficient to provide an "approaching a station" indication. By delaying the negative voltage developed at the grid of the limiter before its application to the tuning indicator grid by an amount equal to the voltage obtained just away from the correct tuning point, i.e. on either side of the central "hump," the voltage at the tuning indicator grid is held constant until the correct tuning point is approached closely. When this occurs the change of tuning indicator grid voltage and the change of control electrode voltage act together to increase the sensitivity of the indicator at the point where a positive indication is required. Obviously the value of delay voltage required depends upon individual circumstances; therefore a circuit diagram with values is not given.

It is not generally necessary to allow for the voltage amplifier anode current when calculating the values of voltage dropping resistors, because this current is small compared with the other currents flowing in the circuit.

The second arrangement harks back to the f.m. tuning indicator described by John D. Collinson in the September 1955 issue of *Wireless World*, and used by the Acoustical Manufacturing Company in their "Quad" f.m. tuner.

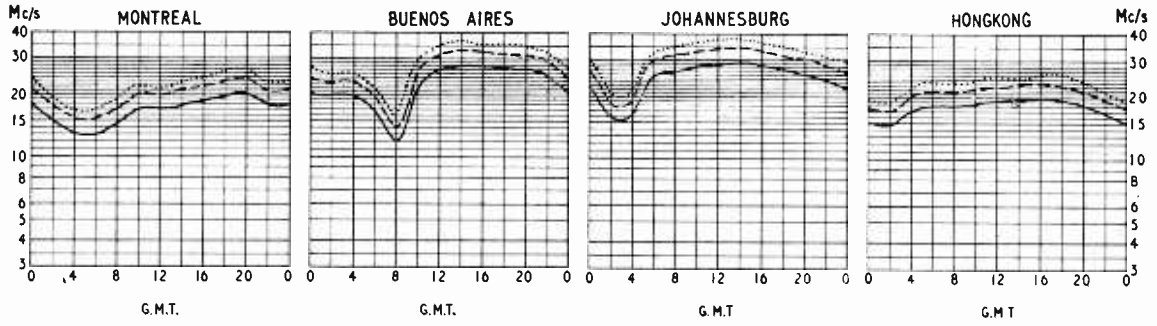
It occurred to the writer that to use a double triode for the tuning indicator alone was rather wasteful, especially when another triode is used as a cathode follower to feed the audio output cable. Therefore an effort was made to use the tuning indicator amplifier as the output cathode follower. The circuit shown in Fig. 2 is the result. The triodes run in parallel at a.f., but as a long-tailed pair for d.c. P_1 allows the light output from the neon lamps to be balanced. It may be necessary to bypass the slider of this potentiometer to chassis to avoid hum.

One word of warning—if the leads to the neon lamps are too long either of them may act as a relaxation oscillator when the current through it is reduced by detuning. This "howl" is possibly one of the best features of the modified circuit—it does prevent positively the fair sex using (or rather: misusing) the tuning knob as a volume control, and it is considerably cheaper than fitting a.f.c.

Incidentally—another feature of the circuit is that it is easy to use a back-biased germanium diode for a.f.c., because the diode can be biased by the positive voltage already present on the cathode of the tuning indicator amplifier-cum-cathode follower.

SHORT-WAVE CONDITIONS

Prediction for May



THE full curves given here 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 May.

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

..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

Direct-Coupled Transistor Audio Amplifier

By D. A. G. TAIT

SIMPLE AND ECONOMIC DESIGN

THE choice of an output stage for transistorized amplifiers and portable receivers would appear to be generally dictated by the requirements of battery economy and the limited power output capabilities of available transistors. In applications where these requirements do not hold, the use of a single class-A output stage with direct coupling througnout as in Fig. 1 is attractive, not least from the aspects of simplicity and component economy. That such direct connection of collector to succeeding base is possible was pointed out by A. R. Owens.* It is a result of the very low "knee" of the collector characteristic (especially when operating at low current levels) coupled with the need for bias in the following stage of the same polarity as the collector potential which bias may exceed the knee potential of the preceding stage.

Economical design demands that the standing collector current of a driver stage be as small as possible, but it must not be less than the base current of the following stage, to be able to fully drive that stage. Thus one would expect to find the ratio of standing collector currents in consecutive transistors to be equal to the current gain of the later stage. In these conditions, the base bias voltage of the later stage may be sufficiently greater than the knee of the driver stage to allow distortionless operation at high gain.

Design Procedure.—Having determined that direct coupling is feasible, the actual design procedure is quite simple. Operating conditions for the output stage are first determined, for example, on the lines indicated by W. T. Cocking† Having determined the output stage standing collector current, I_c, this is divided by the current gain, α'_3, to give the value of base bias current. Since the driver stage has to operate at this current level, the current in the feed resistor R_2 of Fig. 1 will be twice this figure. Thus $R_2 = V_b\alpha'_3/2I_c$, where V_b is the

* *Proc.I.E.E. Part B*, Nov. 1957, p. 583.
† *Wireless World*, March 1956, p. 109.

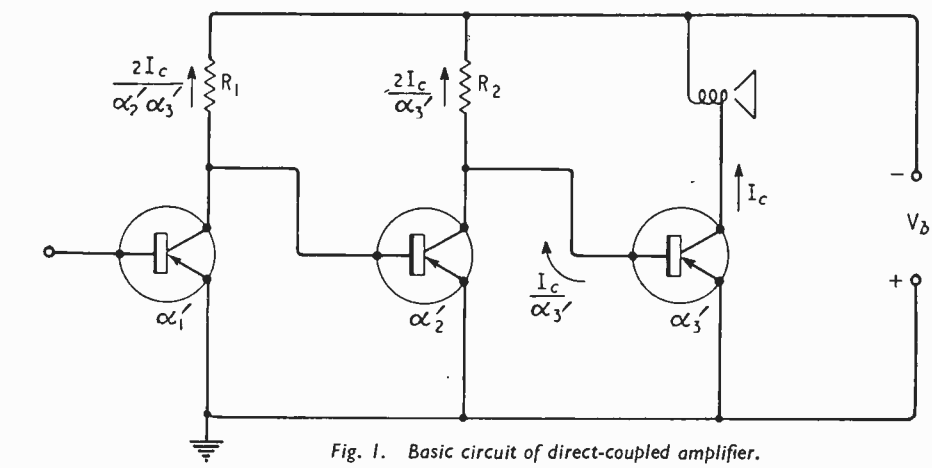


Fig. 1. Basic circuit of direct-coupled amplifier.

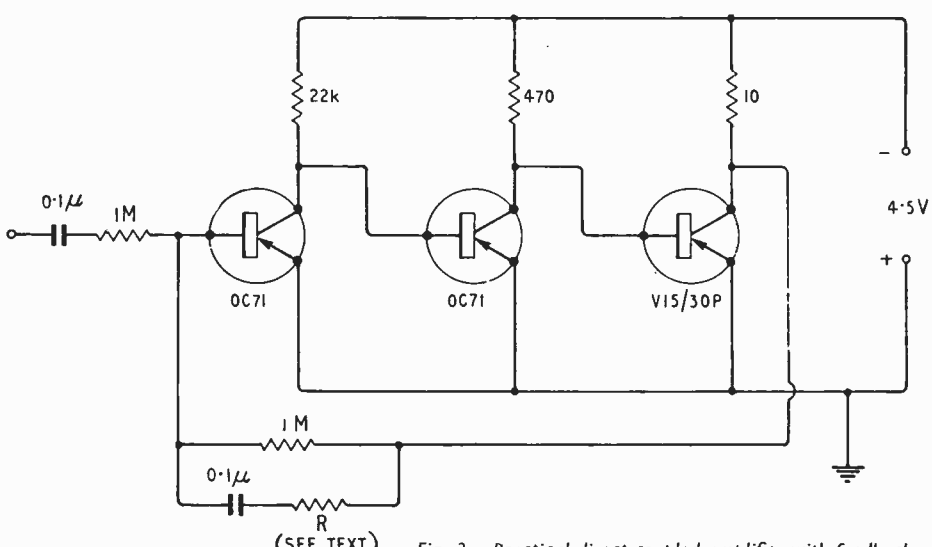


Fig. 2. Practical direct-coupled amplifier with feedback.

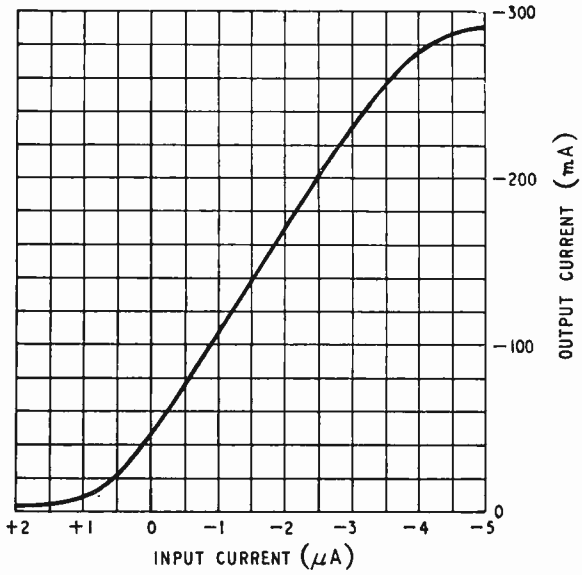


Fig. 3. Overall current transfer characteristic of the amplifier of Fig. 2 with no feedback.

supply voltage, and ignoring the small base-cum-collector to emitter voltage. The nearest lower preferred-value resistor is chosen.

The collector-cum-base feed resistor for the preceding stage (R_1) is then found by multiplying by α'_2 the value of R_2, and so on. This procedure cannot be carried on indefinitely, since after a few stages one would be demanding a current less than the leakage current, and the system would break down. Use of a battery in a feedback loop can allow operation below the leakage current by providing the necessary reverse bias; and the arrival of silicon transistors of extremely low leakage current may eventually allow extension of the principle to cover four or five stages.

A practical way to determine the value of feed resistors is to earth the base of the penultimate stage and adjust its collector resistor to give the designed peak current in the output stage; and then to earth the base of the preceding stage and adjust that collector's resistor for a minimum current in the output stage. The base bias for the first stage is then chosen to give the correct standing current in the output stage.

Performance. — Fig. 2 shows the complete circuit of an amplifier designed originally to give about 200mW in a speaker of 10Ω resistance, modified to allow measurements to be made using a 10Ω resistive load. The V15/30P output transistor is run very conservatively: with a higher supply voltage or lower speaker impedance, a much greater output power should be possible, the limit in this type of amplifier being set by the permissible current in the preceding OC71 (10mA). Fig. 3 gives the overall current transfer characteristic without feedback. The early turnover at 290mA is due to the battery potential falling to 3V at the high current level. The current gain is 64,000 times, or 96dB.

The curves of Fig. 4 give the frequency response for the following degrees of feedback:—

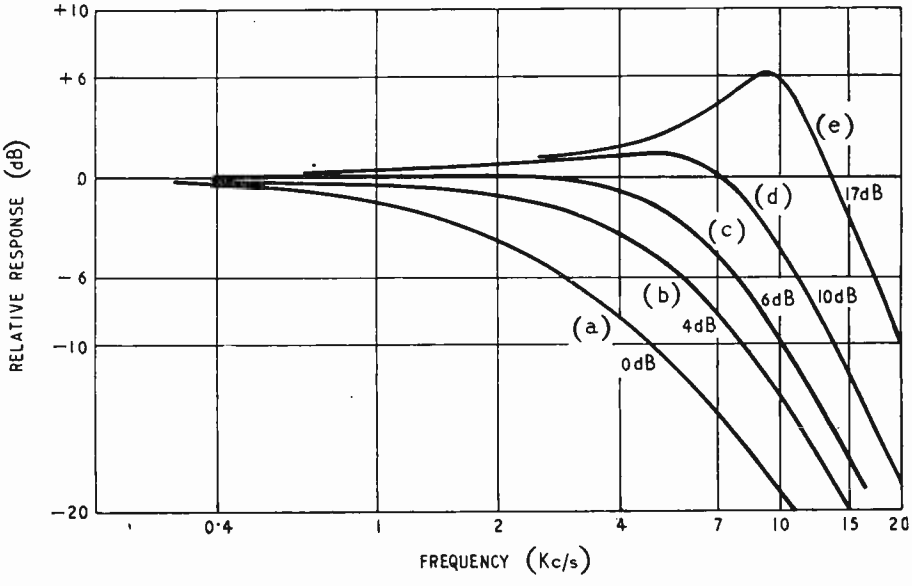
Curve (a) Feedback path broken.
„ (b) With d.c. feedback, equivalent to 4dB gain reduction.
„ (c) With R=1MΩ, equivalent to 6dB gain reduction.
„ (d) With R=330kΩ, equivalent to 10dB gain reduction.
„ (e) With R=100kΩ, equivalent to 17dB gain reduction.

Curve (c) could no doubt be improved by suitably phasing the feedback to give a substantially flat response to about 10kc/s. However, it should be appreciated that a moving coil loudspeaker load will modify the response due to its inductive impedance at high frequencies. Moreover, the power-handling capacity falls according to curve (a), since the design procedure inevitably results in the first stage being overloaded whenever the input is boosted at high frequencies to compensate for the fall in output.

Some degree of feedback should be applied to give good loudspeaker damping. The output impedance of the amplifier is given by the value of the feedback resistor divided by the unmodified current gain.

Advantages of direct coupling.—The economy in coupling components is obvious. Battery decoup-

Fig. 4. Frequency response of the amplifier of Fig. 2 with various amounts of feedback.



ling components also appear to be unnecessary, since any change in the base current to the output stage via its feed resistor (R_2) due to variations in the supply voltage is cancelled (at least at low frequencies) by the amplified current change in the opposite sense from the preceding feed resistor (R_1), when these two resistors are in the correct ratio. This argument is valid regardless of the source of any such changes in supply voltage; i.e., valid whether these changes are due to signal currents flowing through the internal impedance of the power supply, or due to ripple voltages in this supply. However, this argument does not apply if there is an odd number of feed resistors. Even in this case though, the situation is healthier than in a comparable capacity-coupled amplifier, due to the higher value of feed resistors used, and to the absence of low-frequency phase shifts. Furthermore, all the feed resistors are operating at virtually constant current at all signal frequencies, so that the output stage is the only one that can cause the appearance of signal voltages on the supply rail.

Since all but the output transistor are operated near the bottomed state, their collector dissipation is very low regardless of current level, and the maximum possible current in a stage is completely defined by the supply voltage and feed resistor.

Two disadvantages are apparent and have already been touched upon. First, the power handling capacity is a function of frequency; and secondly, an increase in leakage current in the first stage, for example due to an increase in the temperature, will restrict the available current swing in the output stage. Further possibly objectionable features arise when the amplifier is directly coupled to the speech coil of a speaker. The efficiency is reduced because of the d.c. power in the speech coil, and the speaker cone is displaced by the standing current. Of these disadvantages, only the temperature dependence of leakage current is likely to be troublesome, and some care will be necessary to ensure that the leakage current of the first stage does not exceed a small fraction of its operating current. It is worth noting that the three stage amplifier gives an overall d.c. phase reversal, being similar in this respect to a single transistor of very high current gain. Any of the accepted methods of stabilizing the operating point of a single transistor may be applied to the complete three stage amplifier with good results.

Application in Amplified a.g.c.—If the amplifier were adopted for use in a receiver, immediately following the detector, then, by direct coupling to this detector, the d.c. potential of the output stage could be used to control the gain of the radio-frequency amplifiers. By suitably biasing the gain-controlled stages, it should be possible to arrange for the gain to fall to an extremely low value when the collector potential of the output stage has fallen to its designed value. One would then have the interesting situation wherein the current of the output stage adjusts itself to the value required to handle 100% modulation of the received carrier. Thus there would be a measure of current economy, and it would be impossible to overload the amplifier!

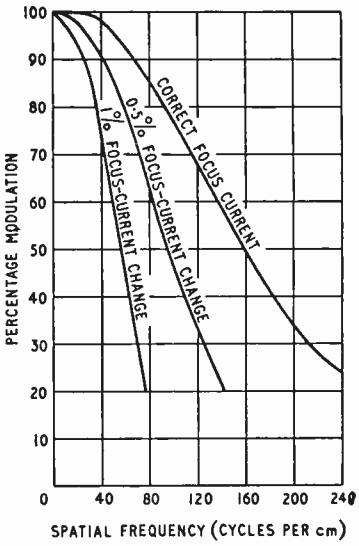
Technical Notebook

Tecnetron Mutual Conductance rising with increasing frequency is the most outstanding feature of the new French v.h.f. semiconductor device. The slope/frequency characteristic was given in our description of the Tecnetron in the March, 1958, issue (p. 132). This phenomenon results from the effect of the anode-cathode capacitance on the output current at high frequencies. Actually the equivalent circuit of the device is a resistance with capacitance uniformly distributed in parallel between anode and cathode. R and C are variable under the effect of the input voltage: the resistance diminishes as the capacitance increases, and *vice versa*. At d.c. and low frequencies the change of resistance is mainly responsible for the output current variation, but at high frequencies the capacitance change has the greatest influence. In a communication to the French Academy of Science (*Séances*, 246 (1), 6th January, 1958, pp. 72-73), M. Teszner, the inventor of the Tecnetron, gives a mathematical expression which shows how the current through the device is dependent on the frequency. The slope actually tends towards an upper limit which is independent of frequency. This is given by

$$s = \frac{dq}{dv}\ 2\pi\ f_c$$

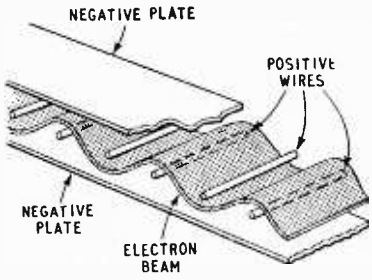
where q is the charge of the anode-cathode capacitance; $v = V \sin \omega t$, the applied input voltage; and f_c is the "critical" frequency $\frac{1}{2}\pi RC$ (where RC is the time-constant of the charge of the capacitance). This upper limit of mutual conductance was suggested in the curve given in the March issue.

C.R.T. Resolution Measurement system described on page 221 is based on the extent to which a tube can reproduce video signals applied as intensity modulation to a horizontal timebase. The results are expressed in terms of "spatial frequency response" and a typical set of curves for a commercial tube is on the right. These show how the spatial frequency response (and hence the resolution) falls off when the spot is deliberately defocused. Incidentally, a spatial frequency of 50 cycles per centimetre corresponds to a modulation frequency of 3 Mc/s in a 405-line television system. In the R.R.E. measurement apparatus, a 100-kc/s signal is applied to the tube as intensity modulation and the timebase speed is varied to give different "spatial frequencies" (see p. 221). The phase of the 100-kc/s signal is advanced continuously with respect to the timebase by 30 cycles per second. As a result the modulation pattern drifts along the trace so that 30 cycles of the pattern pass a given point on the screen every second. An image of the trace is



formed across a narrow slit and light passing through the slit falls on a photocell, which produces an output pulse whenever the scanning spot crosses the strip of screen viewed by the slit. The photocell output pulses are amplitude modulated at 30 c/s to an extent proportional to the modulation of trace luminosity which is to be measured. This 30-c/s modulation is converted by conventional techniques to a direct voltage which is indicated by an output meter. When the spatial frequency is varied by altering the time-base velocity there is a change in the average density of current reaching the screen and hence in the trace brightness. This alters the amount of light reaching the photocell, so the whole measurement system has to be calibrated afresh at each spatial frequency.

Slalom Electron Focusing, so called from the zigzag ski race, is described in an article by Cook, Kompfner and Yocom in *Proc. I.R.E.* for November, 1957. A sheet of electrons with a suitable speed and direction will describe a wavelike path (see illustration) interlinking a number of long positively charged equally spaced parallel wires which are equidistant from two negatively charged plates. Using this system, beams of quite high current density (compared with those usually obtained by electrostatic focusing) were obtained by the Bell Telephone workers. If V is the potential between the wires and plates in volts, and I the transmitted beam current in amperes, a useful measure of this current density or perveance is given by $I/V^{3/2}$, and values up to 10^{-5} were achieved. Of course, such a set of wires may easily form part of a microwave circuit; and using a laterally squashed helix on this basis, backward wave oscillations between



3.3 and 4.3kMc/s were readily obtained. However, in spite of the interlinking of the circuit by the electrons, the interaction between them is somewhat less than with a straight grazing but non-interlinking beam. Besides such use with travelling wave tubes, slalom focusing may also have applications in switching. This arises because if one of the wires is made negative, the current in the beam can be switched to one of the side plates by a very much smaller current in the wire. If the wire is made highly negative, the beam has been observed to double back upon itself, going under the wires it had previously gone over and vice versa. By continually shunting the beam to and fro in this way a storage device could be made. The storage time would, of course, be limited by defocusing of the beam due to collisions with the residual gas and possibly by space-charge effects.

Microwave Frequency Multiplication in a gas discharge is described in a letter to *Proc. I.R.E.* for October, 1957. A 3mm gap between two 7mm-diameter cylindrical electrodes at pressures of from 0.4 to 4mm of mercury was used, the discharge being initiated by about 1kV at 50c/s. With a power input to the discharge of 12.4 watts at 3,033 Mc/s from a magnetron, second, third and fourth harmonic power outputs from the discharge of 60, 21 and 0.6mW respectively were obtained by the Nihon University (Tokyo) workers. The output power was found to increase with decreasing pressures and increasing gap lengths. There are three advantages of this method of harmonic generation. First, a large power input can be used. Secondly, the conversion efficiency is better than that of a crystal frequency multiplier. Finally, the electrode construction is simple and has dimensions greater than those of a conventional microwave generator.

Thin Oxide Films.—The sensitive layer in a camera pickup tube under development in the U.S.A. is coated on to a supporting base. This base must be extremely thin, transparent, very strong and self-supporting over the coated area. According to *Electronic News* for 17th February, 1958, Westinghouse engineers have developed a simple technique for obtaining suitable films of aluminium oxide for this purpose. A piece of flat aluminium foil has its protective coating of aluminium oxide on one side removed by treatment with a caustic solution. The foil is then placed in an acid bath which dissolves the now unprotected metal. Only the film of oxide from the untreated surface remains. This is washed and mounted suitably. The tensile strength of the film is said to be similar to steel of the same thickness. It is between 25 and 30 molecules thick and this is maintained within a tolerance of one molecule size. The thickness can be varied by anodizing the foil.

Honeycomb Directional Viewer for reducing the effect of light on television or film screens is described in *Journal of the Society of Motion Picture and Television Engineers* for June, 1957. The screen is covered by a mesh of honeycomb-like cells whose walls are at right angles to the screen, and with depths comparable with the width of the cell. Light from sources outside the designed viewing angle will not reach the screen if the mesh walls absorb light. Moreover, since there are no long straight lines in such a mesh, interference effects with television scanning lines are avoided. The directional characteristics are determined by the ratio of the length, width and depth of an individual cell; different horizontal and vertical characteristics being obtainable with the length and width unequal. By oscillating the mesh to and fro through a distance comparable with the cell size at about 16c/s, permanent concealment of parts of the screen by the mesh is avoided within the designed viewing angle, and the mesh becomes invisible. With a honeycomb mesh oscillation in only one direction is necessary.

Transistor Transmitter

Economical Portable Set for W/T, R/T and M.C.W. Operation on 160 Metres

By L. F. SHAW

MANY radio operators and experimenters believe that satisfactory radio communication on the amateur bands is only possible provided considerable power is used and it is not often realized that surprising results have been obtained with only a few milliwatts in the aerial. The user of low-powered, or QRP equipment, to use a familiar amateur expression, must be prepared to exercise great patience and not be discouraged by early failures to obtain replies to his CQ calls. So far no great distances have been covered by the small all-transistor transmitter described here for use on the 1.9-Mc/s (1600 metre) amateur band. Nevertheless on one occasion communication over 20 miles was effected with an input to the aerial of only 2.5mW and as the transmitter is capable of supplying considerably more r.f. power than this it is felt that much greater distances will be covered in time.

After several early attempts the transmitter described here, the circuit of which is shown in Fig. 1, was evolved. It employs three r.f. transistors, their function being: a variable frequency oscillator (v.f.o.) TR_1; a buffer amplifier and isolating stage TR_2 and a final amplifier, TR_3.

The VFO.—This employs a parallel-tuned Colpitt's circuit with C_1L_1 in the earthed-base configuration and in this form may appear a little strange to those more familiar with valve transmitting circuits. R_1R_2 is the base bias potential divider joined across the battery and C_2 is an r.f. bypass to the d.c. positive, or earthed, line. C_1C_5 is the conventional tapped capacitor network and is connected between the collector of TR_1 and earth with the emitter joined to the tapping (junction of C_4C_5).

Resistor R_3 is not a bias resistor as might be supposed but is part of the feedback and d.c. stabilization network of the circuit. L_1 is an Osmor QA4 aerial coil but only the winding with the single layer of enamelled wire is used, and it is tuned by C_1 which is one section of a Jackson Bros. miniature 365-pF two-gang variable capacitor.

The Buffer.—This stage has two main functions, (1) to serve as a reasonably high impedance output load for the v.f.o. (TR_1) and (2) as an isolating stage between the v.f.o. and the final amplifier (TR_3) to reduce "pulling" when the final is tuned, adjusted, modulated or keyed. The base resistors, R_4 R_5, are bias and stabilization components and it is desirable they be ±5% tolerance type. Elsewhere 20% tolerance components are permissible. The closer tolerance for R_4R_5 is to ensure that the optimum drive be applied to TR_3.

Final Amplifier.—In basic form this is a class B or C amplifier with R_9 and C_{10} pre-set to allow for adjustment to provide a constant output over the full frequency range of the band. They also serve as a means of suppressing spurious oscillations or "birdies" which may appear if the stage is operated with a d.c. supply much in excess of 5 volts. R_9 and C_{10} are primarily frequency-compensating, or linearizing, components and their adjustment must be a compromise between linearity and safe operation of the final amplifier, which is discussed later. J_1 is a miniature open-circuit telephone jack for plugging in a morse key, applying

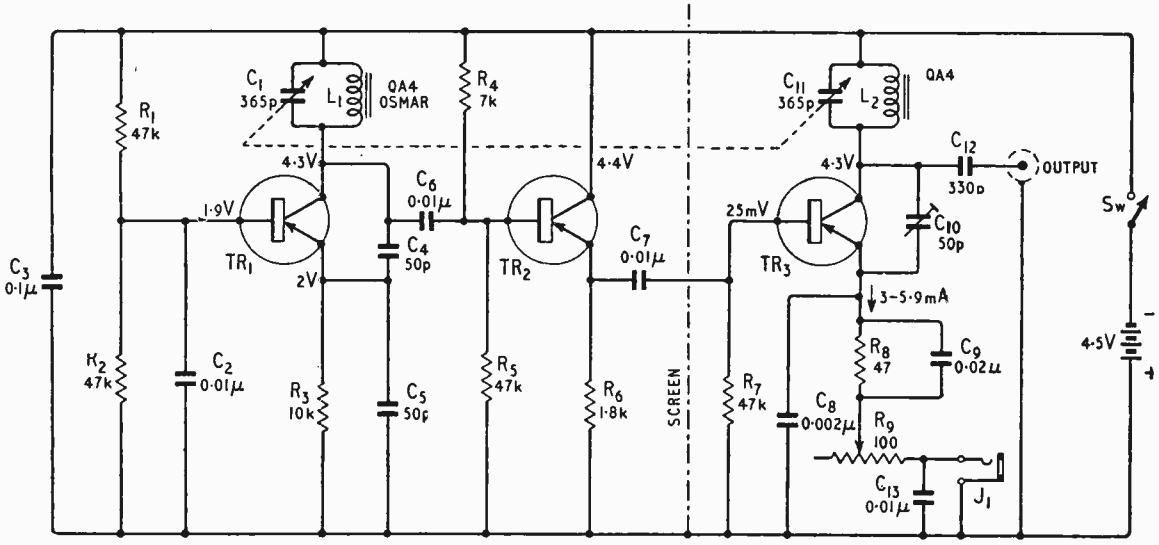


Fig. 1. Circuit of the transistor transmitter. Resistors can be ¼-W type and capacitors the lowest rating obtainable above 6 volts.

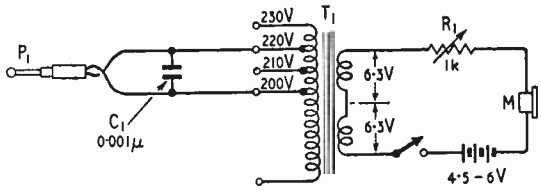


Fig. 2. Circuit of a simple R/T modulator for the transmitter.

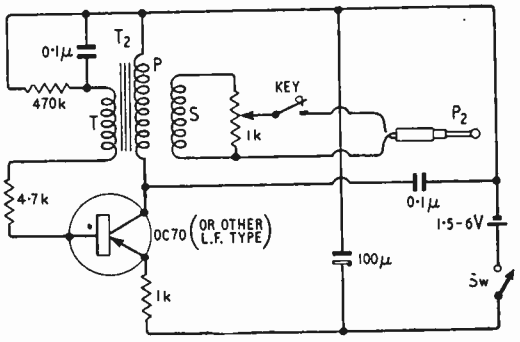
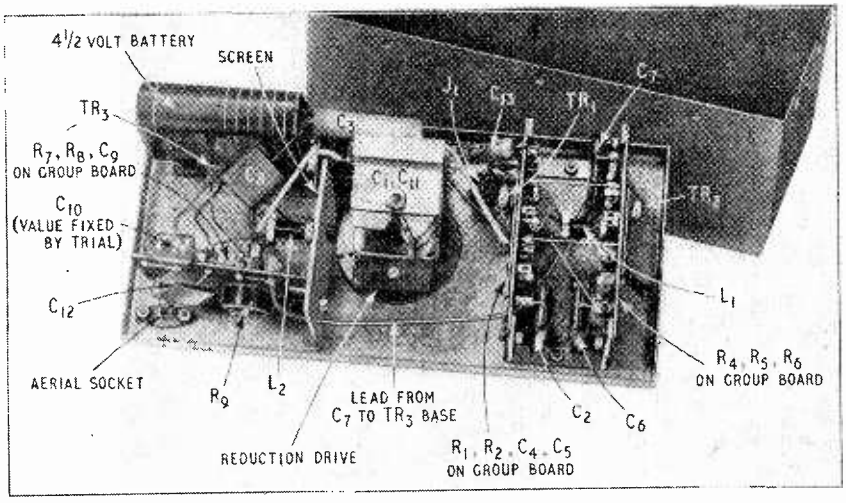


Fig. 3. Transistorized m.c.w. modulator for the transmitter. Details of the transformer T_2 are given in the text.

modulation or for metering the final amplifier. For the last-mentioned purpose a 0-10mA meter is satisfactory but it must be bypassed to r.f. with a capacitor of about 0.1μF.

Setting Up Adjustments.—With the tuning capacitor, C_1C_{11}, vanes about half meshed the dust core in L_1 is adjusted so that the v.f.o. is heard in a receiver tuned to 1.9Mc/s. With an aerial about 132ft long connected to the transmitter the dust core in L_2 is adjusted for maximum reading on a close-coupled field-strength meter or on an output meter. Some readjustment of the dust core in L_1 may be required while L_2 is being adjusted in order to achieve maximum r.f. output from TR_3. These



The transmitter is assembled on the lid of a metal box measuring 9in × 7in × 4in deep. The layout of the parts is clearly shown here. The tuning capacitor C_1C_{11} is insulated from the chassis.

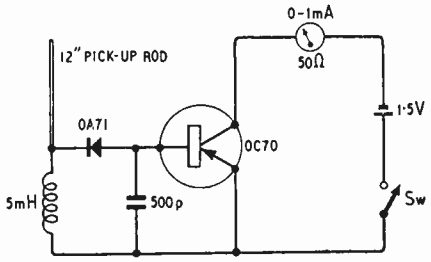


Fig. 4. A simple transistor field-strength meter can be made with this circuit.

adjustments must be carried out with a shorting plug in J_1, as measurement of emitter current for this purpose is likely to be misleading. After the circuits L_1C_1, L_2C_{11} have been correctly aligned the meter can then be plugged into J_1 and the emitter current noted. With the transistors used here this should fall between 3 and 5.9mA. R_9 and C_{10} provide the means for making adjustments to correct for excessive current and as previously explained for "birdies." During adjustments the output of the transmitter should be monitored on a suitably de-sensitized receiver with the beat oscillator on to check for a clean note.

Capacitive coupling via C_{12} is used for the aerial as this was found by experiment to be the most efficient method. No attempt was made to actually match the output stage to the aerial although on theoretical grounds this should improve the performance. Aerials of from 66ft to 132ft have been found satisfactory.

Modulation.—Either speech or tone modulation can be applied to the transmitter, but a separate unit, or units, are required as neither facility is embodied in the main equipment. The modulating circuit shown in Fig. 2 has been used for radio telephony and it consists merely of a high output-type carbon microphone M, a variable resistance R_1, to give a control of modulation depth, and a modulating transformer T_1. In the absence of a more suitable component a small mains transformer was used for T_1 by joining two 6.3-volt windings in series to form the primary (microphone winding) and using the 200- and 220-volt tappings on the original mains winding as the secondary.

An audio oscillator is required for tone modulation and this also can be transistorized and arranged as shown in Fig. 3. The transformer T_2 was wound on a small iron core about 1in cube with the primary (P) having 1,200 turns of No. 42 s.w.g. enamelled copper wire, the secondary (S) 300 turns of No. 40 s.w.g. enamelled wire and the tertiary (T) 100 turns

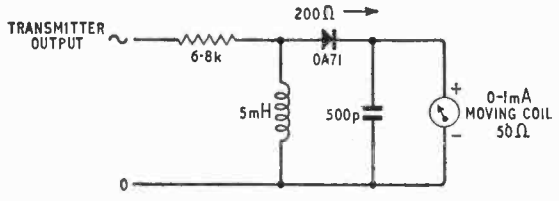


Fig. 5. Simple output meter for aligning the transistor transmitter.

of the No. 40 wire. A larger core could be used if more convenient, say the core of a small loudspeaker transformer, in which case heavier gauges of wire could, with advantage, be employed. The telephone plugs, P_1 for R/T or P_2 for m.c.w., plug into the jack J_1 on the transmitter according to which form of modulation is used.

Earlier in the description mention was made of field-strength and output meters for adjusting the transmitter. The field-strength meter used was also transistorized and its circuit is given in Fig. 4. It is self-explanatory and the same can be said of the circuit of the simple output meter, which is shown in Fig. 5.

Notes.—Sometimes a little frequency modulation of a non-crystal-stabilized transmitter results when the output stage is amplitude modulated, especially by speech. Should it occur in the present transmitter and be found troublesome it can be reduced to negligible proportions by reducing R_4 (Fig. 1) to 47kΩ and increasing R_6 to 10kΩ. These changes unfortunately reflect adversely on the performance of the transmitter and the r.f. output is reduced from about 12mW with the original values to between 2 and 3mW with the amended ones. Compromise values for R_4 and R_6 would, however, enable a reasonably good output to be obtained without too much frequency modulation appearing. Only experiment can decide which values will be best for these two components if changes have to be made from the original.

The actual transistors used by the writer were metal-cased ones having one red and one yellow spot on the top. The actual type is unknown but the characteristics are briefly:—collector voltage 5V; power dissipation 20mW; collector current 10mA; emitter current 10mA; frequency cut off 2.5Mc/s minimum, 3.5Mc/s average specimen. The red spot identifies the emitter and the yellow spot the collector. They are obtainable from Lasky's Radio and from Home Radio of Mitcham and possibly other firms as well. Several Mullard OC72s have been tried and found to be excellent oscillators in the circuit of Fig. 1. Out of 15 all oscillated above 1.6Mc/s with the majority reaching 2.5Mc/s and some even higher.

B.B.C. TELEVISION CENTRE

As can be seen from this aerial photograph, construction of the B.B.C. Television Centre on the old White City exhibition site is well under way. The White City Stadium (top right) gives some idea of the area covered by the Centre. There will be seven studios in the outer ring of the building, the first four being brought into service in 1961. All the studios will be linked by an internal 20ft wide runway along which scenery, etc., will be conveyed from the scenery block (left), which is already in use. Two floors of the main administrative circular block in the centre will house the engineering equipment. The studio control rooms will look down from this circular block into the studios radiating from it. The Centre will house the national central control room and also the Continental control point for Eurovision at present in Broadcasting House. The garden in the central ring will be 150 feet in diameter—about the size of Piccadilly Circus.

The Band V convertor assembled as a self-contained, screened unit, including power supply.

U.H.F. Convertor with Signal Frequency Amplification

By H. N. GANT,* A.M.Brit.I.R.E.

Television Reception on Band V

As mentioned in the article on Band V tests in *Wireless World* for December 1957 (p. 566) experiments are being conducted to ascertain the possibilities of this band, using different television systems and types of receiver. For this purpose the B.B.C. are transmitting signals from their station at Crystal Palace and the reception at various places is being assessed. Some of the receivers, however, are of a type unsuitable for ordinary domestic use at present.

One of the principal problems facing the designer of a television receiver for use at u.h.f. is the noise factor. In the U.S.A., where this band is already in use for television broadcasting, it is common practice to use no amplification at u.h.f., the signal being fed directly into a crystal diode mixer. The local oscillations are often derived from a harmonic of the existing v.h.f. (Band III) oscillator. This yields a noise factor of some 18 to 20dB at 650 Mc/s owing to the conversion loss in the crystal and the presence of noise sidebands with the oscillator harmonics. It is, however, neat and cheap since the entire unit can be built on to one position of an orthodox television turret tuner.

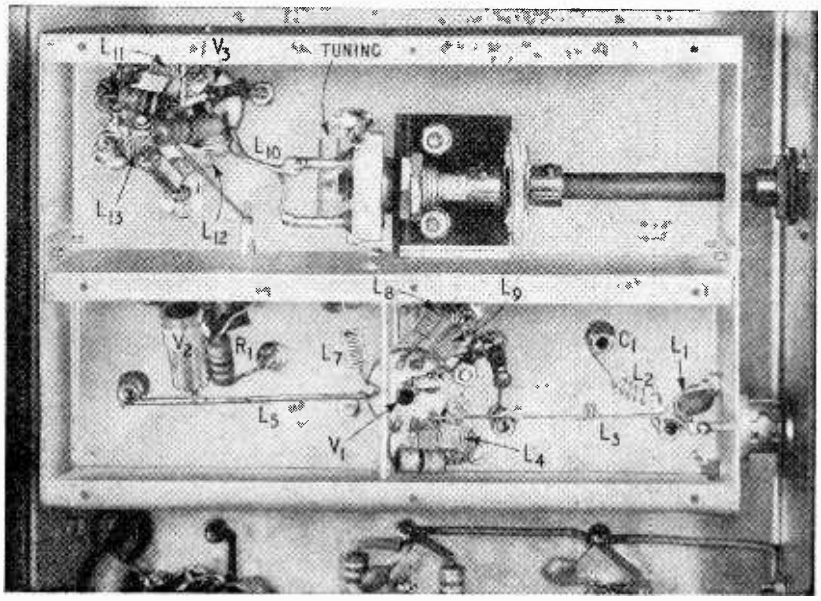
The use of Lecher lines or resonant cavities for the u.h.f. circuits, and a separate u.h.f. oscillator, would give an improvement in the noise factor of 16 to 18dB. Experimental models have been described which are much better than this, down to 10 to 11dB, but these are not in commercial use at present.

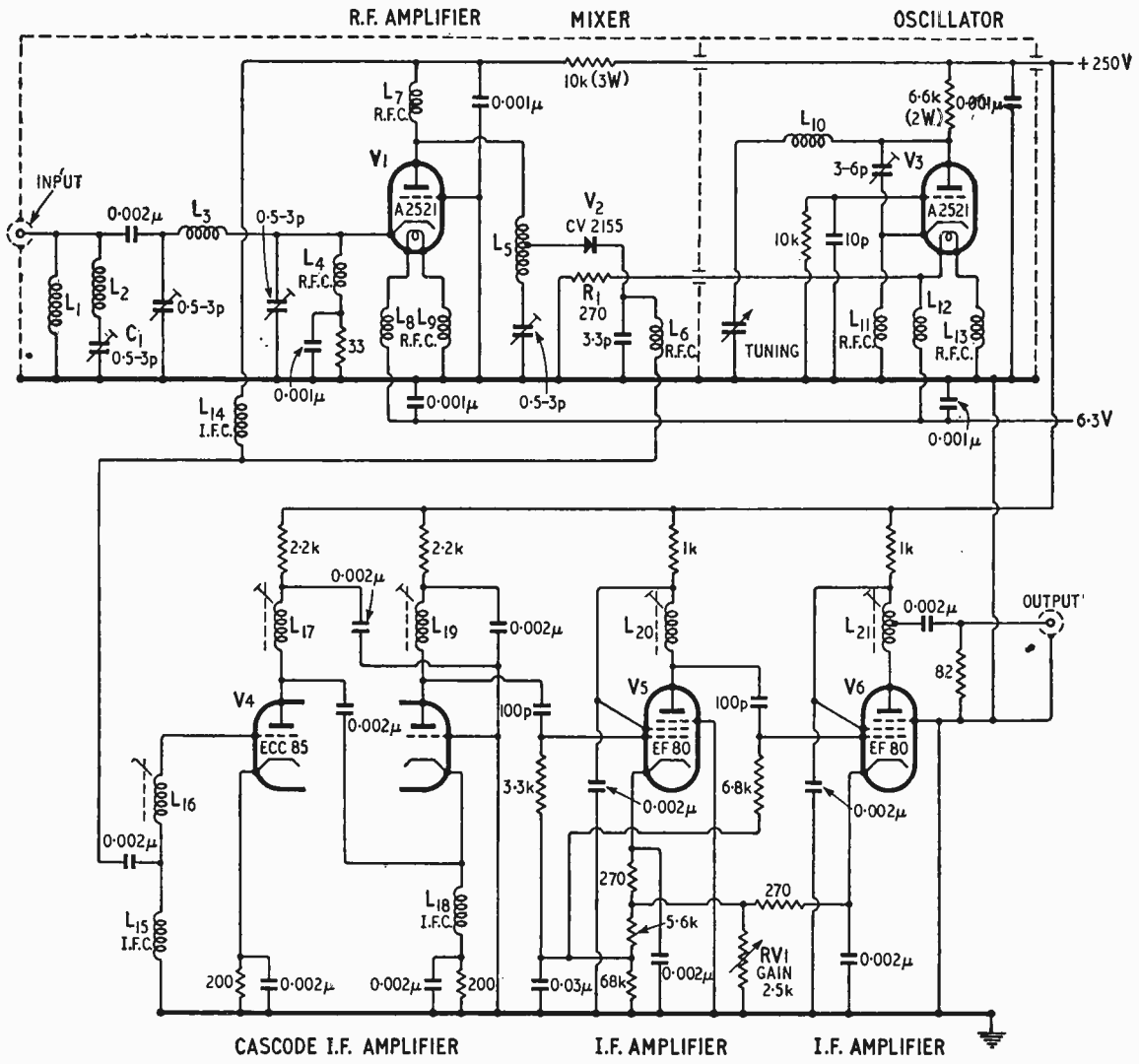
The addition of an r.f. amplifier stage will permit a worth-while improvement in the noise factor, but only a few valves really suitable for this application are available. The older disc-seal triodes achieve their performance by running with high anode currents, and it is necessary to use them in conjunction with large masses of metal to act as a heat sink for the anode seal. This form of construction is admirably suited to ultra low-loss co-axial circuits but would be prohibitively expensive for domestic use.

Recently introduced valves, however, will give satisfactory performances as u.h.f. amplifiers with only modest anode currents. One such is the M.O.V. Type A2521 which has an ordinary B9A base and the electrode assembly mounted horizontally and directly on the header pins. The claimed performance for

* E.M.I. Electronics Ltd.

R.F., mixer and oscillator section of the convertor; it comprises that part of the circuit enclosed by broken lines.





Theoretical circuit diagram of the Band V television convertor described in the text. The tuning capacitor is a modified air-space trimmer with plates removed to leave one fixed and one moving. All resistors ½-W unless otherwise stated.

this valve as an r.f. amplifier at 650 Mc/s is a power gain of 13.5dB with a 13-Mc/s bandwidth and a noise factor for the stage alone of 10dB.

A number of convertors have been manufactured and supplied for experimental Band-V reception by E.M.I. Electronics to the order of B.R.E.M.A. These use an A2521 valve as an r.f. amplifier, another as the local oscillator and a radar-type crystal diode, CV2155, as the mixer. This r.f. section is followed by a cascode double-triode first i.f. amplifier and two further pentode i.f. amplifiers as shown in the circuit diagram. The output is intended to be fed to a television monitor, or to a receiver having provision on the channel-selector switch for accepting a signal at the standard television i.f.

Since the valves are conventional plug-in types, it was decided to attempt to use ordinary television receiver-type components throughout. Series resonant circuits tuned with ceramic tubular preset capacitors have been found quite satisfactory, although the inductor reduces to a straight piece of 16 s.w.g. wire in some places. Small chokes of 0.1in diameter and self supporting, wound with a few turns of silk-covered wire are used where necessary and have been found to introduce negligible loss. In fact there are very few unconventional parts of the circuit. As can be seen in the illustration of the u.h.f. portion of the convertor, the oscillator anode inductor consists of two wires in parallel, the spacing between them being adjusted on test to bring the oscillator to the correct frequency with the variable capacitor at mid travel, thus obviating the necessity for a trimming capacitor, which would reduce the oscillation amplitude and restrict the frequency range available on the main tuning capacitor. Local oscillations for injection into the mixer circuit are taken from the live heater of the oscillator valve, and thence to earth through a 270-ohm resistor (R_1) placed close to the crystal. Adjustment of the relative position of V_2 and R_1

COIL WINDING DATA

L_1	1in of No. 18 s.w.g. tinned copper wire.
L_2	5 turns, 0.1in dia. No. 20 s.w.g. tinned copper wire, $\frac{3}{8}$in long.
L_3	1½in with 2 turns, 0.1in dia., spaced one wire diameter in the centre, No. 20 s.w.g. tinned copper wire.
L_4 L_5, L_6, L_7, L_8 L_9, L_{11}, L_{12}, L_{13}	R.F. choke, 10 turns closewound, 0.1in diameter. No. 22 s.w.g., d.s.c. air core.
L_{10}	Two, 1¼in long, No. 16 and No. 20 s.w.g. tinned copper wires in parallel.
L_{14}, L_{15}, L_{18}	I.F. chokes; 98 turns No. 44 s.w.g. En. on $\frac{5}{16}$in diameter moulded former.
L_{16}	18¼ turns No. 28 s.w.g. En. closewound on $\frac{5}{16}$in dia. moulded former with dust core.
L_{17}, L_{19}	14¼ turns otherwise as L_{16}.
L_{20}	7½ turns otherwise as L_{16}.
L_{21}	21¼ turns tapped 3½ turns from h.t. end otherwise as L_{16}.

permits the optimum crystal current to be achieved, while the resistance limits the heater current flowing. This arrangement has been found to give constant injection over the tuning range with negligible pulling or loading effects on the oscillator. The bandwidth of the r.f. circuits is set by adjustment of the crystal tap position on L_5. The rather large capacitance of the aerial input socket is roughly tuned out by an inductor (L_1), connected to the chassis and consisting of about one inch of wire; it gives the appearance of a short circuit on the input. A series resonant circuit (L_2C_1) at the image frequency (727Mc/s) is also added across the input circuit. This consists of a π network adjusted to give optimum aerial coupling for minimum noise factor. The coupling required differs considerably from that giving maximum power gain. Although not of primary importance in this application, it has been found that the oscillator drift over long periods of use is less than 500kc/s.

The performance specification achieved by this convertor is:—

Frequency	654.25Mc/s, tunable ±5Mc/s
Gain	40dB.
Input and output impedance	75 ohms.
R.F. Bandwidth	±6.5Mc/s to −3dB points.
I.F. Bandwidth	33 to 40Mc/s, flat ±1dB.
Noise Factor	10.5 to 11dB measured in 3Mc/s bandwidth.
Spurious responses	at least 30dB down.

MAY MEETINGS

LONDON

6th. I.E.E.—"Some case histories of business computers in the U.S.A." by Dr. A. T. Starr at 5.30 at Savoy Place, W.C.2.

8th. Society of Instrument Technology.—"Control of the radio telescope" by Dr. J. G. Davies at 7.0 at Manson House, Portland Place, W.1.

9th. I.E.E.—Discussion on "The teaching of applied acoustics" opened by G. Mather at 6.0 at Savoy Place, W.C.2.

14th. I.E.E.—"A new cathode-ray tube for monochrome and colour television" by Dr. D. Gabor, P. R. Stuart and P. G. Kalman at 5.30 at Savoy Place, W.C.2.

15th. I.E.E.—Annual general meeting followed at 6.30 by "Recent developments in electronics in the United States" by D. G. Fink at Savoy Place, W.C.2.

16th. B.S.R.A.—Annual general meeting at 7.15 followed by "High fidelity in sound and colour" by Leslie Guest (Gaevart) at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

19th. B.S.R.A.—Lecture-demonstration by RCA (Great Britain) at 7.0 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

19th-23rd. I.E.E.—International convention on microwave valves, Savoy Place, W.C.2.

21st. Brit.I.R.E.—"Cold cathode voltage transfer circuits" by J. H. Beesley at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1.

MALVERN

28th-29th. Physical Society.—Conference on spectroscopy of solids (including semiconductors, ionic conductors, metals and insulators) at the Royal Radar Establishment.

MANCHESTER

13th. Society of Instrument Technology.—Manchester section annual general meeting at 7.30 followed by "Magnetic amplifiers" by Dr. D. A. Bell at Manchester College of Technology.

LATE-APRIL MEETING

29th. Society of Relay Engineers.—"Television relay with particular reference to the BRW Mark II television relay equipment" by K. A. Russell (British Relay Wireless) at 2.30 at 21, Bloomsbury Street, London, W.C.1.

CLUB NEWS

Bournemouth.—A mobile rally is being organized by the Bournemouth Amateur Radio Society for Sunday, May 18th, in Kings Park, Boscombe. Two talk-in stations will be operating from 10.30 B.S.T. onwards (G2HIF/P on 145 Mc/s and G3HLW/P on 1880 kc/s). Sec.: C. R. Davies (G3JAU), 107, Talbot Road, Winton, Bournemouth.

Brighton.—The Brighton and District Radio Club meets each Tuesday at 8.0 at "The Eagle Inn," Gloucester Road. At the meeting on May 6th the Mullard film "Made for Life" will be shown. On May 20th J. P. Clement will deal with the cathrode-ray oscilloscope. Sec.: R. Purdy, 37, Bond Street, Brighton, 1.

Bury.—Aerials will be discussed at the technical forum of the Bury Radio Society on May 13th. Meetings are held at 8.0 at the George Hotel, Kay Gardens. Sec.: L. Robinson, 56, Avondale Avenue, Bury.

Gilwell Park.—Throughout the Scout weekend Jamboree at Gilwell Park on May 10th and 11th a radio transmitter is being operated by the Wanstead, Woodford and District Radio Club. It will use the call sign GB3BP. Two operating positions will be available, one for the 160 and 80 metre bands (to be confined to "G" calls), and the other for the 7 to 28 Mc/s bands. Transmissions will be mainly in the s.w. sections of these bands. Further details are obtainable from the organizing secretary, Boy Scout International Jamboree-on-the-Air, 965, Oxford Road, Tilehurst-on-Thames, Reading, Berks.

Prestatyn.—At the May 5th meeting of the Flintshire Radio Society the secretary of the club will speak about amateur television. The club meets at 7.30 at the Railway Hotel. Sec.: J. Thornton Lawrence (GW3JGA/T), 9, East Avenue, Bryn Newydd, Prestatyn.

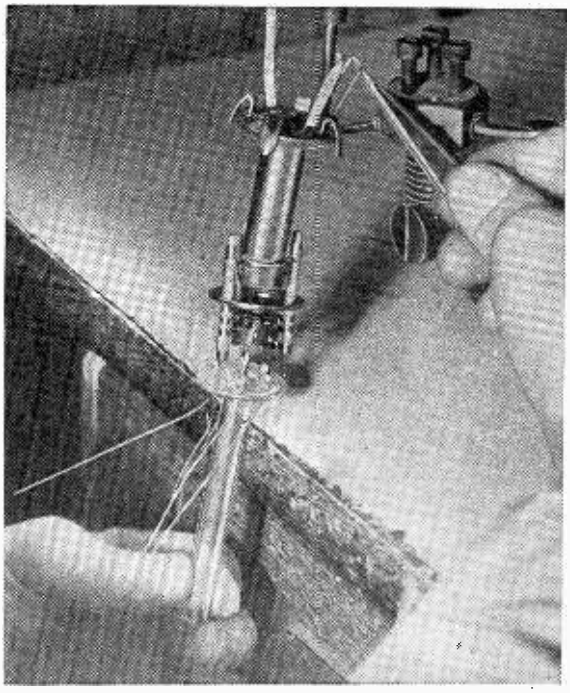
Stockport-Manchester Rally.—A joint rally is being organized for May 18th by the Stockport Radio Society and South Manchester Radio Club. It is planned to include a mobile field-strength competition and a "walking" d.f. contest. Particulars are obtainable from C. M. Denny, 18, Willoughby Avenue, Didsbury, Manchester, 20.

"NEW TUBES FOR OLD"

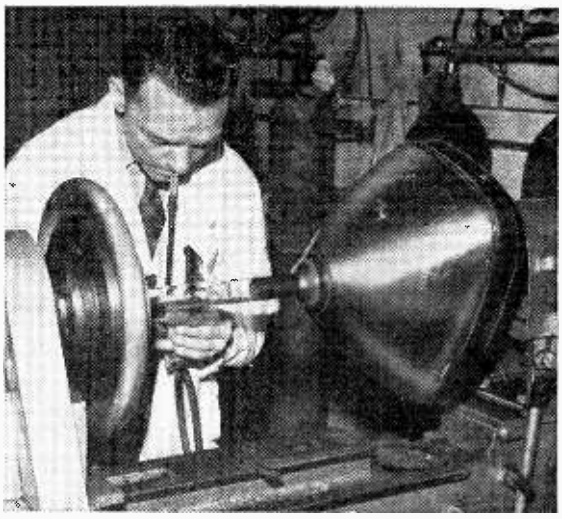
THE cry of the modern versions of Aladdin's magician uncle who offer to renovate worn-out cathode-ray tubes may be regarded with some suspicion by the more technically-minded television viewers. Terms like "reconditioning" and "renovating" in advertisements can mean various things, and even the more precise "re-gunning," "re-vacuuming" and "reactivating" leave some element of doubt on the exact nature of the techniques. There are, however, certain firms who are known for doing a very complete job of replacing the vital parts of the tube, as being the only sure means of obtaining a genuine new lease of life.

Recently *Wireless World* had the opportunity of seeing this kind of process being performed at the works of Nu-Life Teletubes at Greenford, Middlesex. Here the vital parts replaced are the cathode and the heater. This can be loosely described as "re-gunning," although in fact the remainder of the electron-gun assembly is used again in its original form.

After a general cleaning-up of the tube, the first step is to test the screen with ultra-violet radiation (applied externally) to see if it is still sufficiently active and free from ion burns and other flaws. When a screen is found to be faulty the radio dealer or owner who sent in the tube is advised that re-gunning will not be worth while. The next process, after removal of the base, is to let air into the tube. This has to be done very slowly and carefully, as a too sudden rush of air would tear off the fluorescent screen. A tiny crack is made in the tube neck near the base by means of an electrically heated wire, and this allows the air to seep in gradually over a period of several hours.



Reassembled electron gun mounted on a new glass pinch with evacuating tube.



Jointing a new section of glass tubing on to the existing neck.

When the inside and outside pressures have been equalized the glass pinch is parted from the tube neck and the electrode assembly mounted on it is withdrawn. The glass pinch itself is removed from the electrode support wires and the cathode and heater assembly is taken out of the electron gun. The coiled tungsten heater wire and capped nickel cathode tube are prepared and coated with the appropriate oxides—providing insulation for the heater and emissive material for the cathode.

Grid-Cathode Spacing

Replacing the cathode-heater assembly in the electron gun is a highly critical business, because the cathode surface has to be very close to the grid aperture (about 12-15 thou') and the spacing must be adjusted to be exactly as in the original gun to preserve the electron-optical design and tube characteristics. An optical system of adjustment is used in which a beam of light shines obliquely through the grid aperture on to the cathode surface, and the grid-cathode spacing is altered until the shadow of the grid-aperture edge falls in a predetermined position. The light-beam angle of incidence is calibrated directly in terms of grid-cathode spacing.

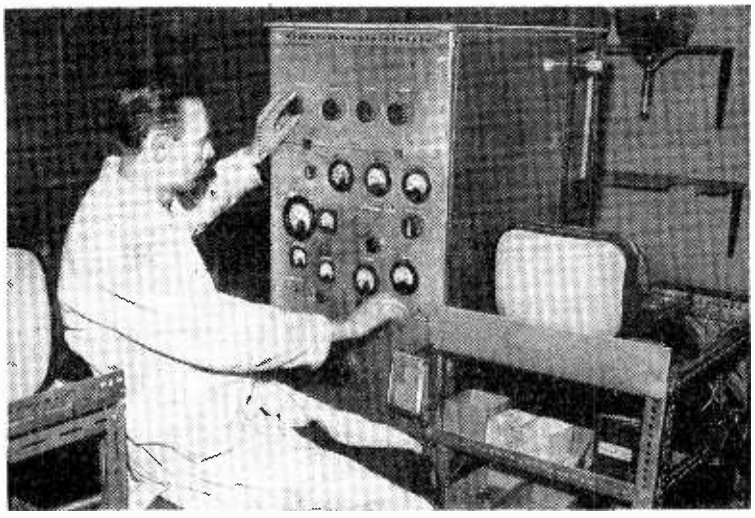
After a new getter has been welded to the electrode assembly and the whole structure has been mounted on a new pinch fitted with an evacuation tube, the electron gun is ready to be put back in the c.r.t. Meanwhile, a new length of glass neck has been joined to the existing neck of the tube on a glass-blowers' lathe. The reconditioned gun is inserted into this new section of neck and aligned

axially by means of a jig, after which the neck glass is melted by a blow-pipe at the right place to join on to the pinch.

Vacuum pumping is the next operation, and this is done on an equipment consisting of a rotary pump backing an oil diffusion pump. The process takes a considerable time—several hours, depending on the size of the tube—because the tube has to be baked in an oven during evacuation to liberate adsorbed gases in the glass and metal, and there is a safe limit to the speed at which it can be heated up and cooled down while under pressure. At the end of the pumping process the getter is fired by h.f. induction heating to complete the vacuum and the tube is sealed off from the pump. Finally the base is refitted and the envelope is recoated with graphite (the original coat having been removed during the initial cleaning).

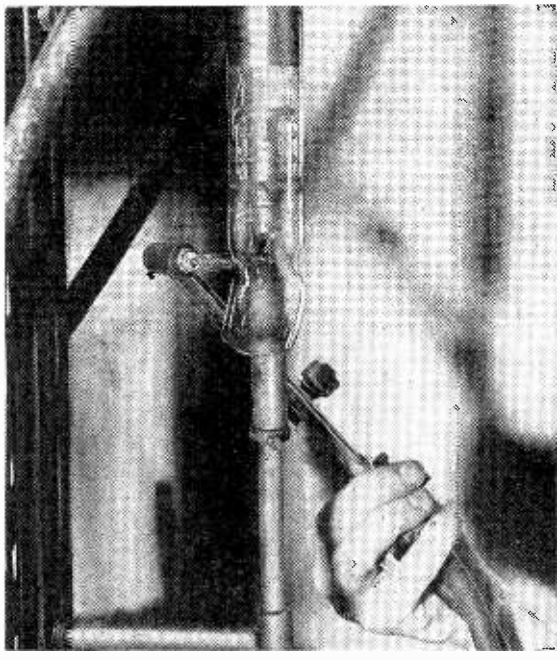
The reconditioned tube is put through a series of tests similar to those applied in c.r.t. manufacture, and is sent back to the dealer or private owner with a guarantee of six months. A client can always be sure of getting back the same tube that he sent in.

One point which particularly impressed *Wireless World* was the high degree of individual skill and craftsmanship required in this sort of work. The reconditioned tubes are virtually hand-made jobs, comparable with those produced in the early days of television. There seems no reason why they should not be as good as the originals. The fact that the service is used by several well-known radio manufacturers, including at least one producer of cathode-ray tubes, is fair enough comment in itself!



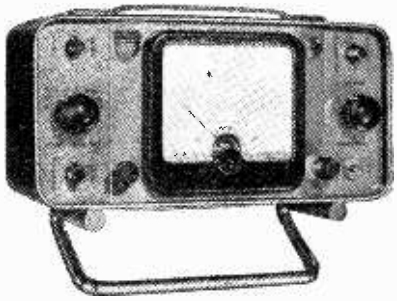
Test equipment for the completed tubes.

Melting the new neck on to the pinch. When the glass is softened the weight of the surplus piece pulls in the neck to join with the pinch. A jig holds the electron gun in the correct position.



Transistor D.C. Voltmeter

FOUR basic ranges with full-scale deflections of 1 to 1,000V, each with an internal resistance of 150,000 ohms per volt, are provided in the Amos of Exeter model



Amos of Exeter transistor d.c. voltmeter.

140 d.c. voltmeter. A "divide-by-two" button for each range halves the full-scale deflection and doubles the internal resistance per volt. Three additional ranges with full-scale deflections of 5, 10 and 20kV can be obtained by the use of a high-voltage probe housing a 200MΩ resistor. The accuracy is said to be better than 2% of the f.s.d. on all ranges. Two grounded-emitter-connected transistors in a balanced linear d.c. amplifier circuit are used. These are mounted in a $1 \times \frac{1}{2}$in solid metal heat sink packed with glass wool inside a case which reflects heat from outside. Under normal bench conditions a reading will not vary more than 1% every two hours due to temperature changes. A $7\frac{1}{2}$V reference supply accurate to 1% is built in, and the total standing drain from the $4\frac{1}{2}$V transistor supply is 300μA. The range of the set zero control is wide enough to give centre-zero scale facilities if desired. Protection against overload is also provided. This voltmeter costs £34, and is distributed by Soundrite, Ltd., 82-83, New Bond Street, London, W.1.

EXHIBITIONS AND CONFERENCES

FURTHER details of the exhibitions and conferences listed below are obtainable from the addresses given in brackets. British manufacturers can obtain information regarding exhibiting at the shows from the Board of Trade, Export Publicity and Fairs Branch, Lacon House, Theobalds Road, London, W.C.1.

UNITED KINGDOM

International Convention on Microwave Valves, Savoy Place, London, W.C.2. ..... May 19-23
(I.E.E., Savoy Place, London, W.C.2)

European Television Exhibition, Park Lane House, London, W.1. ... May 19-24
(Prestige Promotions, Ltd., 45 Park Lane, London, W.1.)

Electronics Exhibition and Convention, Manchester College of Science and Technology ..... July 10-16
(Institution of Electronics, 78 Shaw Road, Rochdale, Lancs.)

National Radio Show, Earls Court, London, S.W.5 ..... Aug. 27-Sept. 6
(Radio Industry Council, 56 Russell Sq., London, W.C.1.)

Farnborough Air Show ..... Sept. 1-7
(Society of British Aircraft Constructors, 29 King St., London, S.W.1.)

Convention of Scientific Instrument Manufacturers, Majestic Hotel, Harrogate ..... Nov. 6-9
(S.I.M.A., 20 Queen Anne St., London, W.1.)

Electronic Computer Exhibition, Olympia, London, W.14 ... Nov. 28-Dec. 4
(Electronic Engineering Association, 11 Green St., London, W.1.)

OVERSEAS

British Electrical Conference, Brussels, Belgium ..... May 16-17
(Secretariat, 36 Kingsway, London, W.C.2.)

International Conference on Solid State Physics in Electronics and Telecommunications, Brussels, Belgium ..... June 2-7
(Société Belge de Physique, 18 rue de Phillipeville, Loveral, Belgium.)

Armed Forces Communications and Electronics Association Convention and Exhibition, Washington, D.C., U.S.A. ..... June 4-6
(A.F.C.E.A., 1624 Eye St., N.W., Washington 6, D.C., U.S.A.)

International Automation Exposition and Congress, New York, U.S.A. .. June 9-13
(Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, U.S.A.)

International Congress and Exhibition of Electronics and Atomic Energy, Rome, Italy ..... June 16-30
(London Agents: Auger and Turner, 40, Gerrard St., London, W.1.)

French Components Show, Paris, France ..... June 20-26
(S.N.I.R., 23 rue de Lubeck, Paris 16.)

International Conference on Semi-conductors, Rochester, N.Y., U.S.A. Aug. 18-23
(G.E.C. Research Lab., P.O. Box 1088, Schenectady, N.Y., U.S.A.)

Western Electronic Show and Convention, Los Angeles, U.S.A. ..... Aug. 19-22
(Wescon, 1435 South La Cienega Boulevard, Los Angeles 35, Cal., U.S.A.)

Colloquim on Electronic Properties of Metals at Low Temperatures, Geneva, N.Y., U.S.A. ..... Aug. 25-29
(International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15, France.)

Swiss Radio, Television and Recording Show, Zurich, Switzerland Aug. 28-Sept. 2
(W. Von Liliencron, 15 Strassburg Strasse, Zurich.)

International Analogy Computation Meeting, Strasbourg, France ..... Sept. 1-9
(F. H. Raymond, 138 Boulevard de Verdun, Courbevoie (Seine).)

International Congress on Cybernetics, Namur, Belgium ..... Sept. 3-10
(International Assoc. for Cybernetics, 13 rue Basse-Marcelle, Namur.)

Instrument-Automation Conference and Show, Philadelphia, U.S.A. Sept. 15-19
(Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

International Symposium on Nuclear Electronics, Paris, France ..... Sept. 16-20
(Société des Radioélectriciens, 10 av. Pierre-Larousse, Malakoff (Seine).)

International Radio-Television-Electronics Fair, Amsterdam, Netherlands. Sept. 22-29
(H. J. Kazemier, Emmalaan 20, Amsterdam Z.)

Irish Radio and Television Show, Mansion House, Dublin, Eire ..... Sept. 23-27
(*Irish Radio & Electrical Journal*, 14-15 Dame Street, Dublin, Eire.)

National Electronics Conference, Chicago, U.S.A. ..... Oct. 13-15
(N.E.C., 84 East Randolph St., Chicago, Ill., U.S.A.)

International Radio and Telecommunications Fair, Ljubljana, Yugoslavia Oct. 31-Nov. 9
(Gospodarsko Razstavisce, Titova 48, Ljubljana.)

International Conference on Scientific Information, Washington, D.C., U.S.A. Nov. 16-23
(Secretariat, 2101 Constitution Ave., Washington, D.C., U.S.A.)

RANDOM RADIATIONS

By "DIALLIST"

Is TV Sound "Hi-Fi" ?

"SEEING the heading of your note on 'hi-fi' TV," writes a Hampton Hill reader, "I hoped you were going to deal with the sound." Heaps of people, he says, have the mistaken idea that their television sound *is* "hi-fi," presumably because their dealers have told them so. It isn't, of course, though reproduction can be made a good deal more pleasing to the ear than that of medium-wave programmes. You can hardly expect "hi-fi" with single pentode output and a small (usually elliptical) loudspeaker crammed into the cabinet of a table model. And since probably well over six million of the eight million TV sets now in use are table models, it would hardly be worth while to transmit high-quality sound. Nor, I believe, would most people be able to appreciate it. They're so occupied by what's on the screen that the sound has to be very bad indeed before they notice that anything is amiss with it. One possible exception is the sound accompanying TV transmissions of concerts. Really musical people, I know, like to watch them in order to study the techniques of the conductor and of the instrumental soloists. But I'd far rather hear a concert on my v.h.f. receiver. And anyhow there are songsters of both sexes who are much better heard and not seen! If you have a console TV set, there's generally room in the lower compartment for a good-sized loudspeaker, and by improving the audio circuit you can obtain sound which is very pleasant to listen to.

The Synchroguide

IN a recent issue I mentioned that I'd been unable to send to a South African reader the particulars of the Synchroguide system of line-scan sync because I hadn't the full circuit with component values. Now a Canadian reader, whose present home is in the U.S.A., has sent me full details of the RCA Synchroguide. If my South African reader cares to write again (I've mislaid his address), I'll be happy to send them on to him and they should tell him all he wants to know. He, if you remember, receives the London TV transmissions, the only snag being that the sync signals haven't sufficient amplitude to lock his line scan. Accounts of reception of the Crystal Palace come from all sorts of distant places.* It was reported in the dailies not long ago that a Moscow amateur has built himself a set which regularly pulled in London. I suppose that most, if not all, of this extraordinary DX reception is due to the present spottiness of the sun and that we'll hear less and less of it as old Sol's complexion clears on the approach of a sunspot minimum.

* See letter in this issue from an Australian reader.—ED.

Interference Problems

THERE are so many possible sources of interference with broadcast transmissions on the medium and long wavelengths and with television on Bands I and III that one is sometimes tempted to wonder that anyone ever satisfactorily receives a sound or vision programme. But, thank goodness, a very respectable proportion of listeners and viewers manage to do so. Most people, I suppose, can come to tolerate a certain amount of interference and not a few whose homes are close to roads carrying heavy motor traffic must be able to accept it as just one of those things. If that weren't so one wouldn't see such numbers of TV aerials above houses so placed. Continuous and violent interference, though, is something that no one can put up with, especially if he's receiving a TV signal in a fringe-area. Some of this arises from high-voltage power-lines under certain weather conditions. But there are too many preventable kinds of interference knocking about. One of them—and a pretty common one, as P.O. engineers know to their cost—is due to the conversion of TV sets of unsuitable types for Band III reception, or the use of convertors of the wrong kind.

I.T.A. Sound on F.M. Receivers

SEVERAL readers report that on their f.m. receivers they can pick up the I.T.A.'s sound or vision signals by putting their sets slightly off tune. All of those who have had such experiences appear to live within quite short distances from both I.T.A. television and B.B.C. f.m. transmitters. All tell me that they receive the I.T.A. signals at settings corresponding to frequencies bearing no apparent relation to those on which they are sent out. It seems not unlikely, then, that the very strong I.T.A. signals are beating with some harmonic of the local oscillator frequency and so forcing their way in. I'd welcome further information on the subject from any who'll be kind enough to send it along.

F.M. in France

THOUGH the expansion of her television system has been to a large extent held up by the economy squeeze, France is going right ahead with the development of a country-wide v.h.f./f.m. network. It is hoped that all the stations will be in action before the end of this year. The biggest snag, it is feared, may be the inability of the P.T.T. land-lines to cope with anything like the 15 kc/s frequency band which the transmitters are designed to handle. Radio links can be difficult in such mountainous country as is found in many parts of France and their installation would in any case considerably increase the cost of the scheme. It may be that to begin with the quality is not as good as it might be. But the French are such good engineers that I've little doubt that f.m. in that country will before long be as good as any in the world.

What is a Billion ?

A LETTER from Reading refers to my March paragraph on the difference between the British billion (10^{12}) and the American billion (10^{9}). The writer says "We are informed by our atomic physics folk that they use 10^{9}, symbol G." Will I please comment? he asks. I don't think that there's any doubt that the commonly accepted value of the British billion is, at any rate in non-scientific circles, 10^{12}. That is what my dictionary shows and it goes on to give trillion as 10^{18}, quadrillion as 10^{24} and so on. But France, the United States and many other countries use 10^{9} for billion, and it's quite likely that some, though not all I think, of our scientific people

have come into line, with the idea of preventing misunderstandings. Actually, if some people have changed to 10^9 and others stick to 10^{12} for the billion, misunderstandings are bound to be increased, as I pointed out. Wouldn't it be a whole lot better if everyone agreed to drop all those numerals above million ending in "illion" and to use the index system instead? Nowadays most people who use large numbers in their calculations are familiar with what one of H. G. Wells's characters referred to as "the little two hup hin the hair."

Factor of Safety

FAR too many breakdowns occur nowadays in resistors, capacitors and other bits and pieces used in sound and television sets. One can't help feeling that components with an insufficient factor of safety are too often used in order to keep costs down. The market is, of course, a highly competitive one and if the non-technical buyer sees two 17-inch TV sets, both equally attractive to the eye and both showing a similar picture, he'll be apt to go for the cheaper one. He may be lucky and have little or no subsequent trouble; but if some of the components in his new set are barely up to their job of work, he may have to spend on repair work far more than he "saved" on the purchase price.

The Things They Write

EVEN in these days, when the majority of our folk are users in one way or another of electricity, people do write and say some rather astonishing things about it. Here's one example, culled from a national daily newspaper:

"TAPED.—Seven years after the electricity meter was removed a house was found reconnected to the main cable with insulating tape. . . ." Hardly, one imagines, the best of conductors! And here's another from a hearing-aid advertisement. "Magnetic waves (*help!*) are those we hear from telephones, radios, televisions (*sic*), etc. With this aid you can listen to normal conversation, then by switching to 'magnetic' you can hear magnetic waves perfectly, without distortion" (my italics). And in a crossword I came across the clue: "Official letters can be electrifying (4)." The answer was, of course "ohms"; but it's more than a mite difficult to see how the unit of resistance could be the active promoter of any kind of electrification.

UNBIASED

By FREE GRID

Mechanized Chalatry

I AM delighted to see that a prominent manufacturer has followed the example of introducing automation in the office, which I set in pre-war days, when I introduced closed-circuit TV to assist a prominent executive to engage a new secretary without yielding to the human weakness of letting his better judgment be over-ruled by purely physical considerations. For those of you who have forgotten it, I reproduce my original sketch from *W.W.* for June 22nd, 1939, showing him rejecting a candidate—albeit reluctantly—for reasons which will be obvious to you.

There are other disturbing factors apart from female pulchritude which upset office routine. One of these is the tea break, sanctity of which seems to have become inviolable. It is this inviolability which a prominent manufacturer has had the courage to tackle by introducing automation in the shape of an ingenious electronically operated tea-break timer.

A reluctant rejection.

This consists of a neat unit which indicates the beginning of the chatasting interval by the clanging of an electric bell. Ten minutes later the bell sounds again automatically to signal its close. One of the most interesting features of it is that the normal interval of 10 minutes can be extended to 15, 30, 45, or even 60 minutes, thus making the instrument suitable for use in Government offices.

While admiring the practical knowledge of modern office routine which the designer of this interesting device shows, the use of a commonplace electric bell to signal the start of such a sacred ritual as chalatry seems to show a certain lack of imagination. Having regard to the quality of office tea it would surely be better to have a short recorded excerpt from Handel's "Water Music" to start the ceremony, the closure being indicated by one of the more sombre settings to the *Miserere*.

Stereo in Paediatrics

IN HIS letter in the April issue, Mr. Antonios Simonis—obviously a scion of the land of Socrates and Plato—appears to rebuke me for saying that our modern witch-word "stereo" is derived from the Greek verb of that name. In actual fact he goes to some trouble to prove that what I said was correct, for I made it quite clear—as he does also—that our word "stereo" was not derived from the Greek verb meaning "to deprive of."

The only point on which we differed is a trifling one. I spoke of the verb as "stereo" whereas in his letter he uses the Attic contracted form of "stero" in which the penultimate "e" disappears in favour of a circumflex accent over the omega. This is also its modern Greek form except that they have streamlined the circumflex accent.

Now although we both agree in stating somewhat dogmatically that the Greek verb has no place in the ancestry of our 3-D word "stereo," I have a nasty feeling that we may both be wrong. It certainly seems strange that too such very similar words as "stereo" and "stereos" (or stereo and sterion as Mr. Simonis says) should have no relationship to each other.

But their English meanings of "to deprive of" and "solid" seem to be poles asunder until we remember that, at a certain period of its life, an infant is "deprived of" its natural nourishment and put on to "solid" food. Surely, in this simple fact of paediatrics, there is a very natural link between the words? I have taken some pains to work that one out and I hope none of you classical "scolards" is going to hold me up to public ridicule.

I find a certain amount of support for my view in the works of the Rev. John Parkhurst, fellow of Clare-Hall, Cambridge, a noted Greek and Hebrew scholar of Hanoverian times who earned some claim to fame by being—as he himself makes clear—the first man to make Greek available to the masses by publishing a grammar which was not based on the supposition that they were already well-acquainted with Latin. I have always thought that the good man overlooked the fact that they might also be not well acquainted with reading and writing English in the year 1769 when he first issued this work.

Bureaucratic Bumbledom

WE ALL receive an annual reminder to renew our wireless, driving and other licences. I suppose few people read these reminders and I must confess I have never done so until this year. This accounts for the fact that I have never before noticed on the wireless-licence reminder the impertinent request which says: "If you are not renewing your licence please state the reason below."

I cannot think of any other activity requiring a licence where a reason is demanded for non-renewal. If I don't renew my driving licence I don't have to give any reason for not doing so. I am spared the humiliation of saying that I can no longer afford to run a car because my expectations under my mother-in-law's will have not been realized.

I wonder if any of you know if any legal penalties are incurred for failing to give a reason. If I don't wish to renew my licence, I don't know what reason would be acceptable to the P.M.G.; in fact, I don't know why on earth he wants any reason at all.

A wireless receiving licence is, after all, a permit to establish and operate a wireless receiving station and the money given for it is in no sense payment for value received in the form of entertainment. It could, therefore, obviously be of no use my telling the P.M.G. that I was dissatisfied with the programmes as he could rightly retort that a licence would still be necessary even if all programmes ceased. The correct answer would, I suppose, be "I am not renewing my licence because I am no longer operating a wireless receiving station." But that would only lead to the P.M.G. asking a supplementary question: "Why are you no longer intending to operate a wireless receiving station?"

If the P.M.G. must ask this impertinent question surely he could print half a dozen answers and tell us to strike out those not applicable. However, I doubt whether the Wireless Telegraphy Act or any other Act of Parliament gives any authority to the P.M.G. for this piece of bureaucratic bumbledom.

Pocket size... pocket wise!

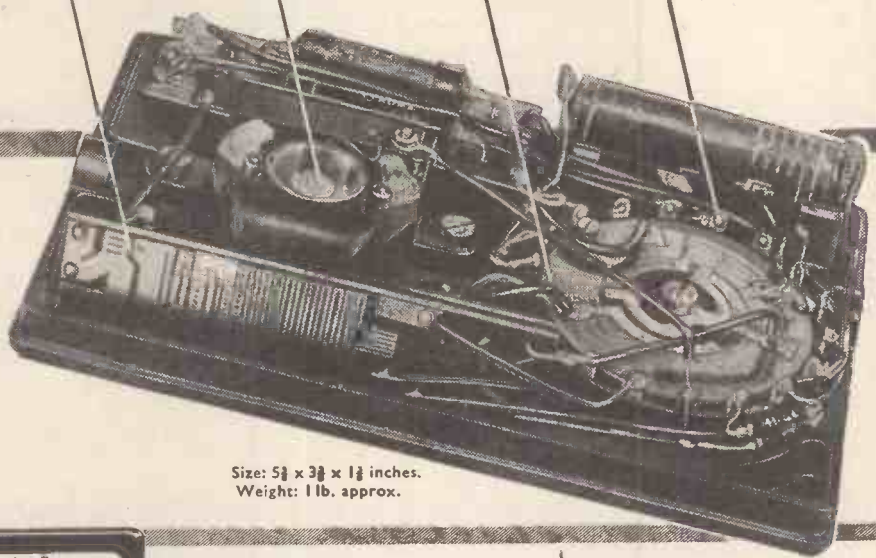
This sturdy multi-range test meter is remarkable for the wide range of test facilities which have been so neatly incorporated. Full advantage has been taken of printed resistor techniques to produce a compact instrument of low weight.

Printed resistance panel for universal meter shunt.

Composite printed resistors and auxiliary switch.

Meter movement is enclosed to give protection against the infiltration of dust.

Robust range switch similar to that used in the famous Avo-Meter. Eighteen fixed silver-plated contacts embedded in a ring of high-grade moulding material are swept by a double contact rotar arm.



AVO

Regd. Trade Mark.

Size: 5¾ x 3¾ x 1¾ inches.
Weight: 1 lb. approx.

7 D.C. Voltage Ranges: 0-1,000 V.

5 A.C. Voltage Ranges: 0-1,000 V.

5 D.C. Current Ranges: 0-1A.

2 Resistance Ranges: 0-20,000Ω. 0-2MΩ.

Sensitivity:
10,000Ω/V on D.C. voltage ranges.
1,000Ω/V on A.C. voltage ranges.

Accuracy:
3% of full scale value on D.C.
4% of full scale value on A.C.

For a small additional charge, instruments can be supplied to a higher degree of accuracy.

THE MULTIMINOR

List Price:

19 Ranges · Single Knob Control · £9:10s.

Complete with test leads and clips. Leather case if required 32/6.

● **Write for fully descriptive leaflet.**

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VICtoria 3404 (9 lines)

A

improved

SOLARTRON

'packaged' power

sub-units

It's so easy to put in a ready-made, self-contained, completely reliable Power Supply sub-unit!

these are design centre performance figures

	SRS 156	AS 516	AS 517	AS 616	AS 619	AS 754	AS 755
VOLTAGE	±150V	±250V or ±300V	±250V or ±300V	±250V or ±300V	±150V to ±180V	±250V or ±300V	±250V or ±300V
CURRENT	0-40mA	0-50mA	10-100mA	0-1A	0-200mA	0-200mA	0-500mA
A.C. OUTPUTS	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 2A C.T. 6.3V 1A	6.3V 10A C.T.	6.3V 4A C.T. 6.3V 4A C.T. 6.3V 1A C.T.	6.3V 6A C.T. 6.3V 6A C.T. 6·3V 2A	6.3V 10A C.T. 6.3V 5A C.T.
D.C. SOURCE IMPEDANCE	<2Ω	0·3Ω	0·2Ω	0·4Ω	0·5Ω	0·4Ω	0·05Ω
STABILISATION FACTOR	400:1	1000:1	800:1	500:1	400:1	500:1	500:1
A.C. SOURCE IMPEDANCE 40c/s—100kc/s	<2Ω	0·1Ω	0·15Ω	0·2Ω	0·2Ω	0·4Ω	0·2Ω
RIPPLE AND NOISE CONTENT	<350μV	100μV	150μV	300μV	100μV	150μV	300μV
DIMENSIONS	9⅛" × 6¼" × 6¼" high	9⅛" × 6¼" × 6¼" high	9⅛" × 7⅛" × 6¼" high	19" × 19" × 10½" high	10" × 10" × 6 3/16" high	13" × 6¾" × 6¼" high	19" × 12" × 8¾" high
WEIGHT	14½ lbs	14½ lbs	20½ lbs	150 lbs	21½ lbs	25 lbs	56 lbs

* Better stability factors
* More heater power
* Less ripple and noise
* No increase in cost for this improved performance
* Lower source impedance
* Stability unaffected by capacity loading
* Delivery ex-stock

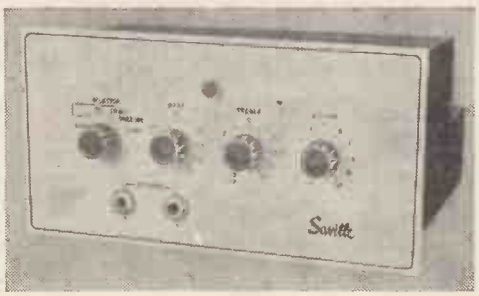
SOLARTRON **Power Supply Sub-units**

THE SOLARTRON ELECTRONIC GROUP LTD • THAMES DITTON • SURREY • ENGLAND

Telephone: EMBerbrook 5522 · Cables: Solartron, Thames Ditton

This is the amplifier that will not date

'Saville' is the amplifier of the future. It has been designed in the light of the very latest developments for the reproduction of sound in the home, including the revolutionary new stereo discs— 3-dimensional sound. Produced by the makers of ***Period High Fidelity,*** *'Saville' inherits all the technical excellence and superlative craftsmanship for which the company is renowned. 'Saville' offers the high fidelity enthusiast a top-quality amplifier with provision for twin-channel tape and disc reproduction plus the ultimate in new recording techniques.*



SAVILLE PRE-AMPLIFIER

Construction and wiring are to the highest instrument standards and all components are very conservatively rated. **PRICE £15.0.0**

SAVILLE MAIN AMPLIFIER

Output transformer is of the distributed load "C" core type, and there is ample H.T. and L.T. for auxiliary equipment. **PRICE £27.0.0.**

ADVANCE FEATURES

PRE-AMPLIFIER

- ★ 6-position control: radio, tape (direct from deck), gram 78, gram L.P, stereo records, stereo tape.
- ★ Equalisation: tape to C.C.I.R. characteristics; gram to R.I.A.A. characteristics; stereo position fully equalised.
- ★ Treble cut and boost:— 20 db to +14 db.
- ★ Bass cut and boost:— 20 db to +20 db.
- ★ Inputs at rear of chassis: radio, tape, gram, stereo tape, stereo gram.
- ★ On front panel, sockets for monaural tape recorder and Ferrograph 77 and 88 stereo recorder.
- ★ Two entirely separate channels are provided, matched to within 1 db, all the controls being matched and ganged on the two channels.

MAINS AMPLIFIER

- ★ Output: 20 watts rated. 30-35 watts peak.
- ★ Power response: at 20 watts — 32 c/s to 30,000 c/s ±1 db
- ★ Distortion measured at 1,000 c/s and 20 watts: <0.1%
- ★ Hum and noise: 85 db down at rated output.

Post this coupon today to

PERIOD HIGH FIDELITY Ltd.,
28 SOUTH ST., MAYFAIR, LONDON, W.1
Tel.: GROsvenor 4686

for full details of the 'Saville' amplifier.

Name.....

Address.....

.....

WW1

Period High Fidelity

LIMITED

28 SOUTH STREET MAYFAIR, W.1. Tel.: GRO 4686

MUTUAL & SELF INDUCTANCE BRIDGE

Designed for the accurate measurement of either mutual or self inductance and resistance in the range 0·001μH to 30mH and 100μΩ to 3000Ω respectively.

All measurements are made in the form of a four-terminal network and inductance and resistance of leads and clips are not included in the measurement.

Accuracy within ± 1% frequency 1592c/s ($\omega = 10\,000$)

Full technical information on this and other 'Cintel' Bridges is available on request.

CINEMA TELEVISION LTD

A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD · LONDON · S.E.26
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McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester 16

The Connectors and Rotary Transformers produced for many years by our Associate Company, Power Controls Limited, will in future be manufactured and marketed by ourselves. This, from our customers point of view is simply a change in name.

Improved cable clamps on the new range of our Miniature Hermetically Sealed Co-axial Plugs and Sockets will withstand a pull of up to 35 lbs., and are suitable for use with Uniradio 70 cable.

They have been developed and Type Approved to Inter-Service Requirement under R.C.S. 322 and are freely interchangeable with the types which they supersede.

The new types are hermetically sealed and 100% production tested. Sealing caps are available for uncoupled units.

MAGNETIC DEVICES LIMITED

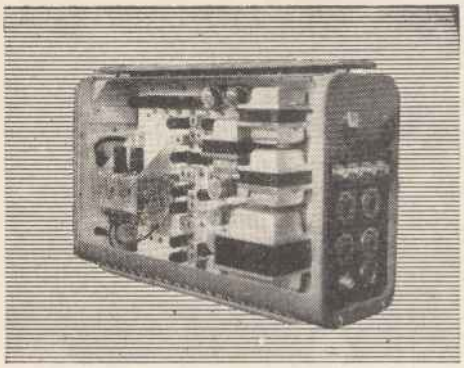
MAGNETIC DEVICES LIMITED

A. I. D. & A. R. B.—Approved

Exning Road, Newmarket, Suffolk

Phone: Newmarket 3181/2/3. Grams: Magnetic Newmarket.

MD 23A

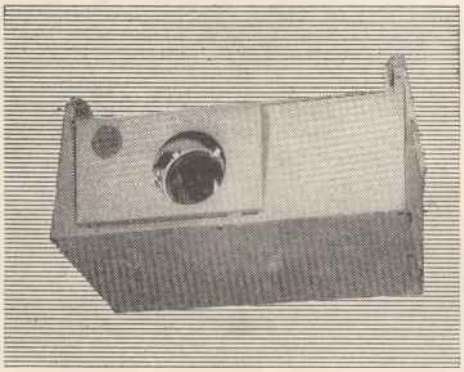


Mobile sound and vision receiver designed and produced by P.A.M. LTD. for Marconi's Wireless Telegraph Company Limited. It is primarily intended for use in studio and mobile control rooms.

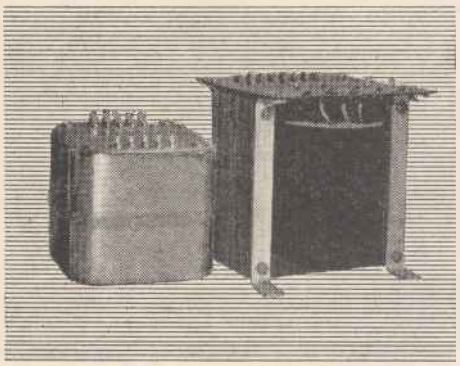
If it's Electronic . . .

and you want it Designed and Developed or produced to your specification*

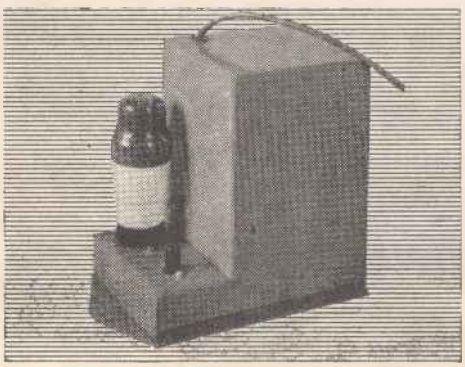
Consult P.A.M.LTD



Model P.48 Ceiling Projection Receiver for closed circuit Television for Industrial use giving a picture up to 4ft. x 3ft.



Open and Shrouded types of Transformers for general use in electronic equipment. Designed and manufactured to individual requirements.



R.F., E.H.T. Unit. A safe, D.C. high voltage unit specially designed to meet the need for a reliable source of supply for Television C.R. Tubes. Also satisfactory for flash testing where a D.C. supply is necessary.

P.A.M. LTD. Electronics Department combines the technique of several companies, long-established in the Electronic field, with the extensive modern production resources of P.A.M. LTD.

Examples of recent work are illustrated.

P.A.M. LIMITED,
Electronics Department,
MERROW, GUILDFORD, SURREY
Telephone: Guildford 2211

**Whichever stage of the struggle you've reached, we can save you time and trouble—maybe money too—write or 'phone without delay.*

One of the group of Companies in the Southern Areas Electric Corporation Ltd.

Six days after disastrous fire . . .

Photo by courtesy of Wiltshire Newspapers Ltd.

MEMORANDUM TO Mr. HECTOR V. SLADE

FROM Sales and Shipping Tuesday 25 March

U.S.A. Shipments.

The following will be delivered to Park tonight by British Road Services.

Los Angeles.
500 RC.121.D Schedule K
S.S. "Drumendyk"
Royal Mail Line
Ex London

New York.
250 T.A. MK.II
200 RCSS D.
M.V. "Britannic"
Cunard S.S. Co
by. Liverpool.

A. G. Sherman

Sales.

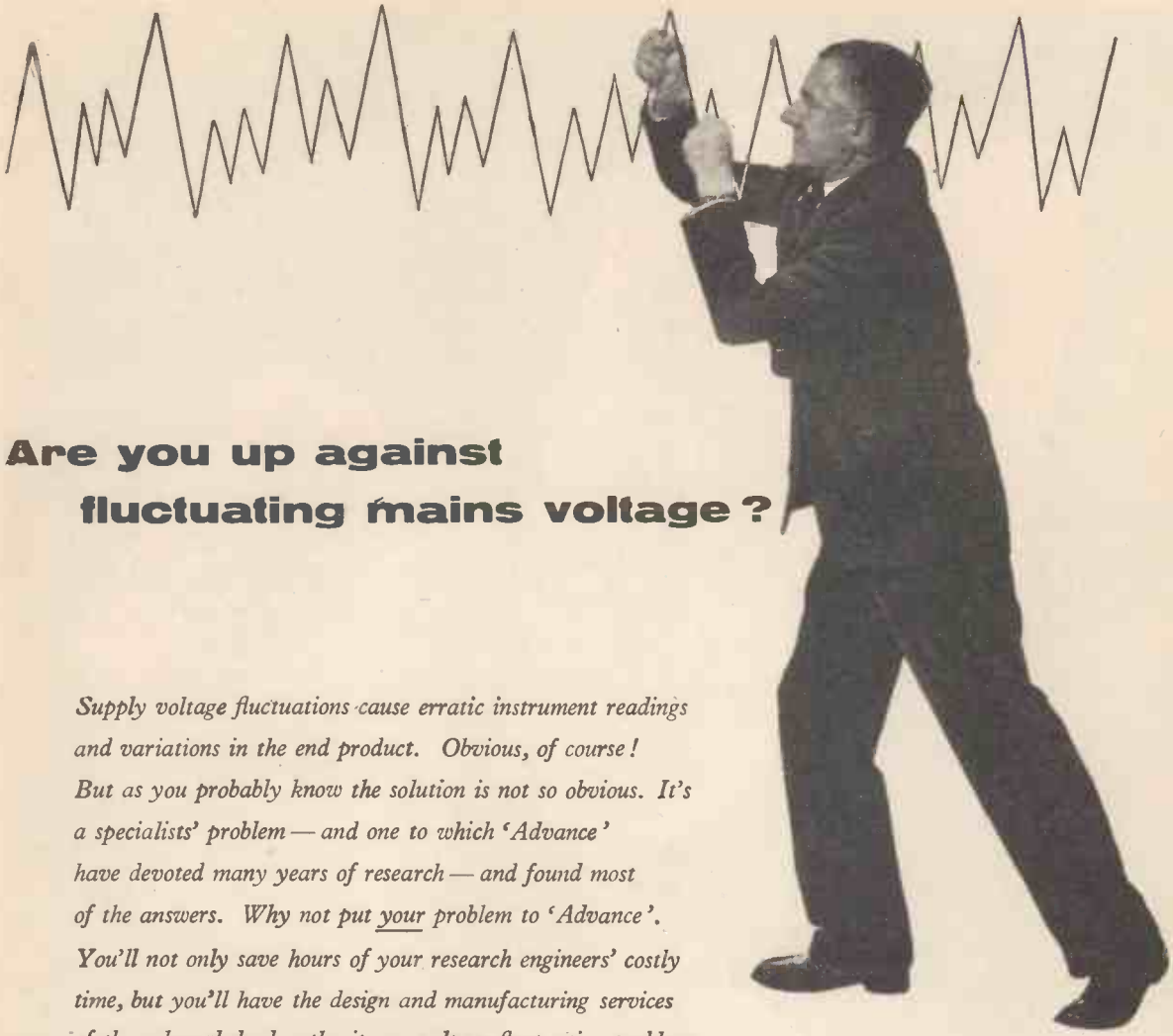
Are these completely new production and wired for States?

HR.

Yes sir.

A.G.S.

. . . exports resumed by Garrard



Are you up against fluctuating mains voltage?

Supply voltage fluctuations cause erratic instrument readings and variations in the end product. Obvious, of course! But as you probably know the solution is not so obvious. It's a specialists' problem — and one to which 'Advance' have devoted many years of research — and found most of the answers. Why not put your problem to 'Advance'. You'll not only save hours of your research engineers' costly time, but you'll have the design and manufacturing services of the acknowledged authority on voltage fluctuation problems.

Advance can help you

Full technical details available in Leaflet W.54.

CVT

CONSTANT VOLTAGE TRANSFORMERS

ADVANCE COMPONENTS LIMITED

ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · Telephone : Hainault 4444

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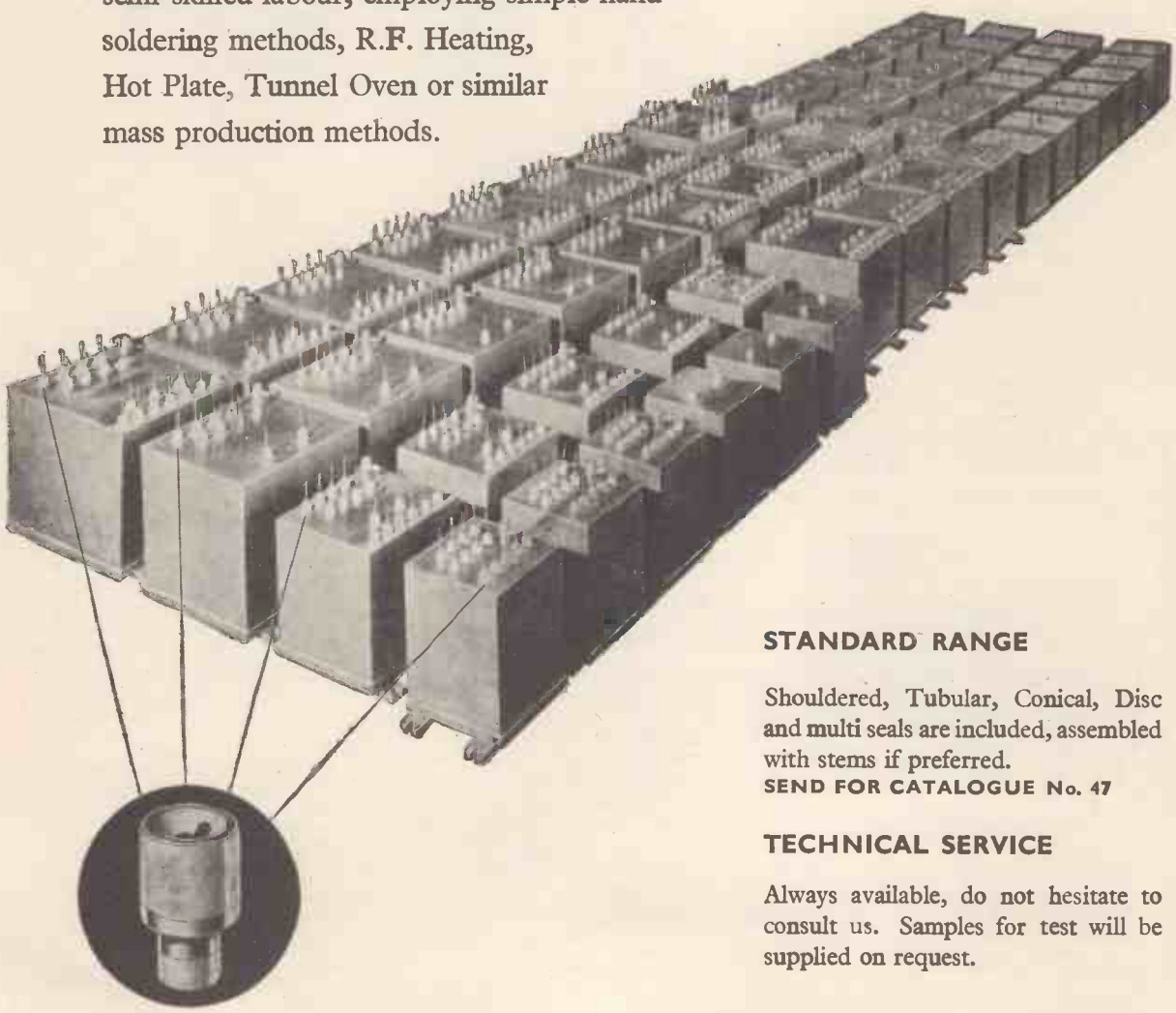
Hermetic Sealing

STEATITE & PORCELAIN
NICKEL METALLISING
Quality Approved (Joint Service R.C.S.C.)
WILL MEET THE MOST EXACTING REQUIREMENTS

METALLISED BUSHES

Perfect Terminations

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



STANDARD RANGE

Shouldered, Tubular, Conical, Disc and multi seals are included, assembled with stems if preferred.
SEND FOR CATALOGUE No. 47

TECHNICAL SERVICE

Always available, do not hesitate to consult us. Samples for test will be supplied on request.

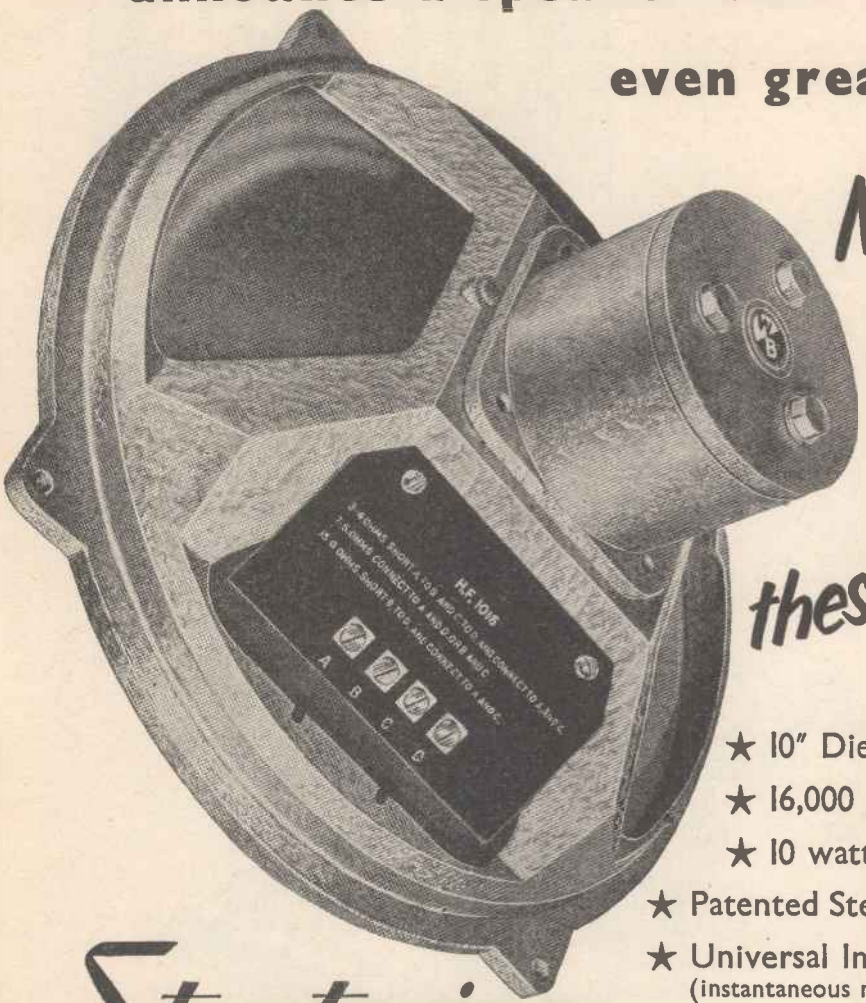
STEATITE & PORCELAIN PRODUCTS LTD.

STOURPORT ON SEVERN, WORCS. **Telephone: Stourport 2271** **Telegrams: Steatain, Stourport**

SP100

The makers of the world famous H.F.1012

announce a speaker that will achieve even greater success



No other speaker has all these features!

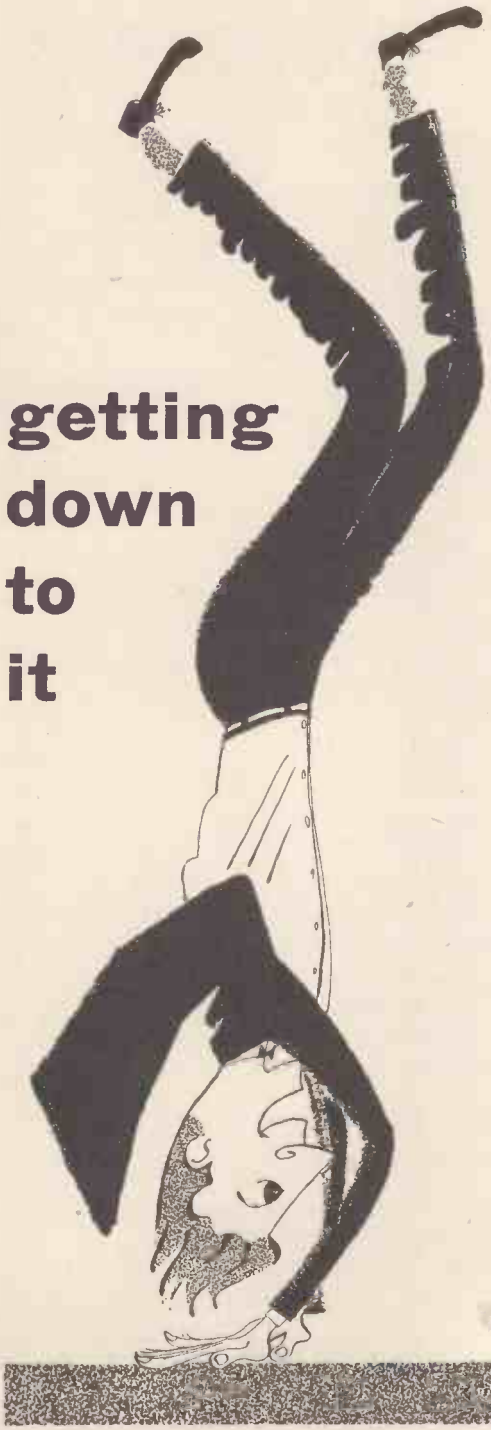
★ 10" Die Cast Chassis
★ 16,000 gauss magnet
★ 10 watts handling capacity
★ Patented Stentorian Cambric Cone
★ Universal Impedance Speech Coil
(instantaneous matching at 3, 7·5 and 15 ohms)
★ 30 - 15,000 c.p.s. frequency response
★ 35 c.p.s. bass resonance

Stentorian H.F.1016

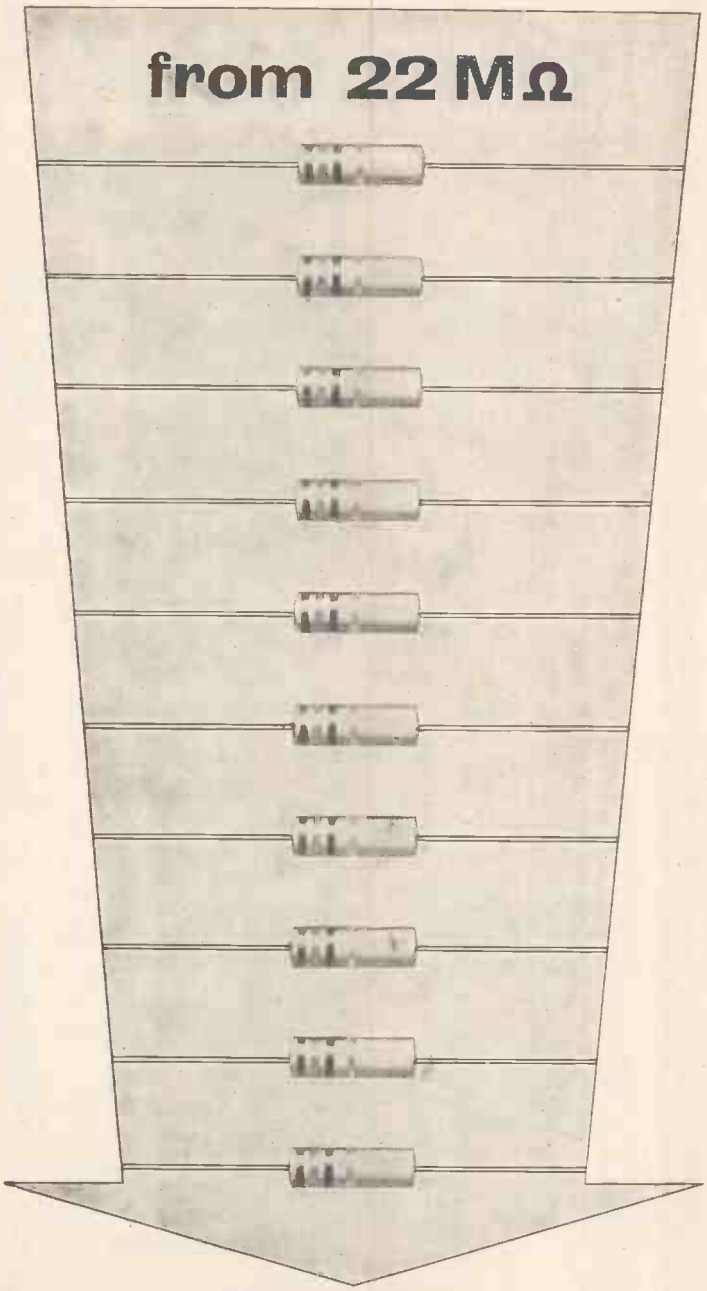
This new High Fidelity Speaker, incorporating a very powerful magnet assembly, is noteworthy for its brilliant transient response when mounted in a bass reflex cabinet. The H.F.1016 is designed for use as a single unit for high fidelity reproduction, but may also be used in conjunction with the Stentorian T.10 Tweeter Unit as an outstanding two-speaker system at remarkably low cost. Write for leaflets on other W.B. products. **£8** *(inc. P.T.)*

The Stentorian High Fidelity range includes speakers (from 8" to 15" dia.), tweeter units, ready-to-assemble cabinets (contemporary and traditional styling) from £5 10s. to £16 16s., the W.B.12 Amplifier and the new W.B. VHF/FM Tuner. Over thirty years' experience in sound reproduction guarantees the quality of every W.B. product. See and hear them at all leading Hi Fi dealers: in case of difficulty, write to our London office (109 Kingsway, W.C.2) for name of nearest stockist. The complete range is demonstrated at this address every Saturday, 9 a.m. to 12 noon.

WHITELEY ELECTRICAL RADIO CO. LTD · MANSFIELD · NOTTS



getting down to it



to 10 Ω

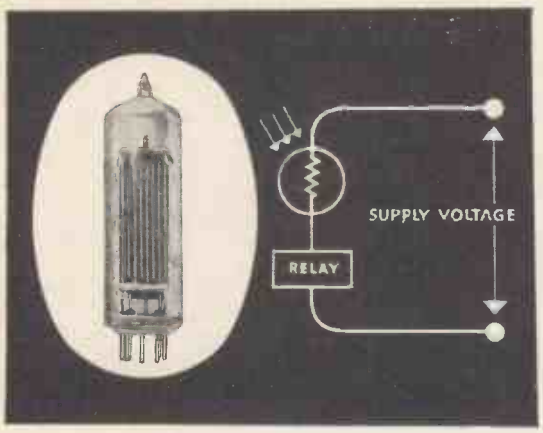
We are pleased to announce that our range of BTA (1W.) and BTS ($\frac{1}{2}$W.) resistors has been extended down to 10Ω. We can now supply these resistors from stock in the preferred values from 10Ω to 22MΩ.

Please write for full details.

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, LONDON W.3.
Phone: ACOrn 2241 Grams: Hivoltcon Wesphone London.
DN 204A

20,000 times more sensitive than an ordinary photocell



New cadmium sulphide technique revolutionizes photocell performance

A new type of photocell with an entirely new order of performance has been developed in the Mullard Solid State Physics Laboratories and is now about to go into production.

Employing a large area cadmium sulphide photosensitive element, the new cell provides a sensitivity approaching that of a photomultiplier . . . *and* a current handling capacity of tens of milliamps.

Technical information is in the course of preparation and you are invited to write to the address below.

Robust relays operated without amplifiers

At the extremely low illumination of 5 ft. candles, robust relays can be operated direct from 40 volt supplies.

Low dark current

In typical applications the ratio of light to dark current is in general more than 10,000 : 1.

Wide spectral response

The usable response extends through the entire visible spectrum to the near infra-red and peaks in the yellow/red region.

A.C. or D.C. operation

The cadmium sulphide type of photocell is non-polar and can be used with either a.c. or d.c. supplies.

Sturdy construction

Like many other solid state devices, the new type of cell is inherently rugged and suited for industrial use.

Wide range of applications

Flame failure detection, door opening, street lighting control, conveyor control, illumination control and smoke monitoring are only a few of the many possible applications.

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COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

Mullard

MVT 344b

PHOTO CELLS IN ACTION

TYPE VA 26T

The Ilford Kenprinter* one of the most modern and versatile pieces of photo finishing equipment produced, employs a 'Cintel' Photocell for exposure control.

This cell is but one from a wide range in current production suitable for photographic applications ; in fact there is a 'Cintel' Photocell for almost every known application.

* *Photograph by courtesy of Ilford Ltd., Ilford, Essex.*

over 100 cell types in the current catalogue. Full data on request.

WORSLEY BRIDGE ROAD
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A Company within the Rank Organisation Ltd. **HITHER GREEN 4600**

CINTEL

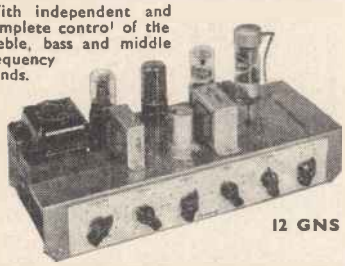
There can be no doubt

whatsoever that "Symphony" products represent the greatest value-for-money on the market to-day

A demonstration will prove to you that the results obtained from our "Symphony" amplifiers, Tuners, Tape Recorders, etc., are of the highest order. This is coupled with sheer long-term reliability.

HOW IS ALL THIS POSSIBLE? We are not subsidised by the State or other body. It is possible because WE SUPPLY DIRECT TO THE PUBLIC and give you what would otherwise be discount to the Trade.
Call for a demonstration any day between 10 a.m. and 6 p.m. except Sunday or send 6d. in stamps to cover postage on our latest catalogue giving details of the following and a host of other High Fidelity equipment. It is essential to quote "Wireless World" when replying to this advertisement.

No. 1 "SYMPHONY" AMPLIFIER Mk. III
With independent and complete control of the treble, bass and middle frequency bands.



12 GNS

No. 2 "SYMPHONY" AMPLIFIER Mk. III

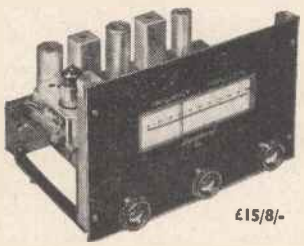
17 GNS

"SYMPHONY" AMPLIFIERS with REMOTE CONTROL

Enables the amplifier proper to be set in the bottom of a cabinet whilst the controls are mounted conveniently higher up. **2 GNS extra.**

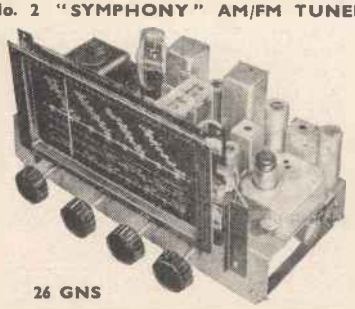
No. 2 PUBLIC ADDRESS AMPLIFIER Mk. III 15 GNS.

No. 1 "SYMPHONY" F.M TUNER



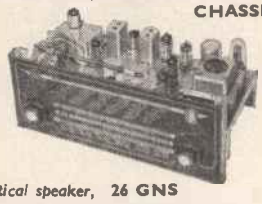
£15/8/-

No. 2 "SYMPHONY" AM/FM TUNER



26 GNS

"SYMPHONY" AM/FM RADIOGRAM CHASSIS



including elliptical speaker, **26 GNS**

GRAMOPHONE & TRANSCRIPTION UNITS by:
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NORDYK CABINETS
All models stocked.

Installations in Cabinets
We can supply any equipment advertised in any cabinet advertised.

"SYMPHONY" CONTEMPORARY REPRODUCER

"Symphony" Amplifier, FM Tuner and Lenco Unit in Nordyk Cabinet. Size 20in. wide x 17in. high x 17in. deep, at **9 GNS** complete with legs.

"SYMPHONY" CONCERT GRAND REPRODUCER KIT

Provides switched VHF Radio, Gramophone and Tape Record/Playback in one cabinet.

W.B. "PRELUDE" CONTEMPORARY BASS REFLEX CONSOLE CABINET 11 GNS

W.B. "PRELUDE" CONTEMPORARY HI-FI CONSOLE CABINET, 13 GNS

W.B. "PRELUDE" CONTEMPORARY BASS REFLEX CORNER CONSOLE, 10 GNS

SPEAKERS by:
Wharfedale, Goodmans, Whiteley (W.B.), Lorenz, Grampion, C.Q., etc.

"SYMPHONY" TAPE RECORDERS

Table Model 52 GNS

Portable Model 52 GNS

TAPE EQUIPMENT by:
Truvox, Collaro, Grundig, Wearite, Ferrograph, Brennell. TAPE—all makes stocked.

SHOP-SOILED BARGAINS

Occasionally one or two slightly shop-soiled, demonstration tape recorders are available (except "Symphony") at substantial discounts.

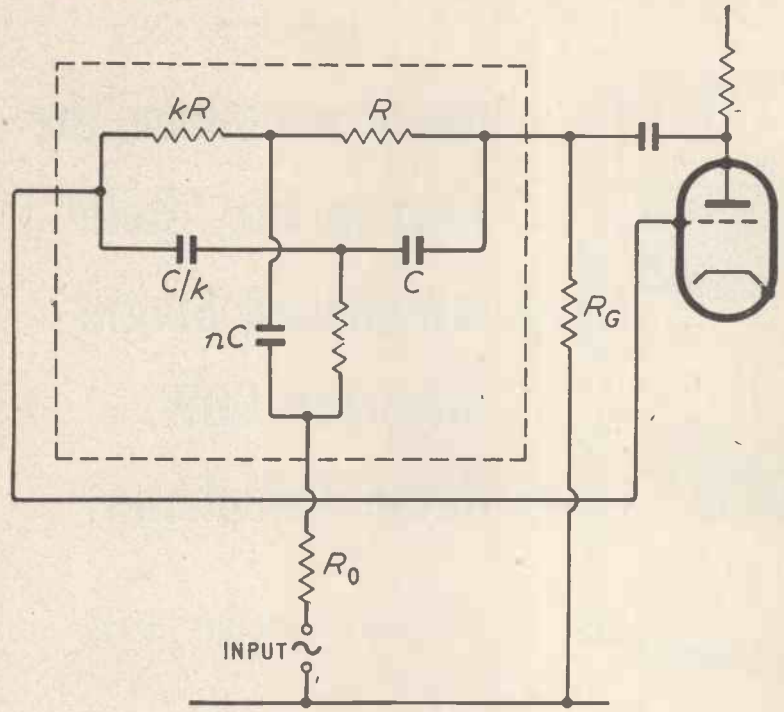
NORTHERN RADIO SERVICES

11 KINGS COLLEGE ROAD, ADELAIDE ROAD, LONDON, N.W.3.

Phone: PRImrose 3314.

Tubes: Swiss Cottage and Chalk Farm.
Buses: 2, 13, 31 113 and 187.

Parallel-T RC Selective Amplifiers



A form of RC selective amplifier for low-frequency use is described in the April issue of *Electronic & Radio Engineer*. Unlike most other types, it is designed for use with a signal source of low impedance. Equations for the computation of performance are given and design is illustrated by a 50-c/s amplifier.

Original articles by leading authorities are a prominent feature of ELECTRONIC & RADIO ENGINEER. *Regular readership will keep you in constant touch with progress in the entire field of electronics, radio and television.*

ARTICLES IN THE MAY ISSUE WILL INCLUDE . . .

MEASUREMENT OF WOW AND FLUTTER IN TAPE RECORDERS

A simple method is described, the only equipment required being a stable audio oscillator and a triggered oscilloscope with facilities for sweep expansion. The oscillator output is recorded, played back, and the wow and flutter calculated from measurements on the playback-signal waveform.

PARALLEL-PLATE TRANSMISSION LINES

The connection between parallel-plate transmission lines and radiators is established mathematically. It is shown that an exact relationship exists between such transmission lines and radiators with at least one infinite dimension.

ALSO
The unique monthly Abstracts and References feature compiled by the Radio Research Organization of the Department of Scientific and Industrial Research.

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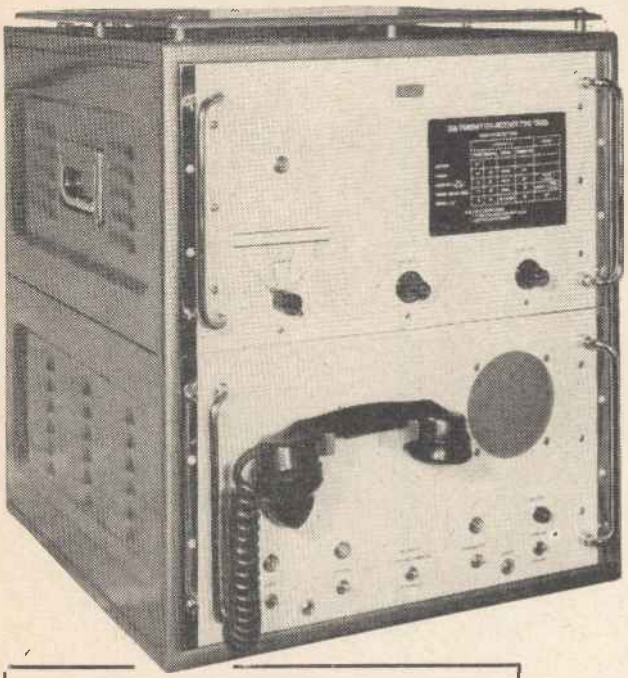
FOLLOWING THE WORLD-WIDE SUCCESS OF THE RA.17 RECEIVER

Over 500 have now been produced for service with armed forces, government, postal and broadcasting authorities



Racal announce the first in the 'field' low priced Single Sideband 60W Radio Telephone

TRA.55 Transportable

ABRIDGED SPECIFICATION

Frequency range:	3-12 Mc/s
Channels:	4 crystal controlled (2 in band 3-6 Mc/s) (2 in band 6-12 Mc/s)
Output power:	60 watts P.E.P. continuous rating.
Aerial:	2 outputs: (a) 75 ohm for tuned aerials (b) single-ended output for long wire untuned aerials
Finish:	High grade tropical standard for ambient temperature of 40°C
Power supply:	100-125 and 200-250V 40/60 c/s AC supply Consumption: 36vA standby 95vA receiver only 180vA receiver with transmitter available 300vA full-power transmission
Dimensions:	Width 20½ inches (52 cms) Height 24½ inches (62½ cms) Depth 20½ inches (52 cms)
Weight:	Approx. 160 lbs. (72.6 Kg)

- ★ **Equivalent to Radio Link 600W on DSB**
- ★ **4 pre-set crystal controlled channels**
- ★ **Frequency range: 3-12 Mc/s in 2 bands**
- ★ **60W P.E.P. continuous rating**
- ★ **Extreme simplicity of operation**
- ★ **Transportable**
- ★ **May be used for CW operation**

The enormous effective gain in power obtained by SSB transmission is now available in compact and economical form, especially suited to the needs of colonial communications authorities, geological survey teams, meteorological services, mining companies, oilfields, civil aviation and overseas armed forces.

The TRA.55 is tropicalised and designed for use by unskilled personnel, the transmitter and receiver being tuned simultaneously to 4 pre-set channels, selected by a single switch. The R/T transmit switch is incorporated in the handset handle. International-type valves and connector are used throughout.

See it at the Instruments, Electronics and Automation Exhibition—STAND 106

RACAL Engineering Limited

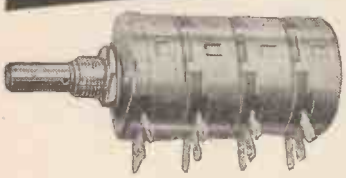
BRACKNELL, BERKSHIRE

Telephone: Bracknell 941.
'Grams/Cables:
RACAL BRACKNELL BERKS.

North England Agent:
Farnell Instruments Ltd.,
Wetherby Industrial Estate,
York Road, Wetherby, Yorks.
Telephone: Wetherby 2544

Scottish Agent:
A. R. Bolton & Co.,
3A, St. Vincent Street, Edinburgh.
Telephone: 32035.

Preset Mk. 2 G type



Type E four gang variation

Preset Mk. 5 G type

MH2 Miniature panel and Spindle Sealed

Type E gang with Switch

Type EN to RCS 1000

Plessey

potentiometers

for special applications

Moulded track potentiometers by Plessey possess a high standard of stability within a wide range of operational temperatures and can be stored for extended periods without deterioration. They can be manufactured to conform, within strictly specified limits, to a designed pattern of values at various positions on the track.

COMMERCIAL TYPES

These are available as single units, dual concentrics or special gangs and are available with or without double pole switch, also in preset form. The standard resistance values are linear 100 ohms to 5 MΩ, log 5KΩ to 2 MΩ. The maximum working voltage is 500V.

Standard Type 'E'. 2 watts at 70°C for linear laws.

Standard with double pole switch Type 'ES'. 2 watts at 70°C for linear laws.

Dual Type 'ED'. 2 watts at 70°C for each section.

Dual with double pole switch Type 'EDS'. 2 watts at 70°C for each section.

Preset Type 'EP'. 1 watt at 70°C for linear laws.

GOVERNMENT AND INSTRUMENTATION TYPES

Available as normal and preset types. In general are in accordance with the appropriate Ministry Specifications. Panel and Spindle Sealed Type 'EH2' 1 watt at 100°C for linear laws. (Type Approval Certificate 906/4 [1230].) Maximum working voltage 500V.

Instrumentation Type 'EN' 2 watts at 70°C for linear laws. (All materials to R.C.S.1000.) Maximum working voltage 500V.

Miniature, thumb operated, with switch, Type 'F' ½ watt at 70°C for linear laws. Maximum working voltage 250V. Sub-Miniature Preset Type 'G'. Marks 2 & 5. ¼ watt at 70°C for linear laws. (Type Approval Certificates 974/2 and 1075/1 [1373].) Maximum working voltage 250V.

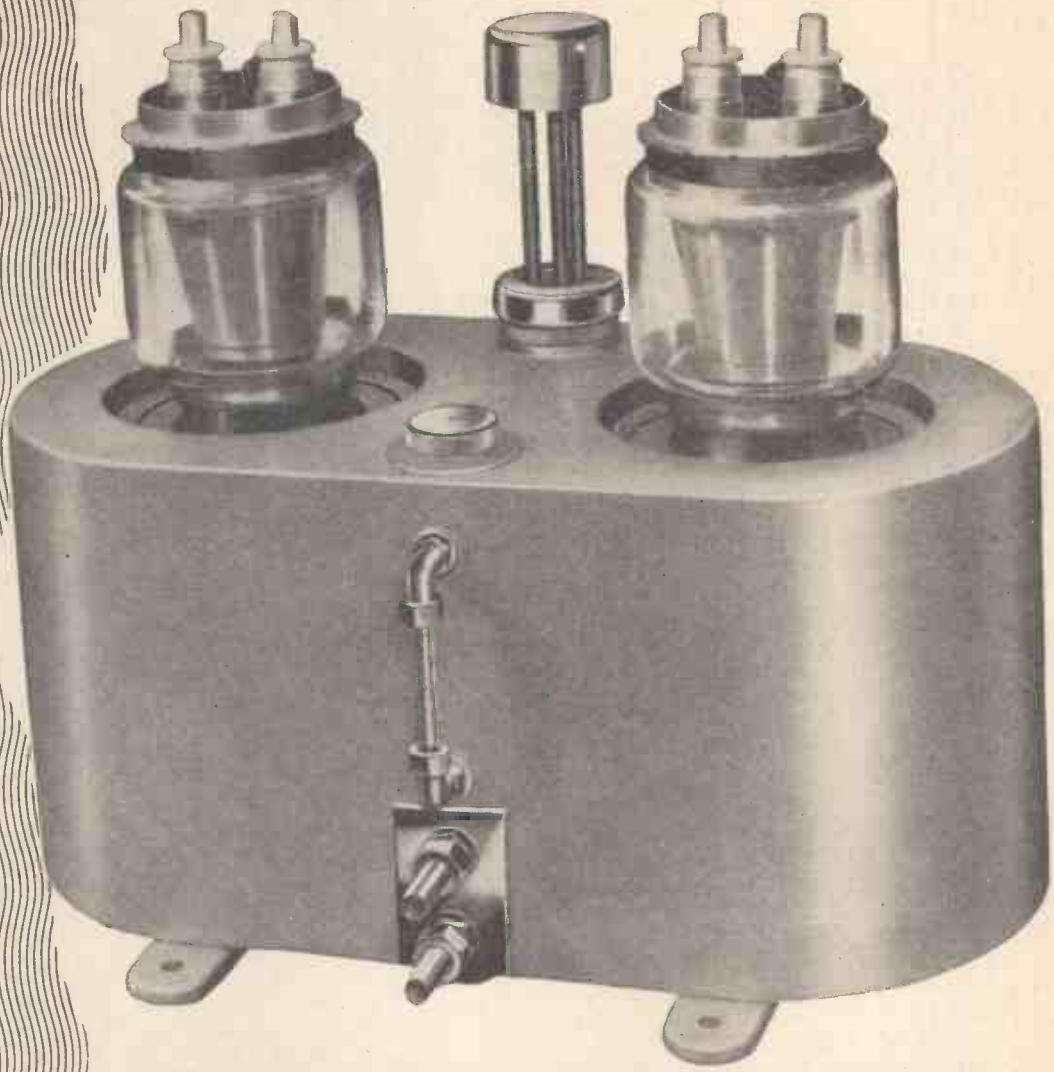
Miniature Panel and Spindle Sealed Type 'MH2' ¼ watt at 70°C. (Type Approval Certificate 1032/1 [1373/1].) Maximum working voltage 250V. A fully sealed version of this potentiometer is also available.

Rating at 100°C is normally one half of that at 70°C.

SWINDON COMPONENTS DIVISION
THE PLESSEY COMPANY LIMITED
KEMBREY STREET · SWINDON · WILTS · Tel: 5461
Overseas Sales Organisation : Plessey International Limited
Ilford · Essex · England · Telephone: Ilford 3040

SCIa

VAPOUR-COOLED VALVES



Conditions sometimes exist both in industry and in communications where neither forced air cooling nor water cooling of high power valves is entirely satisfactory. Air may be so dirt laden that the cleaning of filters and radiators calls for undue effort and cost and at the same time water may be expensive, scarce or otherwise unsuitable.

Under such conditions the E.E.V. vapour-cooled valves may give just the advantages needed: low water cost; built-in protection against failure of water supply; quiet operation; and greater overload capacity. Many types in the E.E.V. range of forced air and water-cooled valves are now available as vapour-cooled versions. Typical examples are

Forced air-cooled	Water-cooled	Vapour-cooled
BR1102	BW1102	BY1102
BR1121	BW1121	BY1121
BR189	BW189	BY189

'ENGLISH ELECTRIC'

ENGLISH ELECTRIC VALVE CO. LTD.

Chelmsford, England
Telephone: Chelmsford 3491

AP101

Mozart

10 watt amplifier

PRINTED CIRCUIT RELIABILITY

In chassis form (8¼ lbs.) or in open-work metal case (9 lbs.) Control panel in copper finish.

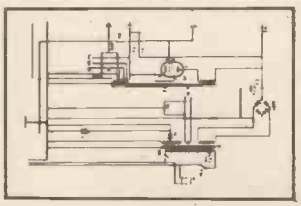
The new Pye Mozart is one of the smallest and most efficient 10-watt amplifiers ever devised. The chassis measures only 10½" x 3⅜" x 5". Its outstanding performance has been reached through good design and expert hand finishing. Leading technical writers have been unanimous in praise of its ingenuity. We reprint below some extracts from an article by Percy Wilson in 'The Gramophone'.

Dialomatic Selector

The Mozart has Input facilities for records, tape and radio. New 'dialomatic' pick-up compensation unit gives instant matching for most types of pick-up.

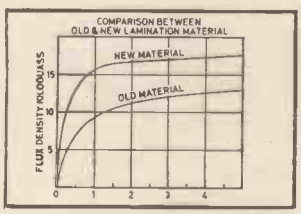
On/Off Push Button

This is completely separate from the volume control and eliminates all mains interference.



Simplified Circuitry

This brilliantly simplified printed circuit uses only 3 valves, a metal rectifier and a minimum of capacitors and resistors, allowing a great saving of space.



Improved Output Transformer

New grain orientated laminations have increased the efficiency and compactness of Mozart's transformers. Curves show how for given outputs, they can be operated at much higher flux densities.

"The performance is REMARKABLY GOOD"

P. Wilson writing in 'The Gramophone'

". . . this is one of the most interesting amplifiers I have seen in recent years."

". . . the chassis lay-out looks good and the arrangement on the printed circuit is particularly cunning."

". . . the circuit itself is both novel and flexible in the matter of control."

". . . the circuit controls are of the most satisfactory types that I know."

". . . we found ourselves unanimous in admiration of its ingenuity."

"The performance is remarkably good . . . one of my colleagues, indeed, was so impressed with the lay-out, components, workmanship and performance that he affectionately nicknamed it Pye's Pint Pot! By which I suppose that he means that it holds a quart."

The creative mind of the scientist . . . in the hands of the craftsman

PYE LIMITED OF CAMBRIDGE

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

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

Pye Pty. Ltd., Melbourne, Australia.

Pye (Ireland) Ltd., Dublin, Eire.

Pye Limited, Mexico City.

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

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

MANIFESTLY . . .

"F.M. deviation is maintained sensibly constant at all carrier frequencies in every band by feeding the reactor valve from the a.f. source via a continuously variable potentiometer, cathode follower, and ganged attenuating system, while A.M. is applied to the last harmonic multiplier in order to overcome the spurious f.m. often encountered when modulating an r.f. oscillator directly."

It's to be expected that a lad familiar with the exploits of Dan Dare, nuclear fission and analogue computors would be knowledgeable about a relatively simple instrument like the Marconi Signal Generator Type TF 995A/2—but are *you* as well-informed? Do *you* know that it has a frequency range of 1.5 to 220 Mc/s, and an output range of 200 mV to 0.1 μV? That it has a built-in crystal calibrator and direct-reading incremental frequency control? That it is F.M. or A.M.—or both, simultaneously? Such basic facts about what is a standard unit of telecommunication test equipment should be known to every electronic engineer. If you don't know them, don't be too shy to admit it—write for leaflet G111 which describes this Signal Generator in detail.

FM/AM SIGNAL GENERATOR
Type TF 995A/2

1.5 to 220 Mc/s; crystal check facilities from 13.5 Mc/s upwards. Output: 0.1 μV to 100 mV at 52 and 75 ohms, and up to 200 mV at 75 ohms. Internal 1000-c/s modulation: a.m., variable up to 50% depth; f.m., variable up to 25 and 75 kc/s deviation on all r.f. ranges, also greater max. deviations—up to 600 kc/s on the highest range. External modulation; f.m., up to 15 kc/s modulation frequency; a.m., up to 10 kc/s.

MARCONI INSTRUMENTS

AM & FM SIGNAL GENERATORS · AUDIO & VIDEO OSCILLATORS
FREQUENCY METERS · VOLTMETERS · POWER METERS
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London and the South: Marconi House, Strand, London, W.C.2. Tel: COVent Garden 1234

Midlands: Marconi House, 24 The Parade, Leamington Spa. Tel: 1408 *North:* 30 Albion Street, Kingston-upon-Hull. Tel: Hull Central 16347

WORLD-WIDE REPRESENTATION

TC 111

4 inch high quality general purpose instrument tube 4EPI

- ✳ High Frequency Operation
- ✳ High Writing Speeds
- ✳ Good Definition
- ✳ Precision Flat Screen

The ETEL 4EP1 is a high quality instrument tube which can be used in a wide variety of applications. For example, where high deflection sensitivity is needed, an overall acceleration of 2kV will result in a sensitivity of 1mm/volt.

On the other hand, at 10kV, photographic recording of single transients at writing speeds up to 1000 km/sec is possible. In addition to the small spot size and high brightness, a blue component in the screen material makes this tube especially suitable for such applications.

Connection to the deflector plates is made by side pins in order to reduce capacities and to simplify amplifier design. Designers' problems are further eased by the high figure of 300 Mc/s for the resonant frequency of the deflector plate system.

Write to the address below for full details of the 4EP1.

Abridged Data

Screen

P1 green fluorescent medium persistence. Other screens available to order.

Capacitances

x^{1} to x^{11}	1.7pF
y^{1} to y^{11}	1.7pF
One x plate to all other electrodes less other x plate	4.0pF
One y plate to all other electrodes less other y plate	3.0pF

Heater

Vh = 6.3V Ih = 0.55A.

Typical Operation

Va1	2,000V
Va2	460 to 530V (for focus)
Va3	2,000V
Va4	4,000V
Vg	−28 to −60V
Sx	36.2V/cm
Sy	23V/cm

ETEL

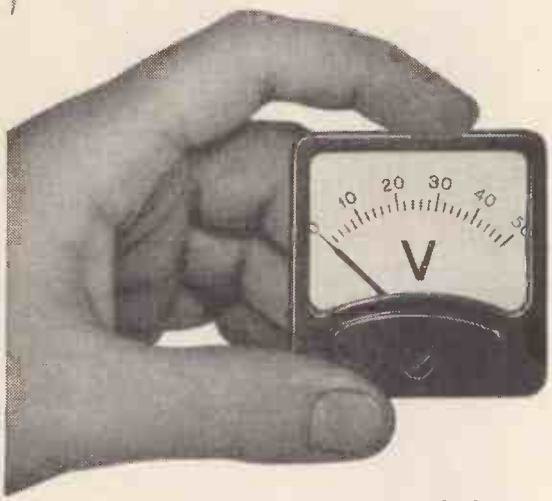
cathode ray tubes

ELECTRONIC TUBES LIMITED

Kingsmead Works · High Wycombe · Bucks · Tel: High Wycombe 2020

ETL1

A NEW RANGE OF "Miniature" Instruments



Above: 2" square moving coil voltmeter

★ **DESIGNED TO HARMONISE WITH ALL MODERN ELECTRONIC EQUIPMENT**

★ **FIXINGS CONFORM TO ACCEPTED PRACTICE**

★ **PRICES ARE HIGHLY COMPETITIVE**

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption. All types have been successfully subjected to the following tests:

RESISTANCE TO IMPACT SHOCK OF 200g in any plane.

VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency.

OSCILLATORY TEST—up to one million operations.

SPECIFICATIONS B.S. 89–1954 and other International Specifications.

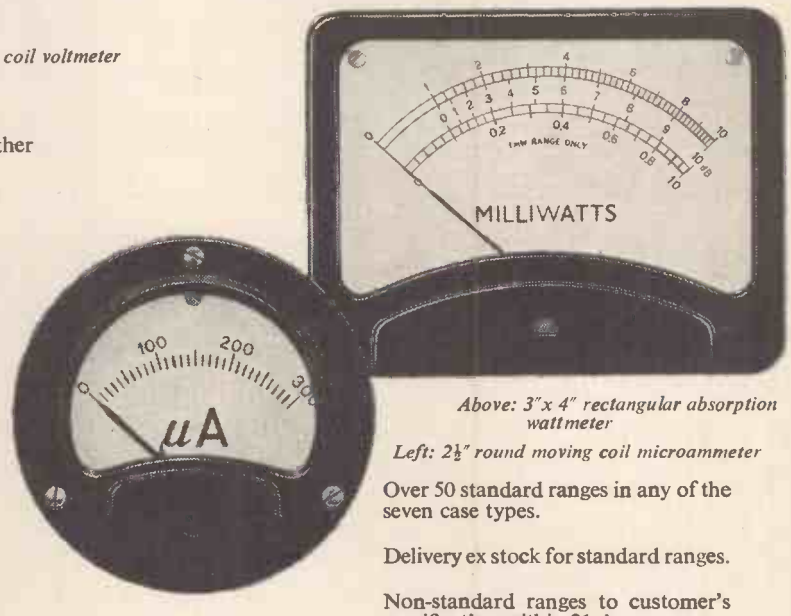
TYPES

Moving coil for D.C. applications.
Rectifier moving coil for A.F. applications.
Thermo-couple operated moving coil for R.F. applications.

SIZES

Square: 2", 2½" and 3½" nominal scale length.
Round: 2½" and 3½" nominal scale length.
Rectangular: 5" x 6" or 3" x 4" nominal case size.

Design registrations pending.



Above: 3"x 4" rectangular absorption wattmeter

Left: 2½" round moving coil microammeter

Over 50 standard ranges in any of the seven case types.

Delivery ex stock for standard ranges.

Non-standard ranges to customer's specification within 21 days.

Literature available on request to The ENGLISH ELECTRIC Co. Ltd., Instrument Department, Stafford.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Meter, Relay and Instrument Division, Stafford

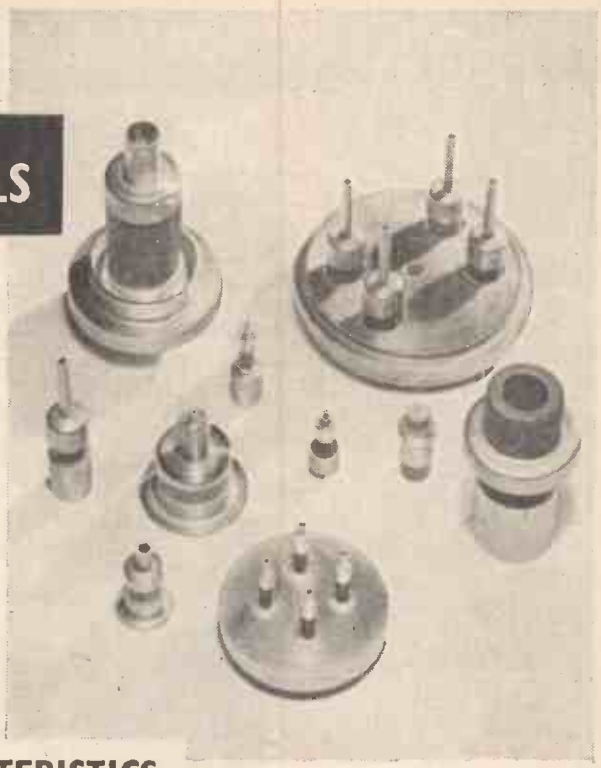
WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

INS.43C8

FERRANTI

CERAMIC TO METAL SEALS

Ferranti Ceramic to Metal Seals have been developed to overcome the limits imposed upon valve performance by the use of conventional glass to metal seals. They perform so successfully that uses are apparent in other fields, particularly as terminals for vacuum and pressure vessels operated at elevated and sub-normal temperatures.



CHARACTERISTICS

Operating Temperature	intermittent 700°C maximum. continuous 300°C - 450°C dependent on atmosphere.
Operating Pressure	at least 100 atmospheres, depending on direction of compression.
Mechanical Strength	shearing force = 2,500 lbs per square inch of seal area.
Electrical Insulation	breakdown voltage in air is greater than 24 kV per inch of ceramic between seals.
Leakage Resistance (Typical)	10^{13} to 10^{15} ohms, at room temperature between two metal rings separated by 0·3″ of clean ceramic surface on a seal 0·440″ in diameter.
High Frequency Performance (Typical)	loss of 56 watts when 1 kW C.W. is passed through a seal incorporated in a ceramic-filled X-band circular wave-guide.

APPLICATIONS

The mechanical and electrical properties listed above suggest a wide variety of uses, a few of which are given below :-

Microwave and ordinary valve envelopes.
Semi-conductor envelopes.
Terminations for single and multicore cables.
Terminals and leads for vacuum and pressure vessels in atomic energy projects.
Thermocouple seals for furnaces.

FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS

London Office: KERN HOUSE, 36 KINGSWAY W.C.2.

FE 181

BUYING GUIDE

CUT THIS OUT AND MOUNT ON BOARD

KEYSWITCHES and PLUNGER KEYS

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THE KEYSWITCH CO.
126 KENSAL ROAD, LONDON, W.10
Phone:
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POTENTIOMETERS · CONDENSORS RESISTANCES

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CABLE— WIRE

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VALVES— —TRANSISTORS

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NUTS - BOLTS SCREWS, ETC.

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TEST EQUIPMENT

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LAMP JACKS— LAMP JACK STRIPS CAPS and LAMPS

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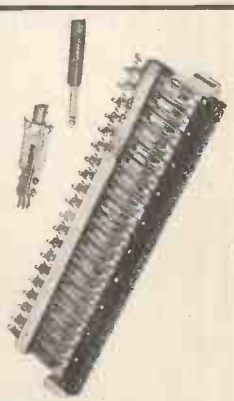

JACKS - JACK PLUGS JACK PLUG STRIPS

from THE KEYSWITCH CO.
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INSULATING MATERIALS

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SWITCHBOARD EQUIPMENT AND SPARES

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THE KEYSWITCH CO.
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LONDON, W.10
Phone ; LAD 0666/4640

TRANSFORMERS and WINDINGS

from .....

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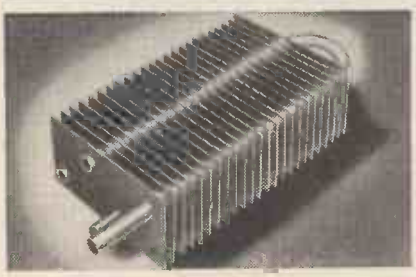
cut here and mount on board

Complex high performance secondary surface heat exchanger.

Aluminium Flux Bath Brazing Makes the Impossible Possible



The tremendous advantages of aluminium dip brazing are at last readily available. The finest plant in the country is at your service.

Dip brazing makes the impossible possible. Design inaccessible joints—as many as you wish. Use aluminium as thin as foil. Think in terms of very close tolerances. All these things you can do. And you can combine them in units so small, so light and so efficient that it would be *impossible* to make them by any other method.

Designing for dip brazing need present no problems. We shall be happy to design for you, or if you prefer it, to discuss possibilities with you and then work to your design.

If you would like to know more about what can be done by this process please contact us. We are specialists in all types of brazing and welding.

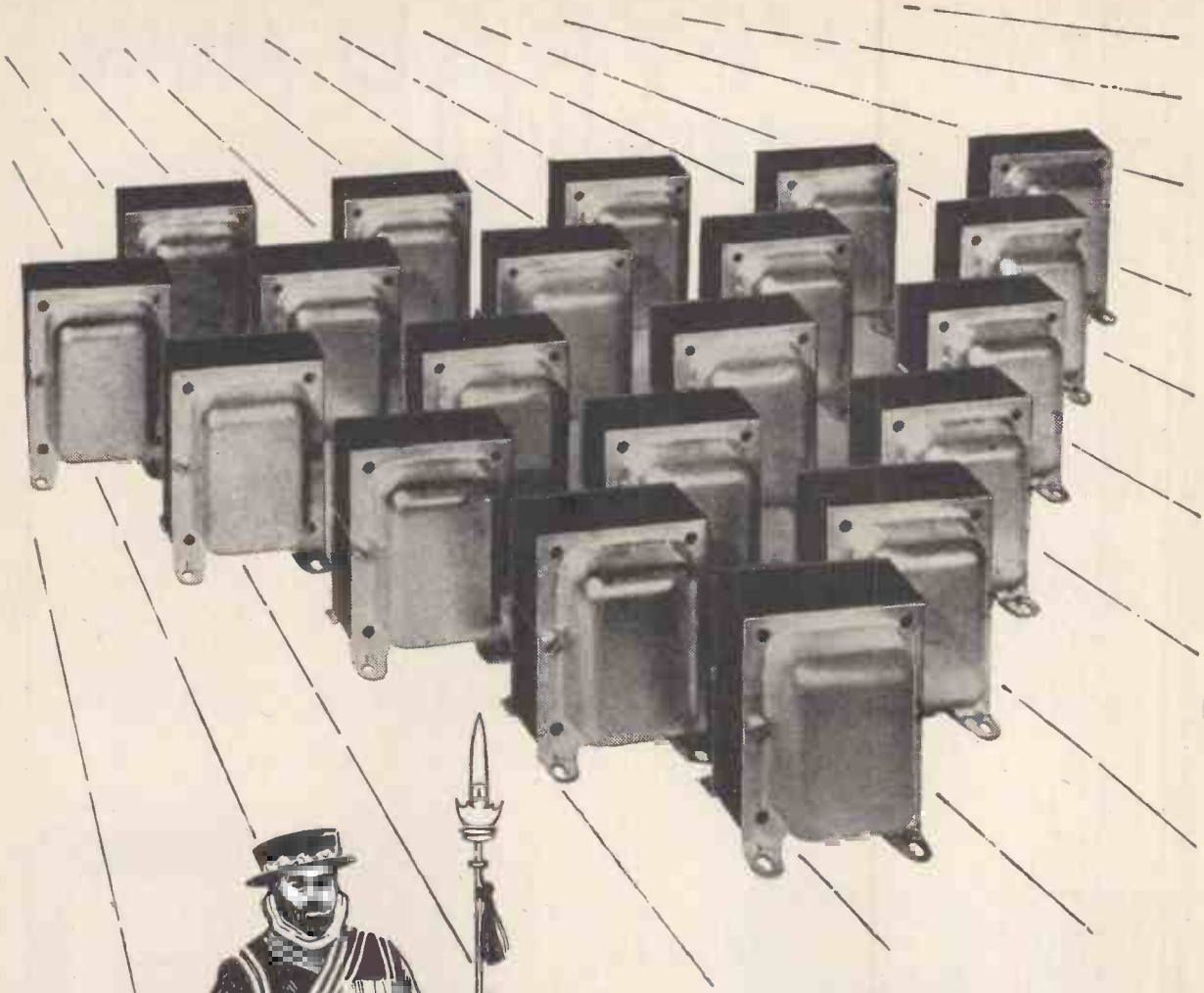
Above: Fuel cooled oil cooler for high performance gas turbine engines.

Below: Typical example of industrial heat exchanger.

Delaney Gallay LTD

Specialists in heat exchange and heat insulation for the aircraft, automobile and marine industries.

Vulcan Works, Edgware Road, London, N.W.2. Telephone: GLAdstone 2201.



The Yeoman Range

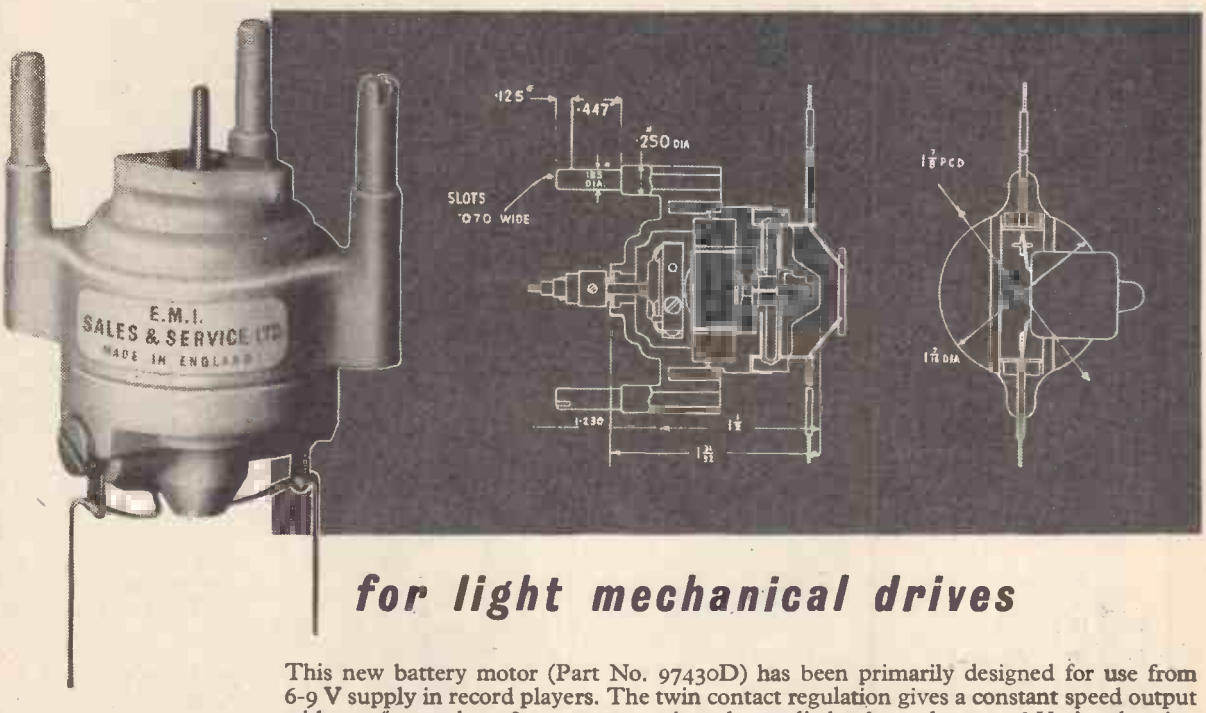
Where reliable transformers are required for commercial purposes, Gresham are able to quote competitive prices. Modern production methods enable high quality to be maintained at low cost.

These transformers are designed and manufactured by the organisation which holds more Type Approval Certificates than any other transformer manufacturer.

GRESHAM
TRANSFORMERS LTD

LION WORKS, HANWORTH TRADING ESTATE, FELTHAM, MIDDLESEX · Telephone: FELTHAM 6661

A NEW BATTERY MOTOR by E.M.I.



for light mechanical drives

This new battery motor (Part No. 97430D) has been primarily designed for use from 6-9 V supply in record players. The twin contact regulation gives a constant speed output with a 12" record at 78 r.p.m. even when the applied voltage drops to 6 V. Acceleration time to 78 r.p.m. with a 12" record is 1 sec. The motor will operate a 4-speed record player for over 100 hours from U2 cells.

Other applications: vending machines, fans, business machines, remote control gear and model building.

Technical Specification

SIZE $1\frac{31}{32}$" (4.9 cm) deep (excluding spindle) $1\frac{7}{16}$" (3.6 cm) diameter.
The motor is fitted with integral mounting legs $\frac{3}{16}$" diameter on $1\frac{7}{8}$" PCD for fitting through rubber grommets. A wire support can then be fixed in open slots in the legs. The motor can be supplied without legs if required.

WEIGHT 2.8 oz (80 gm).

SPINDLE 0.094" diameter +.00025-0000". Maximum extension 0.5" from top bearing. Actual length to suit customer.

BEARINGS Self-lubricating bronze type with felt reservoirs for bearing at spindle end.

ROTATION Anti-clockwise.

SPEED GOVERNOR Twin contact centrifugal type. Normal speed 2600-2660 r.p.m. at 4 gm-cm torque over 9 V to 6 V DC. Can be set to other speeds between 2400 r.p.m. and 2800 r.p.m. to suit customer. Speed regulation better than 0.13% per gm-cm applied torque. Motor available without speed governor if required.

VOLTAGE 9 V maximum. Designed to operate from 6 to 9 V.

CONSUMPTION Current consumption linear with applied torque. 65 mA at free speed. 100 mA at 4 gm-cm i.e. designed working load torque. Consumption independent of applied voltage over range 6-9 V DC for constant load torque.

TORQUE Starting torque not less than 30 gm-cm at 6 V DC. Governed torque not less than 10 gm-cm at 6 V. Acceleration of 12" record to 78 r.p.m. in 1 sec.

Our range of motors includes shaded pole induction motors, split phase motors, induction motors, designed for use in tape recording equipment, tape machines, record players, automatic record players, fans, mixers, etc.

SEE THIS AND OTHER NEW PRODUCTS AT THE COMPONENTS EXHIBITION STAND No. 152

E.M.I. SALES & SERVICE LTD
HAYES · MIDDLESEX · ENGLAND

ES172

WHAT MAKES A GOOD TAPE RECORDER?

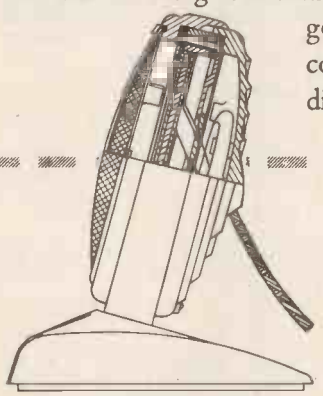
Some of the glitter MUST BE GOLD

Microphones have been designed for a great many different purposes but what the tape recorder owner most often needs is a good general purpose microphone. One which will do justice to the performance of his recorder under the majority of conditions.

It should have a good and adequate frequency response; it should have a high sensitivity in order to achieve a high signal to noise ratio; its cost should be reasonable.

The Grundig Condenser Microphone fulfils all these requirements.

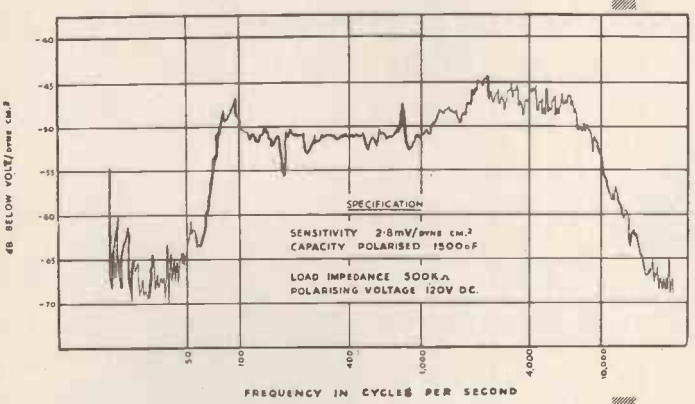
In the Grundig Condenser Microphone a plastic diaphragm, covered with pure gold is made to press against a copper plated, perforated counter electrode. Fluctuations in air pressure cause the diaphragm to be pressed into and against the edges of the perforations which result in variations of the capacity.



PART SECTIONAL VIEW OF GRUNDIG CONDENSER MICROPHONE

A Polarising voltage of approximately 100 to 150 volts is required to operate the Microphone and provision for this is made on Grundig Recorders. The sensitivity is very high compared with other Microphones and is in the order of 2.8mV/μbar. The total capacity in its energised condition is approximately 1500pf.

The two illustrations show the internal construction of the Grundig Condenser Microphone and its frequency response.



GRUNDIG

Makers of the finest Tape Recorders in the world

GRUNDIG (Great Britain) LTD.

39/41 NEW OXFORD STREET, LONDON, W.C.1

(Electronics Division, Gas Purification & Chemical Co. Ltd.)

GS110a

6 and 12 amp Xenon Triode Thyratrons

New Disc-Seal construction gives these positive advantages

- ✳ **High hold-off voltage**
- ✳ **Freedom from arc-back**
- ✳ **Ruggedness**
- ✳ **Long life**
- ✳ **A year's guarantee**

The basic advantages of Xenon thyratrons are enhanced in the Mullard XR1–6400A and XR1–12 by a new type of construction which provides improved electrical and mechanical performance.

The XR1–12 will continuously control currents of up to 12 amps, while the maximum capacity of the XR1–6400A is 6.4 amps. These two valves are rugged and their long life is backed by a year's guarantee. Their heating-up time is only one minute and they will operate efficiently over a wide range of ambient temperatures.

Both types can be employed with confidence in a variety of power control applications including direct welding control, lighting control, motor control, electronic switches and regulated power supplies. Write to the address below for full data.

Type No.	American Type No.	Vf (V)	If (A)	va (pk) max. (kV)	P.I.V. max. (kV)	ik (pk) max. (A)	ik (av.) max. (A)	Heating-up time (secs)
XRI-6400A	6807	2.5	21	1.5	1.5	80	6.4	60
XRI-12	5855	2.5	34	1.5	1.5	150	12.5	60

Mullard Limited
Mullard House · Torrington Place · London W.C.1 · Tel. LANgham 6633

Mullard
COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

MVT333d

RADIO CO

YOURSELF SPECIALISTS 23 TOTTENHAM COURT RD., LONDON. W.1. Tel: MUSeum 3451

Build this New TAPE RECORDER KIT

for only **£38.15.0**

This Kit comprises:

2-speed lane Mk. VI Deck £18/10/-
Premier Tape Amplifier complete with separate plug-in-type power pack £14/-/-
7 × 4 Elliptical Speaker £1/1/6
De-luxe Cabinet with gilt fittings and detachable lid £4/19/6
Reel of Scotch Boy 1,200ft. Tape and empty Spool £1/11/6
Latest Type ACOS microphone .. £2/15/-

All the above sections can be purchased separately.

The New De-Luxe TAPE RECORDER TR3

for £6/5/- DEPOSIT AND 8 MONTHLY PAYMENTS of £5/17/11 OR CASH 45 gns. plus 21/- post and pkg.

TRADE TERMS

Case finished in Red and Cream with Gilt styling and fittings. Size 18¼ × 15 × 9in. For A.C. mains 200/250 v. 50 cycles. Complete with tape and latest Acos microphone 2-speed twin track giving 1 or 2 hours recording respectively, incorporating a 10 × 6in. high flux loudspeaker.

SPECIAL ANNOUNCEMENT

WEARITE 3A Decks £35/0/0
" 3B Decks £40/0/0
COLLARO Decks £22/0/0

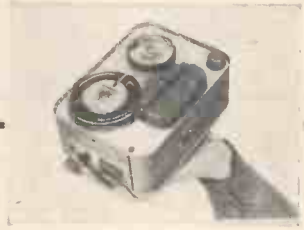
Packing and Carr. 10/- extra on all three items.

Why not make the best!

MULLARD AMPLIFIER KIT

NOW SUPPLIED WITH ULTRALINEAR OUTPUT TRANSFORMER.

All the components for model 510, PLUS pre-amplifier, on one chassis (total six valves), chassis gold hammer finished. May be purchased for £12/12/- plus pkg. and post 7/6. This version complete and tested £15/15/-. Or pre-amplifier and tone control in a separate unit £14/14/- plus pkg. and post 7/6.



Introducing the

PHONOTRIX

BATTERY TRANSISTOR MINIATURE

TAPE RECORDER

Supplied complete with Microphone and small Loudspeaker, operates on 4 U2 Torch batteries, weighs only 4 lb. and plays for 30 minutes Size 6½ × 4½ × 3½in. **26 gns.** complete plus 5/- pkg. and post. Retail Price OR on Credit Terms: Deposit £3/8/- and 8 monthly repayments of £3/10/-.

THE JASON "ARGONAUT"

MW/FM DESIGN

★ **All Premier components are designer approved**

ALL components to build the complete Receiver, including output stage, may be purchased for £15/5/-, or all components less output stage but including Power Supply, for £13/19/6, plus packing and postage 3/6 on each.

COMPACT GRAM AMPLIFIER

1 valve. Overall size 7in. long × 6in. wide × 3½in. high. Suitable speaker for above 7in. × 4in. elliptical 21/10.

Complete ready to connect to any type of Pick-up and Speaker (3 ohms) A.C. Mains 200/250 v. Volume and tone control on 9in. extended leads,

Price **£2.19.6**

Plus pkg. & post 2/6.

CABINETS — PORTABLE

MODEL PC/S
Grey Lizard Rexine covered 45/-
Overall dimensions 15in. × 13½in. × 6½in. Clearance under lid when closed 3in.

MODEL PC/2 DE LUXE
Two colours, wine and grey, with cut-out for speaker and amplifier 55/6
Dimensions 15in. × 14in. × 7½in.

MODEL PC/3
Grey Lizard Rexine covered 69/6
Overall dimensions 16½in. × 14½in. × 11in.
Clearance under lid when closed 3½in.

MODEL PC/3 DE LUXE
As above but with cutouts for Speaker and Amplifier 79/6
Dimensions as above.

THE ABOVE CABINETS ARE COMPLETE WITH CARRYING HANDLE, FASTENERS AND PANEL.
Packing and Postage 3/- each.

Junction Transistors 10/- each

LORENZ MODEL PL 562
4-speed gram. motor.
Price **£3 . 13 . 6**

PUT IT TOGETHER YOURSELF

and save pounds!

Cabinet £2/19/6, plus 5/- *pkg. and post.*
Premier 1 valve Gram. Amplifier £2/19/6, plus 2/6 *pkg. and post.*
Premier 2 Valve Printed Circuit Amplifier £3/5/6, *plus* 2/6 *pkg. and post.*
8in. × 5in. Speaker 27/6, *plus* 1/6 *pkg. and post.*
Collaro 4-Speed Changer £8/19/6, *plus* 5/- *pkg. and post.*
BSR 4-Speed Changer £8/15/-, *plus* 5/- *pkg. and post.*
If a set of parts is purchased together pkg. and post will be 10/-.

SEND 3d. STAMP FOR OUR LATEST CATALOGUE

We carry a comprehensive stock of components by all leading manufacturers.

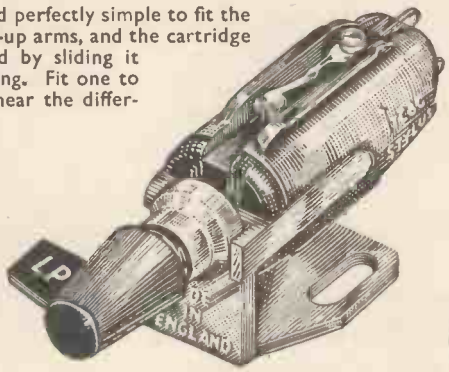
(Dept. WW) 207 EDGWARE ROAD · LONDON W.2.

Mr. Monarch has all the answers!

On the subject of perfection in musical reproduction Mr. Monarch scores top marks in any examination—wins the highest degree in tone engineering.

The Ful-Fi turnover crystal cartridge is a brilliant example of this. Its tonal range and flat response bring out the best in all amplifiers, give any player new life—new clarity.

Remember—it's quick and perfectly simple to fit the Ful-Fi to all standard pick-up arms, and the cartridge can be instantly removed by sliding it out of its snap-fork housing. Fit one to your player today—and hear the difference.



The cantilever type sapphire needles are finely ground and polished like jewels—that's why Ful-Fi means longer life for discs. When buying new needles insist on B.S.R. replacements for continued excellent results.

The T.C.8M "Ful-Fi" cartridge is a high-fidelity medium output crystal cartridge, with replaceable cantilever type sapphire needles. Used wherever high fidelity reproduction is desired.
The T.C.8H is a high output crystal cartridge, fitted with replacement cantilever type sapphire needles. Usually used with single valve amplifiers.

SPECIFICATION

Equivalent capacity	...	1,250 p.f.
Output at (1,000 Cps.) at 1.2 cm/sec.	...	T.C.8M—.3 volts. T.C.8H—.9 volts.
Response, using latest N.A.B. curves	...	T.C.8M flat, within ± 3 db up to 12,000 c/s. T.C.8H flat, within ± 3 db up to 7,000 c/s.
Load resistance	...	1 megohm.
Weight of cartridge	...	11 grams.
Stylus pressure	...	T.C.8M—6 to 10 grams (depending on tone arm construction). T.C.8H—10 grams.

Designed to track when used with average as well as high fidelity pick-up arms and, at the same time, gives adequate protection to the finest microgroove recordings.
Sensitivity: Will drive an amplifier or receiver with sensitivity of:—
T.C.8M 4 volts
T.C.8H 12 volts
} for full output.

BSR Ful-Fi Needles are the best you've ever had

Sapphire needles, as fitted to the T.C.8M and T.C.8H cartridges, are specially ground and polished to very fine limits to ensure minimum wear and maximum life to records.
The standard 78 r.p.m. needle has a tip radius of .0025in. and the microgroove needle has a tip radius of .001in.

There's a FUL-FI in every

Monarch UA8

World's Finest 4-Speed Autochanger!

BSR

—the autochanger most manufacturers select for its outstanding performance, reliability and precision.

"MAKES MUSIC FOR MILLIONS"

BIRMINGHAM SOUND REPRODUCERS LIMITED

Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: F. L. DEVEREUX, B.Sc.

MAY 1958

In This Issue

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A service for all who need complete data on Mullard valves, tubes and semiconductor devices

The Mullard Technical Handbook is a loose-leaf publication, issued on a subscription basis and containing data sheets on all Mullard valves, tubes and semiconductor devices in current production.

From one to twenty pages are devoted to each type, data including: standard ratings, recommended operating conditions and performance figures for various applications, limiting values, characteristic and performance curves.

Subscribers receive supplementary or revised sheets automatically as they are issued and thereby have early intimation of new introductions.

At present the Handbook comprises four volumes with the following contents:—

VOLUMES I and IA
Data on current Receiving and Amplifying Valves. Cathode Ray Tubes. Crystal Diodes and Transistors. Photocells. Cold Cathode Tubes. Small Thyratrons. Miscellaneous and Special Tubes.

VOLUME 2
Data on earlier type Receiving and Amplifying Valves and Cathode Ray Tubes still in limited production for the maintenance of existing equipment.

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Data on Power Valves for Transmitting and Industrial Equipment.
Power Rectifiers. Large Thyratrons. Microwave Devices.

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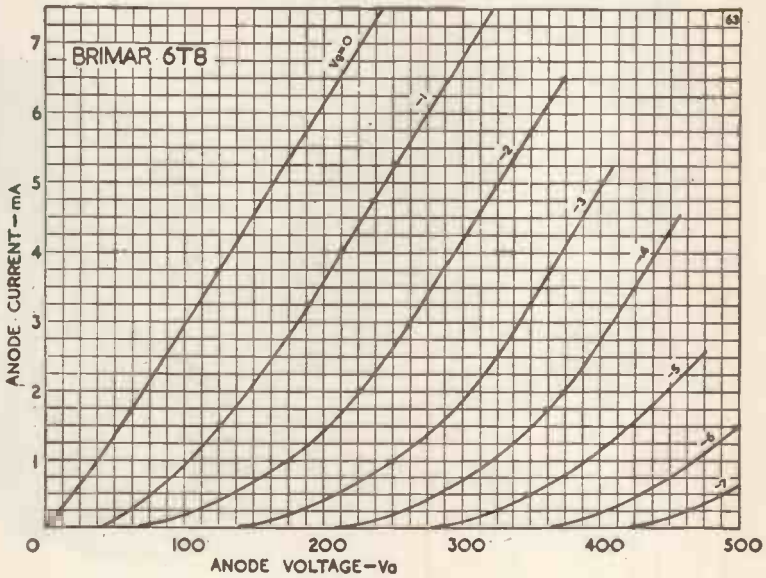
Mullard

BRIMAR 6T8

TRIPLE DIODE TRIODE

The Brimar 6T8 is a triple-diode-triode in which one diode has a separate cathode. The triode section has a high amplification factor making the valve suitable for use in AM/FM receivers in the demodulation and first stage audio circuits. The diodes may be used in series shunt limiter circuits, for example, in the audio sections of television and communications receivers, followed again by the triode section for A.F. amplification.



Near Equivalents
EABC80
DH719
6AK8

Typical Triode Operating Characteristics as an R.C. coupled amplifier.

Heater Voltage		6.3 volts
Heater Current		0.45 amp.
Anode Supply Voltage	250	250 volts
Anode Load Resistor	0.25	0.25 megohms
Grid Resistor	1.0	10 megohms
Cathode Bias Resistor	3	0 kilohms
Peak Output Voltage	43	40 volts
Stage Gain (for 24 V peak to peak output) ...	42	42
Distortion (for 24 V peak to peak output) ...	1	5%

Cut this out for further reference or write to the Publicity Department at Footscray for a data sheet.

Name .....

Address .....

WW

Doh, *rah* and *me* look deceptively simple as musical notes. In reality they are complex little fellows, because the sound you want to hear includes a host of harmonics. Acos Series 65 turnover cartridges are notable for bringing notes to life, giving you faithful sound reproduction at a reasonable cost. Many well-known record players rely on Acos cartridges and there are different types for different applications. All have the famous Acos x 500 tested styli. It pays to look for the Acos tag on a cartridge.

acos ARE DOING THINGS IN STYLI

COSMOCORD LTD WALTHAM CROSS HERTS · TEL: WALTHAM CROSS 5206 (London subscribers please dial-WA4 5206)

"BELLING-LEE" NOTES

Chillerton Down, I.o.W.

By the time you are reading this, the I.T.A. pilot transmitter will be sending out a test card from Chillerton Down, Isle of Wight: the seventh site from which it has operated.

The four-stacked folded dipole array is already in position, it was designed and manufactured by " Belling-Lee " and is mounted on a " Belling-Lee " 75ft. " Sky-tower." We must make it clear that although we built and operated the transmitter for some time, it is no longer our responsibility, although we still have a great interest in its performance.

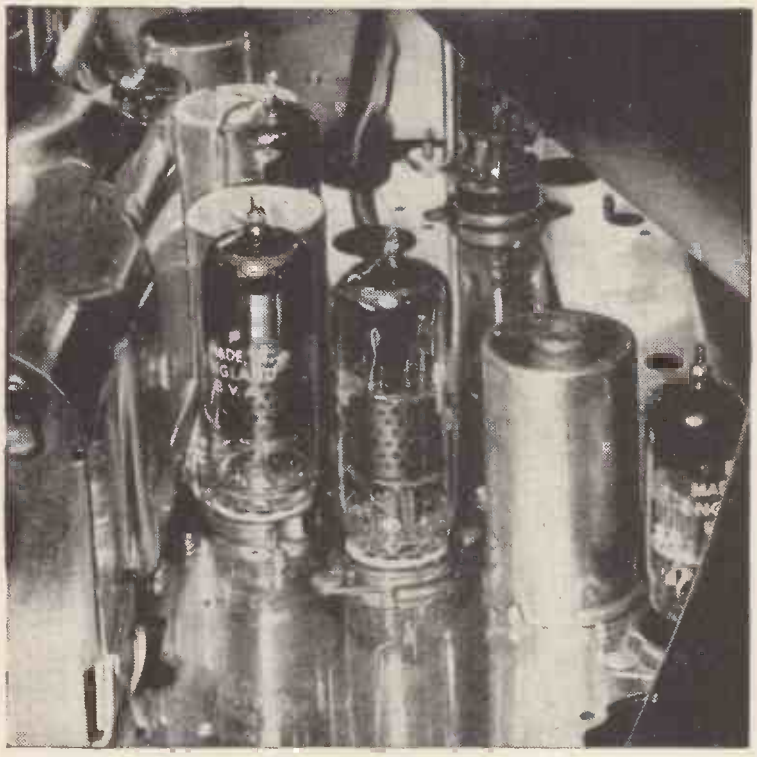
Its usefulness has been questioned, in our opinion unreasonably. Our " guestimate " of its range, conservative, yet based on experience, will be the coastal towns from Swanage round to Chichester or Littlehampton, including most places on Southampton Water, and part of the town of Southampton, remembering that places near docks often suffer from reflected images or ghosts. This estimate of the pilot transmitter cannot be taken as official, it is the personal opinion of the writer.

It must always be remembered that ground heights—hills and valleys are very important in assessing reception. If you are within the primary service area, on the side of a hill facing the transmitter and without a higher hill between, then you will probably receive a good picture without an elaborate aerial, but if you are on the other side, or at the bottom of the same hill, that is, backing on to the transmitter, then you will find you will have to exercise great care, and probably use quite elaborate aerials to get a picture of entertainment value. Always expect difficulties in river valleys—there will be places on the east side of the Avon, particularly north of Ringwood, where conditions might be tricky.

A primary service area is often described as " where most receivers, *unless they are situated in particularly unfavourable positions* should receive a consistently satisfactory service." We contend that viewers on the wrong side of hills or valleys are particularly unfavourably situated.

Ventnor, I.O.W., is well within the normal service area, but will have its own very real difficulties.

'First Preference' range of 0·3 amp heater current type TV valves



The Ediswan Mazda 'First Preference' range of 0.3 amp heater current valves provides an up-to-date type for every job in the TV set. In the case of the 6/30L2, 30FL1, and 30PL1, the triode sections have identical characteristics and as a result they permit great flexibility in the physical layout of components.

DOUBLE QUALITY CONTROL

All Ediswan Mazda valves are subject to a stringent system of quality control, and in addition, every type in the First Preference TV range is controlled for secondary parameters which have a vital effect on the performance of TV circuitry.

Ediswan Mazda 'First Preference' Range

TYPE NO.	FUNCTION
30L1	Band 1, 2 & 3, Cascode amplifier
30C1	Band 1, 2 & 3, Triode pentode frequency changer
30C13	Ditto specially designed for printed circuit tuners
30F5	High slope straight IF & Video amplifier pentode
6F19	High slope var. mu. IF pentode
6D2	Double diode signal rectifier
6/30L2	Double triode, LF & time base generator
30FL1	Triode pentode, for Video, Audio & Time base application
30PL1	Triode pentode Audio output & frame time base application
30P12 30P16	Pentode Audio output & frame time base application
30P4	Line output pentode
U191	Efficiency diode
U25	EHT Rectifier (wired-in)
U26	EHT Rectifier (noval base)

• If you are a TV equipment manufacturer we shall be pleased to supply full technical details together with a complete set of valves as listed above for testing on receipt of your enquiry.

EDISWAN
MAZDA

SIEMENS EDISON SWAN LIMITED

An A.E.I. Company 155 Charing Cross Road, London, W.C.2. Telephone: GERrard 8660. Telegrams: Sieswan, Westcent, London

CRC 15/13

COMPANY MEETING

MARCONI'S WIRELESS TELEGRAPH
WORLD-WIDE ACHIEVEMENTS IN MANY FIELDS

SIR GEORGE H. NELSON'S REVIEW

The 60th Annual General Meeting of Marconi's Wireless Telegraph Company Limited was held on March 13th at Marconi House, Strand.

Sir George Nelson, Bart., Chairman, in his address said:

EXPANDING RESEARCH FACILITIES

For 60 years Marconi's have led the world in research into many of the aspects of radio and electronics which are now taken for granted, and with each year that passes we face new problems requiring apparatus of great complexity which must operate with impeccable reliability, often in confined spaces and exacting environments.

Since the war there has been a remarkable growth in both the size and scope of our Research activities. We have recently almost doubled the floor area of our Great Baddow laboratories to give us additional technical facilities.

We have made great progress in the many fields of microwave communication, including the " over-the-horizon " techniques known as Tropospheric and Ionospheric Scatter, which promise to revolutionise long-distance radio communication.

DOPPLER NAVIGATORS

In the aeronautical field, the outstanding event of the year concerned the Doppler Navigator, a revolutionary device to provide an accurate position anywhere in the world without having to rely on any ground-based aids. Our effort on this problem, in conjunction with the Ministry of Supply, has resulted in the Marconi Doppler Navigator which has been in operational service with the R.A.F. and some Commonwealth air forces now for more than three years.

RADAR FOR MANY PURPOSES

Our Radar Division continues to make its vital contribution to National Defence. The past year has also seen the development of a long-range airfield surveillance radar and of new techniques of remote display, making the operation of civil airlines ever more safe. On the naval side, your Company continues to contribute substantially to the Admiralty development and production programme for shipborne radar equipment.

MARCONI COMMUNICATIONS SYSTEMS

A Diamond Jubilee is always an event of importance, in our case not merely because our Company was the world's first radio manufacturer, but because during the 60 years since we founded this new science and industry we have surely made a unique contribution to the development of radio communications between people and places throughout the world. There are few countries indeed where Marconi telecommunications equipments are not in daily use.

While the range and variety of these equipments is very large, we have recently specialised in designing and installing entire multichannel radio communication systems to serve complete territories. We are at present surveying, planning or installing such communications systems in many countries of the world.

FURTHER EXPANSION IN TELEVISION

I now want to turn to two entirely different, but very important branches of our activities, television and sound broadcasting, in both of which your Company has a world-wide reputation, second to none, for the design and efficiency of its equipments. For well over a quarter of a century your Company has devoted a considerable proportion of its resources to develop the finest television equipment for the transmission of this modern entertainment medium. Since 1946, we have supplied for both home and overseas customers 70 transmitters, 33 aerial systems, equipment for 51 complete studio installations, 25 outside broadcast units, and over three million pounds worth of associated ancillary equipments. A proud record indeed. Your Company is today probably the largest exporter of capital television equipment in the world.

WORLD-WIDE DEMAND FOR SOUND BROADCASTING

The world demand for sound broadcasting continues to increase, even in countries which now have a large television audience. Our scientists and engineers are constantly striving for better and even more reliable equipment, though there are many Marconi broadcasters in the world which are still giving impeccable service after 25 years of almost continuous operation.

MARCONI INSTRUMENTS

It must be stressed that without efficient electronic instruments for testing and measuring purposes, few of the scientific and industrial achievements of our age could have come to pass. Without the aid of such instruments, much of our industrial life, much of our transport, our radio communications and television networks, much of the life of our hospitals—indeed, a very large section of our national life, would be severely handicapped, if not paralysed. Year by year, the range of Marconi instruments is enlarged to meet requirements in all fields of electronic measurement. Well over a hundred different types of Marconi instruments are now available, which combine precision and reliability with the highest operational convenience.

The Company is constantly adapting itself to the new and changing requirements of the electronic field, and new engineering groups have been formed to work on nuclear reactor instrumentation, guided weapon test equipment and instruments for use with radio multichannel link equipments. In hospitals and clinics everywhere, Marconi electro-medical and X-ray apparatus is helping to speed the progress of medicine.

I wish to end on a more personal note by recording our very sincere thanks to our Management, Staff and Works employees for their loyalty, enthusiam and hard work during the year.

The Report and Accounts were adopted.

Vortexion quality equipment

Model W.V.B.

Our specialised MONITOR HEAD MODEL W.V.B. has an additional head and amplifier which enables this recorder to perform a number of useful functions. The most important of these is to monitor the recorded tape a fraction of a second after it is made, and if necessary compare it by throwing a switch, with the signal before it is recorded. This allows the recording engineer to make certain that he has made a first class recording before the artists leave the studio, without the necessity of waiting while another run though is made.

Additional items may be recorded one on top of another while listening to the first, since a switch is provided for the erase, and the bias, which also acts as a partial erase, can be lowered slightly, and its new value checked on the meter. In a similar manner the original signal may be fed back and recorded, resulting in an echo, the time constant of which is controlled by the speed of the tape and the distance apart of the heads.

VORTEXION RECORDERS use a synchronous capstan motor to ensure accurate recording and play back speed.

Many years of steady development have enabled us to still further improve the Vortexion W.V.A. and W.V.B. recorders which are now fitted with clock type position indicators.

All components which could contribute to noise or reliability are carefully measured and selected individually before incorporation, resulting in an exceedingly low background noise and distortion with frequency response within ± 1.5 db 50–10,000 c/s and ± 3 db 40-12,000 c/s.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 4 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

POWER SUPPLY UNIT for operation with Tape Recorder or similar equipment on 12V. car battery.

This D.C. to A.C. supply unit has been specially manufactured to provide 1% accurate 50 cycle A.C. power for 50 c/s synchronous motors and amplifiers sensitive to mains noise. The output from the 50 cycle is well filtered to reduce harmonics and give approximately the same degree of quietness as normal 50 cycle mains.

The efficiency is over 80% at wattages over 50. Terminals for a remote control switch are fitted to prevent carrying the heavy low voltage L.T. cables any distance from the battery. The unit can then be fitted at the point closest to the battery to prevent voltage drop on leads and the A.C. satisfactorily extended to any required position.

The unit is fitted in an 18 gauge steel case to give screening, but it should not be placed close to tape heads in case the field causes slight hum.

The case measures 9in. x 6in. x 9in.

Full details and prices of the above on request

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

Everybody wants EMITAPE

-you'll sell more this year!

EMITAPE "88" *General Purposes.*

EMITAPE "99" *Long play, giving 50% increased playing time.*

* 4 SPOOL SIZES

to fit all standard magnetic tape recorders

3" MESSAGE **5" JUNIOR**

5¾" CONTINENTAL **7" STANDARD**

* HIGHEST TECHNICAL STANDARDS

- High sensitivity
- Low noise level
- Low print-through factor
- Freedom from curl and stretch
- Anti-static
- Low head wear

* EMICASE

solves storage problems

protects spools from dust

allows easy identification of leader tapes

TYPE No.	TITLE	SIZE	LENGTH APPROX.	EMITAPE IN "EMICASE"	PRICE WITHOUT "EMICASE"
88/6E	"Junior"	5" dia	600'	£1 . 3 . 6	£1 . 1 . 0
★99/9E	"	5" dia	850'	£1 . 10 . 6	£1 . 8 . 0
88/9E	"Continental"	5¾" dia	850'	£1 . 10 . 6	£1 . 8 . 0
★99/12E	"	5¾" dia	1200'	£1 . 17 . 6	£1 . 15 . 0
88/12E	"Standard"	7" dia	1200'	£1 . 17 . 6	£1 . 15 . 0
★99/18E	"	7" dia	1800'	£2 . 12 . 6	£2 . 10 . 0

★ *LONG PLAY—50% increased playing time.*

EMITAPE *the magnetic recording tape with the world-wide reputation!*

E·M·I SALES & SERVICE LTD (*Recording Materials Division*) **HAYES · MIDDLESEX**

ES159

NEW

LEAK

"Point One Plus" Pre-amplifier TL/12 Plus Power Amplifier

★

Make this
THE HEART
of your
Hi-Fi EQUIPMENT

Styled by the world-famous designers
RICHARD LONSDALE-HANDS ASSOCIATES

Designed by HAROLD J. LEAK to give OPTIMUM RESULTS from :—

Any pickup available in the world.
Any tape recorder/reproducer available in the world.
Any radio tuner available in the world.
Any dynamic microphone available in the world.

★

30 GNS
COMPLETE

A price made possible only by WORLD-WIDE SALES

The Point One Plus pre-amplifier and TL/12 Plus amplifier, when used with the best available complementary equipment, give to the music-lover a quality of reproduction unsurpassed by *any* equipment at *any* price. Even when the complementary equipment falls below that of the best obtainable, the use of these amplifiers will enable one to obtain very marked improvements in reproduction.

The new Point One Plus and TL/12 Plus were exhibited and demonstrated at the New York Audio Fair and received enthusiastic consumer acceptance resulting in initial orders for one thousand one hundred and fifty sets.

LEAK amplifiers have been the choice of the B.B.C. (over 500 delivered), the South African Broadcasting Corporation (600), I.T.V. and many other Commonwealth and overseas broadcasting and TV systems, who use them for transmitting and/or monitoring (quality checking) the broadcasts to which you listen. Also, many of the gramophone records you buy are cut via LEAK amplifiers: This acceptance by professional audio engineers has led to a demand for LEAK equipment from music-lovers throughout the world.

It is appropriate here to mention one of the basic principles of LEAK design. From long experience and by extreme attention to design details during development work on the pre-production models, we enable our craftsmen to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at reasonable prices.

LEAK *The First Name in High Fidelity*

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, LONDON, W.3, ENGLAND.

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Telephone: SHEpherds Bush 1173/4/5 Cables: Sinusoidal, London

Please send details of

- ☐ *FM Tuner*
- ☐ *Amplifiers*
- ☐ *Gram. pickup*
- ☐ *Name and address of my nearest Hi-Fi dealer*

Name.....

Address .....

.....

WW5/58

Tube Tester and Re-Activator

We can supply all the main components for making this unit which will not only test Cathode Ray Tubes but also will re-activate them, supplied complete with full instructions. Price £3, plus 2/6 post and ins.

Transistor Timer

All the parts for making transistorised Enlarging or Process Timer with constructional details. £2/10/-, plus 2/6 post and pkg.

Beginner's Superhet

All the components including metal chassis, valves, metal rectifier, coils, tuning condenser, etc., etc. required to build the "Beginner's Superhet" as described in the January issue, are available as a parcel. Price £3, plus 3/- post and ins.

Condenser Tester and Re-Activator

This unit tests condensers under correct working conditions at proper voltages, it can also be used for "reforming" electrolytics. All basic parts and full instructions, 50/-, plus 2/6 post and ins.

Band III Converter

Suitable Wales, London, Midlands, North, Scotland etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers, and resistors. (Metal case available as an extra.) Price only 19/6, plus 2/6 post and insurance. Data free with parts or available separately 1/6.

Making a Solder Gun

A 7-second solder gun of the type costing £3-£4 was described in Prac. Mech. Only two essential parts are required—(a) transformer and (b) push switch. These we can supply at 13/6, plus 2/- post. The rest of the parts you will have in your own "junk" box. Copy of the article concerned given free with the kit.

Morganite Potentiometers

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

Connecting Wire

P.V.C. covered in 100ft. coils—2/9 a coil or four coils different colours, 10/-, post free.

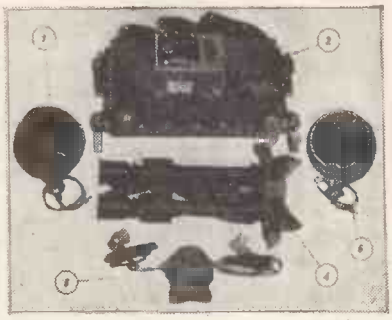
Mains Transformer. 250-0-250, 60-80 mA. 6.3 v. standard mains input. Half shrouded, 15/-, post and insurance 2/6.

.1 mfd. 350 v. Small Tubular Metal Cased Condensers. Made by Dubilier. 2/6 per dozen.

Germanium Diodes. B.T.H., with wire ends. 10d. each or 9/- dozen.

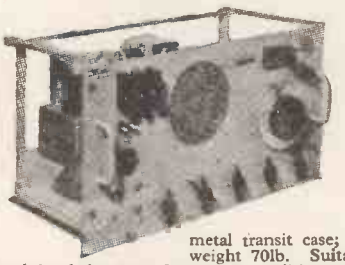
Midget I.F. Coils. Dust cored, size 1½ × 1in., 465 Kc/s. 6/6 pair.

COMPLETE SEE-IN-THE-DARK EQUIPMENT



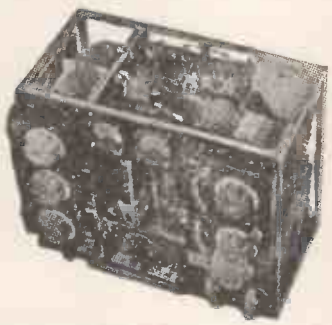
Complete equipment as fitted to Army vehicles for night driving, etc. Comprises: 2 Infra Red Radiators, adjustable binoculars, powerpack for 6 or 12 volts, control units and inter-connection cables. Original cost probably around £100. Unused and in perfect order—£10, plus 10/- carriage and insurance.

Short Wave Communications Receiver R208



This is a super short wave receiver covering 5-30 metres (10-60 mc/s) Uses 6 valves. Has R.F. stage, 2 I.F. stages B.F.O. etc. Muirhead instrument drive, two internal power packs, mains and battery vibrator pack. Complete with own P.M. speaker. Provision for phones and speaker muting. Complete in metal transit case; size approx. 24 × 18 × 12; weight 70lb. Suitable A.C. mains, 100-250 and 6 volt battery. In perfect condition, practically unused. Tested before despatch and guaranteed. Handbook free with each. Price £6/19/6, carriage and insurance 15/-.

Famous Transmitter Virtually Given Away



The famous R1154—unused but slightly soiled and not tested. Covers 200-500 Kc/s., 3-5.5 mc/s and 5.5-10 mc/s. Has unique "click stop" mechanism (7 stops) and permits selected frequency to be held, returned to, etc. Hartley oscillator, power amplifier, keying and speech. Wonderful breakdown value meters, relays, switches. Complete with valves—real bargain at 29/6, plus 10/- carriage.

A.C./D.C. Multimeter Kit

Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000.

D.C. milliamps 0-5, 0-100, 0-500. Ohms 0-50,000 with internal batteries. 0-500,000 with external batteries.

Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6, plus 2/6 post and insurance.

Telephone Repeater No. 1, Mark I

This equipment is for amplifying telephone signals in both directions of traffic and also to remedy line distortion of speech. It is intended for use with two wire or four wire circuits, has four amplifiers and is in fact two quite independent repeaters mounted on the same panel and having a common power supply. The power supply may be operated from a 12-volt car battery or from standard A.C. mains. The units are absolutely new in original packing complete with spares and instructional manual. Price £20 each.

Hi-Fi Bargain

12in. Hi-fidelity loudspeaker. High flux, permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price 32/6, plus 2/6 post and insurance.

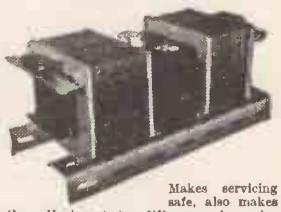
Yaxley Switches

3-pole, 2-way	1/3
12-pole, 2-way	1/6
3-pole, 3-way	1/6
9-pole, 3-way	2/-
2-pole, 4-way	2/-
6-pole, 4-way	2/6
4-pole, 5-way	2/6
2-pole, 6-way	2/6
1-pole, 7-way	2/6
1-pole, 12-way	2/6
6-position shorting switch	2/-
Double-pole mains switch for attaching to Yaxley switches	1/6

Discount of 10% allowed where a dozen of one type ordered.

Special quotes 144 or over.

MAINS ISOLATION TRANSFORMER



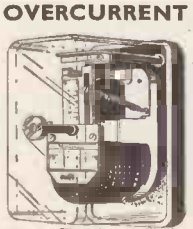
Makes servicing safe, also makes the adjustment for differences in mains voltages very simple Input tapped 200-250 v., output tapped 200-250 v. Continuously rated at 500 watts, intermittent rating 2,000 watts. Cable entry by terminal blocks, two separate screens for suppressing mains interference. Size approximately 14in. × 6in. × 6in., weight approximately 40lb. Price £5/12/6. Carriage and insurance 7/6 (up to 250 miles).

W.D. CIRCUIT DETAILS

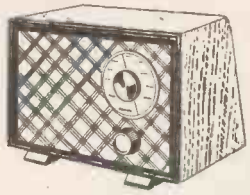
Diagrams and other information extracted from official manuals. All 1/6 per copy. 12 for 15/-.

American Service Sheets	R.109
A.1134	78 receiver
BC.348	76 receiver
BC.312	R28/ARC5
R.103A	R1116/A
B.C.342	RA-1B
BA-1B	AR88D
R-208	AN/APA-1
R-1155	78
R-1124A	R.T.18
R-1132A/R-1481	CAY-46-AAM-
R-1147	RADAR
R-1224A	A.S.B.-3
R-1082	Indicator 62A
R-1355	Indicator A.S.B.3
B.C.1206-A/B	Indicator 62
B-455-A (or -B)	Indicator 6K
B-454-A (or -B)	R.F. unit 24
B-453-A (or -B)	R.F. unit 26
Transmitter T1154/	R.F. unit 25
B.D.J.N.	R.F. unit 27
58 walkie-talkie	Wireless set No. 19
Frequency meter	Den.obbed valves
B.C.221	

OVERCURRENT RELAY



Beautifully made by the famous American Westinghouse Company. These are the surface mounting through panel type with clear Pyrex glass covers. They have coils for remote push button resetting. Type A—calibrated for currents between .1 and .4 amps. Type B—calibrated for currents between .5 and 2 amps. Price, unused and perfect, £3/17/6 each.



THE SKYSEARCHER

This is a 2-valve plus-metal receiver set useful as an educational set for beginners, also makes a fine second set for the bedroom, workshop, etc. All parts, less cabinet, chassis and speaker, 19/6. Post and ins. 2/6. Data free with parts or available separately 1/6. 3-valve battery version also available at the same price.

ALL-MAINS AMPLIFIER

Powerful three-valve. Mains amplifier ideal for dances, parties, etc. Complete less chassis, cabinet and speaker (available if required)—data 1/6 (free with parts). Price 19/6, plus 2/6 post and insurance.

CLOCK CASE

Also suitable for barometer or other instrument. Nicely polished. Price 4/6, post and packing 1/6.

Clock numerals to suit these cases etched on metal, 2/6.

Post 9d. if ordered separately.

Simplex Transistor Kit

Makes ideal bedroom radio, uses one transistor and one crystal diode. Complete less case 19/6, case 5/- extra, post and ins. 1/6.

GLASS PANELS

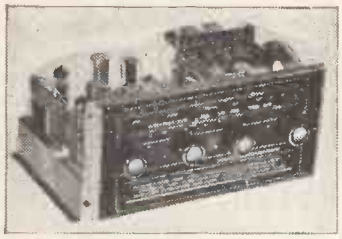
Size 10¾ × 9½—panel of five panels.

8/6

Post free

MINI-RADIO

Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown Bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/10/-, plus 3/6 post. Constructional data free with the parts, or available separately, 1/6.



AM/FM Chassis

Made by the famous McCarthy Radio. This employs a printed circuit in the F.M. Tuner section, it uses 8 valves and has a very attractive three colour dial, size approximately 12 × 5¼in., covers four wavebands: 1,000-2,000 m., 200-550 m., 15-50 m., and 88-100 mc/s. This is a precision made chassis with four controls, tuner, volume, wavechange and tone. Fully guar. Price £22/10/-, post and ins. 5/-.

"THE CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:—

- Ferrite Rod Aerial.
- Low consumption valves (DK96 range).
- Superhet circuit with A.V.C.
- Ready built and aligned chassis if required.
- Beautiful two-tone cabinet.
- Guaranteed results on long and medium waves anywhere.

All parts, including speaker and cabinet, are available separately, or if all ordered together the price is £7/15/- complete. £1/15/- deposit and seven monthly payments of £1. Post and insurance 3/6. Ready built chassis 30/- extra. Instruction booklet free with parts or available separately 1/6.

A FREE GIFT WITH YOUR AVO

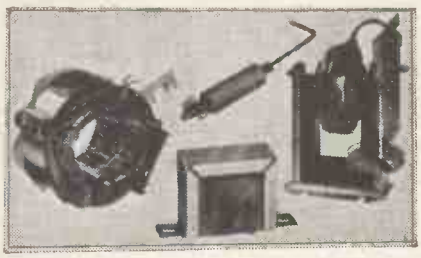
Like all AVO meters it is a very fine instrument; it has a sensitivity of 10,000 ohms per volt and 19 most useful ranges as follows:—D.C. volts 0-1,000 (seven ranges). A.C. volts 0-1,000 (five ranges). D.C. Current 0-1 amp. (5 ranges), resistance 0-2 megs. (2 ranges) (complete with test leads). Immediate delivery. Cash price £9/10/—non-callers please add 3/6 post and ins.

FREE GIFT.—All purchasers of the above item this month will receive the M.M. Range Extender which adds: capacity 0.1 m.f. in two ranges —inductance 0-100 henrys and decible —20 to +36.

THIS MONTH'S SNIP

A 5.K.V.A. Oil Cooled Power Transformer for 440/480V. 3 phases to 230/250V. single phase 50 cycles. Limited quantity £25 each ex works.

Four items for the price of one



This set of modern T.V. parts is equally suitable for modernising an old televisoror for building into a new one. Suitable for wide angle 14in or 17in. tubes using E.H.T. or 12-14 K.V. The four items comprise: (1) line output E.H.T. transformer; (2) 70° scanning coils on ferrite yokes; (3) width control with ferrite core; (4) frame output transformer. With these parts we also give free, complete circuit diagram of modern televisor which uses them. We offer the whole lot at the price of the line output transformer only, namely 57/6, plus 2/6 post and insurance.

EX-GOVERNMENT VALVES

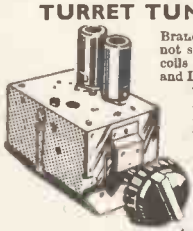
Many types in stock. Here are some of the more popular ones:

1T4	7/6	6K8	9/6	954	3/6
1LD5	3/6	6L6	9/-	1625	10/6
2X2	4/9	6N7	7/6	DDT4	8/6
3A4	7/-	68A7	8/-	DDT13	8/6
5Z4	9/6	6Q7	9/6	DH73	9/6
5U4	8/-	68J7	8/6	DL74	9/6
6AC7	6/6	68K7	6/-	EF80	8/6
6AL5	6/6	68L7	3/-	EL50	10/6
6B8	4/-	6V6	9/6	H63	6/6
6C4	6/6	7A7	9/6	HL4G	6/6
6C6	6/6	7V7	9/6	HL13	9/6
6D6	6/6	7Y4	8/6	HL1320	9/6
6F6	7/6	25Z4	9/6	KT61	9/6
6F8	9/6	25Z6	10/6	KT72	9/6
6G6G	4/6	25Y5	10/-	KTW61	4/6
6H6	2/6	42	8/-	KTW73	9/6
6J5	5/-	43	10/-	KTZ41	9/6
6J7	6/-	75	12/6	U12	8/6
6K6	7/-	77	8/6	U74	9/6
6K7	7/6	78	8/6	U71	9/6
		84	8/6		

Install those extra power points

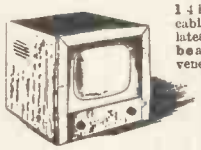
Three core 7.029 P.V.C. insulated. Cores coloured red, blue and white. Outer covering of braiding compounded. Suitable for 3-phase or power extensions. 75/- per coil of 100 yds., carriage 3/6.

NOW TWO MODELS TURRET TUNER



Brand new stock, not surplus, with coils for Band I and III, complete with valves. Model I. —I.F. output 33/38 mc/s. Series heaters. Model II. I.F. output 16-19 mc/s. Parallel heaters with circuit diagram, 79/6. With knobs 3/6 extra, post and ins. 2/6.

14in. T.V. CABINET



14in. T.V. cabinet of the latest styling—beautifully veneered and polished—limited quantity—sale price 19/6 ea. Carr. and packing 3/6 extra. Masks 10/- extra.

F.M. TUNER

This is a high fidelity unit which although moderately priced has a performance equal to the highest priced. Its stability is very good and extremely good results have been received with the simplest of aerials as far away as Eastbourne. The unit is made up ready to work and has its own power supply for A.C. mains. Demonstration at all our branches. Price 12 gns. or £1/12/- down and 6 payments of £2. Post plus insurance 5/-.

You can build our TV in one evening

There are only 24 solder joints to make —suitable 14in. or 17in. tube, cost £29/10/-. We will gladly send full constructional details and circuit diagram on receipt of 3/6 which will be credited in full if you buy the kit.

ELECTRONIC PRECISION EQUIPMENT, LTD.

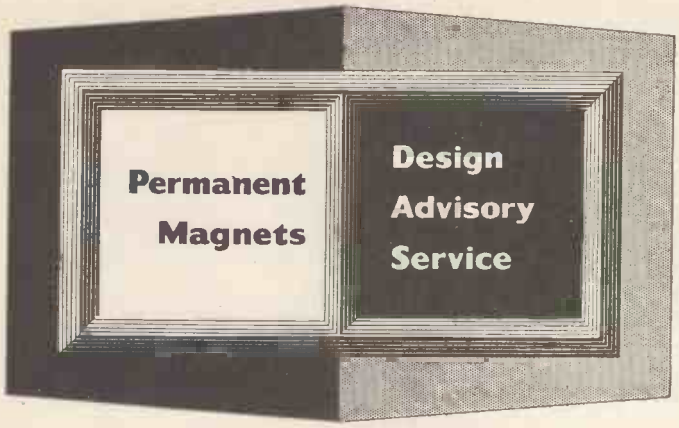
Post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2.

42-46, Windmill Hill, Ruislip, Middx. Phone: RUISLIP 5780. Half day, Wednesday.

66, Grove Road, Eastbourne, Sussex. Half day, Saturday.

29, Stroud Green Rd., Finsbury Park, N.4. PHONE: ARChway 1049. Half day, Thursday.

266, London Road, Croydon. Phone: CRO 6558. Half day, Wednesday.



No. 2

Magnetic Circuits

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

The fundamental factors governing the design of a magnetic circuit are:—

(*a*) The magnetic field strength required in the air gap.

(*b*) The physical dimensions of the air gap.

(*c*) The leakage flux from the surface of the magnet (and pole pieces, if used).

If the dimensions of the gap and the flux required in it are known, the length of the magnet may be determined with the aid of either of the following simple formulae.

c.g.s. System

Length L_m of magnet in cm.

$$L_m = \frac{H_g \times L_g}{H_d} \times K_l$$

H_g is the field in the air gap in oersteds; L_g is the length of the air gap in cm; H_d is the design value of H from the magnet material characteristic.

M. K. S. System

Length L_m of magnet in metres

$$L_m = \frac{B_g \times L_g}{H_d} \times 4\pi \times 10^{-7} \times K_l$$

B_g is flux density in gap in webers/metre²; L_g is length of gap in metres; H_g is in ampère-turns/metre.

K_l is a factor which may vary between 1.05 and 1.2. The lower value would apply if iron is of good magnetic quality operating well below saturation; also if joints in the magnetic circuit do not present appreciable reluctance.

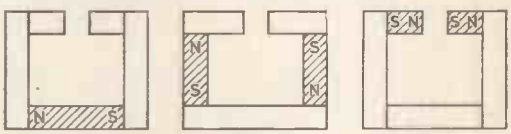
The cross-sectional area of the magnet may be obtained by this formula.

Area A_m of magnet in sq. cm.

$$A_m = \frac{B_g \times A_g}{B_d} \times \text{Leakage Factor}$$

B_g is the flux density required in the air gap ($B_g = H_g$ in air); A_g = area of gap in sq. cm.; B_d = design value of flux density of the magnet material.

Leakage factors vary enormously with different applications and therefore, some experience or information is necessary in order to get a sufficiently close approximation for practical purposes. An example illustrating leakage is shown below.



3%-5% 5%-10% 10%-20%

APPROX. EFFICIENCY

Using the M. K. S. System the same formula still applies with B_g and B_d in webers/metre² and the area in square metres.

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

Mullard

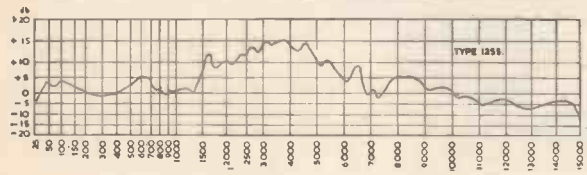
'TICONAL' PERMANENT MAGNETS
'MAGNADUR' CERAMIC MAGNETS
FERROXCUBE MAGNETIC CORES

MULLARD LIMITED, COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1 Tel. LANgham 6633
MC 262A

. . . you will realise that Grampian high fidelity equipment gives you the nearest approach to "Concert Hall listening" in your own home. You will, for instance, appreciate the extra-ordinary delicacy of reproduction achieved by their new 12in. loudspeaker. A great deal of research and new manufacturing methods were necessary to produce a speaker unit with such an extended audio frequency coverage at such a reasonable cost.

GRAMPIAN
12" SPEAKER UNIT
Type 1255/15

Frequency Range.....20-15,000 c.p.s
Voice Coil Diameter.....1¼in.
Voice Coil Impedance.....15 ohms
Fundamental Resonance.....40 c.p.s.
Power Handling Capacity.....10 watts
Flux Density: 14,500 lines per sq. cm.
Total Flux: 130,500 lines per sq. cm.



CYCLES PER SECOND INPUT ¼ WATT
RESPONSE CURVE for speaker unit 1255/15

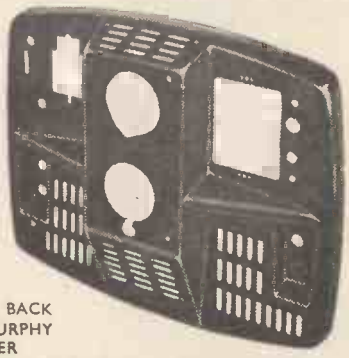
A specially designed reflex cabinet suitable for either corner or side of room is now available as an easy-to-assemble kit of parts, complete with grille material ready to assemble, stain and polish. Although it is primarily intended for use with the Type 1255/15 speaker the cabinet will give excellent results with other units of similar specifications. Price £11

Deferred terms available if desired for both speaker and cabinet kit!

Full details from:

GRAMPIAN
REPRODUCERS LIMITED
Makers of quality high fidelity equipment
17 HANWORTH TRADING ESTATE, FELTHAM, MIDDLESEX
Telephone: Feltham 2657/8

Are you looking for
HIGH MECHANICAL STRENGTH at LOW COST?



MOULDED BACK
FOR 17" MURPHY
TV RECEIVER

Size of product often precludes the use of a moulding but FIBRE FORM can be moulded in any size.

FIBRE FORM is a new material based on the combination of strong cellulose fibre with synthetic resins. There are other reinforced plastics but FIBRE FORM mouldings are not only LIGHTER and STRONGER but they are CHEAPER.
Leading manufacturers use FIBRE FORM for TV portable cabinets, portable radios, TV masks, TV cabinet backs (right up to 21in. console model), radiogram backs, TV tube end protectors, etc., etc.
The illustration shows a moulded back for the new Murphy 17in. TV cabinet. Its strength, dimensional stability and good appearance make this back a vital STRUCTURAL component of the cabinet design.

WE CAN IMPROVE YOUR PRODUCTS AND REDUCE YOUR COSTS

FIBRE FORM LIMITED
Garratt Mills, Trewint Street,
London, S.W.18
Tel.: Wimbledon 3946

WAFER SWITCHES TO SPECIFICATION

As we specialise *only* in the manufacture of small quantities of wafer switches (to individual specification) we guarantee competitive prices and fast delivery.

SWITCHES TO PUBLISHED DESIGNS (FROM STOCK)

G.E.C. 912-PLUS

S1 (14061/B1) } 14/6 pair
S2 (14062/B1) }
S4 (SS/556/1) ... 11/6
S5 (SS/556/2) ... 10/6

Mullard Tape Amplifiers

Amplifier "A"
SS/567/A } 32/6 the set
SS/567/B }
SS/567/C }

Amplifier "B"
SS/567/A ... 16/6

G.E.C. 88-50 Pre-Amplifier

Input Selector (state number of positions) ... 12/-
Treble Selector ... 7/9

Write for Price List and Design Chart.

SPECIALIST SWITCHES

23 Radnor Mews - Sussex Place
London W2 - AMBassador 2308

Suppliers to the leading electronics, aeronautical and automobile companies and to research institutions, the G.P.O. and Universities.

'EMISTRUCTOR' HI-FI

✻ ASSEMBLE THE UNITS

✻ LEARN AS YOU BUILD

At last! Here's YOUR opportunity to own a magnificent Hi-Fi — a complete hi-fi system in a beautifully-styled cabinet at *two-thirds* of normal price — plus all the *extra* satisfaction and fun of building it yourself! The units are easy to assemble — *no* experience needed — and the FREE instruction book guides you at each stage and teaches you all about Hi-Fi!

CHOICE OF UNITS AVAILABLE:

Superb contemporary style cabinet · 8 or 14 watt high quality amplifier (push-pull output with feed back) · 4-speed auto-change record player with compensation · High quality speaker system · Tape transcriptor with pre-amplifier · Record storage compartment · Instruction Manuals on assembly and on Hi-Fi sound reproduction. All equipment available on deferred terms.

EMI INSTITUTES

The Educational Organisation associated with

"HIS MASTER'S VOICE"
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COLUMBIA
Etc.

POST TODAY

To: E.M.I. Institutes, Dept. H.F. 127, London W.4.

Please send, without any obligation, your free brochure to:—

NAME.....

ADDRESS.....

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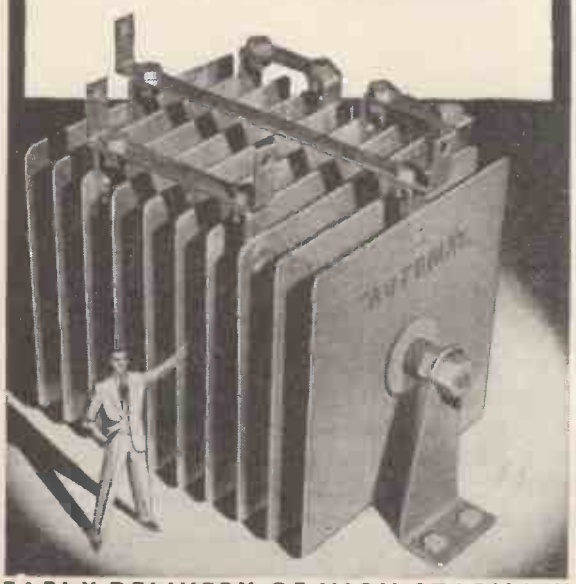
MAY/58 IC122

48 HOUR PROTOTYPE SERVICE



EARLY DELIVERY OF HIGH STABILITY RECTIFIERS
to any rating.

AUTOMAT MOORSIDE, SWINTON, MANCHESTER. Tel.: SWI 4242

CW 4352

42 gns ? - impossible

yes **42** gns. & it's all British

FIRST TIME EVER

a genuine **HI-FI** tape recorder at a price all can afford. The star-studded Verdick **SI** tape recorder made to very high standards with particular emphasis on trouble-free long term stability.

★ ★ ★ ★ ★

FIVE STAR FEATURE separate record and playback amplifier and 3 head system allows playback of tape as you record. No more ruined recordings — you hear it as you record it.

- TAPE SPEEDS 3¾"/SEC, 7½"/SEC.
- SEPARATE RECORD AND PLAYBACK AMPLIFIERS.
- FIVE VALVES PLUS MAGIC EYE LEVEL INDICATOR.
- TWIN SPEAKERS.
- FREQUENCY RANGE 40 C/S TO 12 KCS.
- HI-FI OUTPUT WITH C.C.I.R. CORRECTION TO PLAYBACK THROUGH YOUR HI-FI AMPLIFIER.
- PROVISION FOR USE OF EXTERNAL SPEAKER.
- SUPPLIED COMPLETE WITH 1200' TAPE AND MICROPHONE.

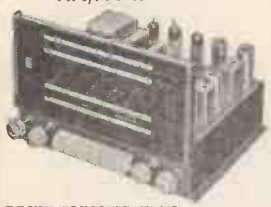
From your dealer or if in difficulty write direct to manufacturers:-

VERDIK

VERDIK SALES LIMITED
139/143 Sydenham Road, London, S.E.26. Sydenham 3118/9

IT'S MUCH BETTER — MODERNISE YOUR OLD RADIOGRAM — IT'S MUCH CHEAPER

THE NEW ARMSTRONG P.B.409 AM/FM RADIOGRAM CHASSIS



PRICE **£29.8.0** (Plus 7/6 carr. and ins.).

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/-. H.P. Dep. £14/14/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION:—
A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Jey" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. × 9½in × 8in. high. Dial size 11½in. × 5½in.

THE ARMSTRONG MODEL A.F. 105 AM/FM RADIOGRAM CHASSIS

A Genuinely Hand Made Chassis

Developed to meet the needs of those who require really high quality radio and record reproduction but who, for reasons of expense or lack of room in existing or proposed cabinets, cannot consider the normal high-fidelity system. The A.F.105 is as good as, or better than many of the high quality amplifiers, and Associated units. Independent and continuously variable Bass and Treble controls give a wide range of control. SEND S.A.E. FOR DETAILS.

PRICE **£37** (Plus 7/6 carr. and ins.).

CREDIT SALE TERMS: Deposit £9/5/- and 9 monthly payments of £3/7/10.
HIRE PURCHASE TERMS: Deposit £18/10/- and 12 monthly payments of £1/14/4.

THE DULCI MODEL H.4

COMBINED AM/FM RADIOGRAM CHASSIS

A 4 Waveband Receiver designed for first-rate reproduction of Radio and Gram.

PRICE **£24.6.6** (Plus 7/6 carr. & ins.).

CREDIT TERMS: Deposit £6/2/- and 9 monthly payments of £2/4/7. H.P. TERMS: Deposit £12/3/3 and 12 monthly payments of £1/2/7.
BRIEF SPECIFICATION:—
- Covers Short, Medium, Long and F.M. Wavebands.
- Employs full A.V.C.
- The latest 7-valve line-up.
- For 3 or 15 ohm P.M. Speakers.
- "Magic Eye" Tuning Indicator.
- Excellent Tone range up to 4 watts output
- Internal aerial for local stations.
- Overall size 12in. × 8½in. × 7½in. high.

A good Quality Chassis and Well Recommended.

HOME CONSTRUCTORS !!

BUILD YOUR OWN "Hi-Fi" LOUDSPEAKER SYSTEM

WITH W-B's WELL-KNOWN RANGE OF READY-TO-ASSEMBLE CABINETS. ALL ARE BEAUTIFULLY MADE AND FINISHED AND VERY EASILY ASSEMBLED. ONLY A SCREWDRIVER IS REQUIRED. THEY ARE PACKED FLAT IN CARTONS AND COMPLETE WITH SCREWS.
WE SHOW A FEW HERE BUT OTHERS ARE AVAILABLE. SEND S.A.E. FOR LEAFLET.

CALL IN AND LISTEN TO THEM.

THE JUNIOR BASS REFLEX CORNER CONSOLE

A new contemporary-style cabinet, specially designed to give maximum reproduction quality from Stentorian 8in. or 10in. units with provision for Tweeter Unit, if required. Measures 33in. × 23½in. × 18½in. Price £9/9/- or with the 8in. Stentorian Speaker £13/12/6 or with 10in. Stentorian Speaker £14/8/6.

The "PRELUDE" Hi-Fi CONSOLE CABINET

Takes any make of tape-deck or record player amplifier, pre-amplifier control unit, and radio tuner. Size 33in. × 19in. × 19½in. Height above baseboard is 6½in. Price £13/13/-.

The "PRELUDE" BASS REFLEX CORNER CONSOLE

This most attractive cabinet has been specially designed to utilise the natural acoustic properties of the walls, and is also obviously suitable for use where space-saving is a consideration. It's sturdily constructed to take every advantage of Stentorian 8in. or 10in. units, with provision for Tweeter Unit. Size 33in. × 21in. × 17in. Price £10/10/- or with the 8in. Stentorian Speaker £14/13/6 or with the 10in. Stentorian £15/9/6.

The "PRELUDE" Hi-Fi TABLE CABINET

Designed to take any make of Tape Deck or Single Record Player (not Auto-changers) Amplifier Pre-amplifier Control Unit, and Radio Tuner. Price £9/19/6. Size 19½in. × 19in. × 19½in.

HIRE PURCHASE and CREDIT SALES TERMS ARE AVAILABLE . . . SEND S.A.E. for details.
WE ALSO HAVE THE GOODMANS SHERWOOD ENCLOSURE IN STOCK.

THE DULCI MODEL H3.

COMBINED AM/FM RADIOGRAM CHASSIS

This model is very similar to the model H.4 described above but covers 3 WAVEBANDS instead of 4 (omitting the Short Band) and is for 3 ohm Speakers only. Overall size is as for the H.4.

PRICE **£20.17.0** (Plus 7/6 carr. and ins.).

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

Stern's "fidelity" F.M. TUNING UNIT

A 5-Valve Tuner incorporating the latest Mullard Permeability Tuned Unit. Price assembled less Power Supply:

£14.10.0

(Plus 7/6 carr. and ins.).

TERMS: (a) H.P. Deposit £7/5/- and 9 monthly payments of 18/4. (b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates: ● The latest Valve line-up—ECC85, 2 type EF85, EF91 and EM80. ● A "Magic Eye" Indicator. ● Power consumption is 1.7 amps. at 6.3 volts and 25 m/a. at 250 volts.

STERN'S "fidelity" COMBINED A.M. and F.M. TUNING UNIT

This is IDENTICAL to the Stern's F.M. Tuner illustrated above, but in addition incorporates the MEDIUM WAVEBAND and thereby also provides a selection of foreign stations. PRICE **£18.18.0** (Plus 7/6 carr. and ins.).

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-; (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.

HOME CONSTRUCTORS . . . You can build

(a) The "fidelity" F.M. TUNING UNIT FOR **£10.0.0**

(b) The "fidelity" AM/FM TUNING UNIT, for **£13.10.0**

The COMPLETE ASSEMBLY DIAGRAMS and INSTRUCTIONS CAN BE OBTAINED FOR 1/6 each.

!! SPECIAL CASH OFFERS !!

The Latest Collaro 4 Speed Single Record Player

Incorporating the very popular STUDIO "O" CRYSTAL PICK-UP For only **£6.19.6** (Plus 5/- carr. and ins.).

Incorporates Auto-Stop and Plays 78 r.p.m. and all types of L.P. Records.

The Collaro "Junior" Rim Drive 4 Speed Record Player

Offered complete with Collaro Crystal Pick-up For **£4/10/0.** (Plus 4/- carr. and ins.) We also offer . . . Gram Motor and Turntable at £3/2/6. Crystal Pick-up only. £1/12/6. (Carr. and Ins. 2/- extra).

"FRUSTRATED EXPORT ORDER"

The Cossor Model 527/X4 Valve "All-dry" Battery Portable.

Offered For **£6.15.0**

Plus 5/- carr. & ins

Consists of a 4 valve Superhet Receiver covering Medium Waveband 197-575 metres, and two Short Wavebands 13.6 to 136 metres. The new low consumption valves are incorporated and the whole is accommodated in an attractive robustly made case. Battery required is 90 volts and 1.4 volts (price 19/6) ..nd is external to case.

THE DULCI MODEL H.4T

Combined AM/FM Tuning Unit incorporating own Power Supply.

MODEL H.4T. This model is the "TUNER UNIT VERSION" of the H.4 Radiogram Chassis illustrated and described above. It has the same coverage of A.M. and F.M. Wavebands (4 altogether) and precisely the same in size and appearance, except that it has three Controls only, being: TUNING, WAVECHANGE and Volume On/Off, mounted centrally on the chassis. A self-contained Tuner incorporating own Power Supply.

PRICE (plus 7/6 carr. & ins.) **£20.17.0**

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

RECORD PLAYERS

THE VERY LATEST MODELS ARE IN STOCK

MANY AT REDUCED PRICES ! ! ! !

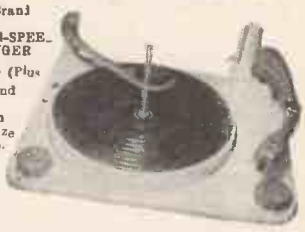
TRANSCRIPTION UNITS—AUTOCHANGERS
SINGLE RECORD PLAYERS

Send S.A.E. for ILLUSTRATED STOCK LIST

CASH ONLY OFFER ! ! !

This latest Brand New B.S.R. MONARCH 4-SPEED AUTOCHANGER **£7.19.6** (Plus 5/- carr. and ins.).

● Minimum baseboard size required 14in. × 12½in. with height above 5½in. & height below baseboard 2½in.



WE ALSO HAVE A FEW ONLY

COLLARO 4-Speed "Mixer" Autochangers. The Units are BRAND NEW and incorporate the STUDIO "O" Pick-up. PRICE **£8.15.0** (Plus 5/- carr. and ins.)

Open Monday to Friday 9 a.m.—6 p.m.
Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

THE 1958 NEW LOOK

MULLARD DESIGNS FOR THE HOME CONSTRUCTOR

AMPLIFIERS PRE-AMPLIFIERS

COMPLETE KITS OF PARTS FOR THE "HI-FI" ENTHUSIAST

Designed by MULLARD—Presented by US strictly to their specification.

THE VERY POPULAR MULLARD "5-10" MAIN AMPLIFIER

Undoubtedly the most successful amplifier yet designed, and used in conjunction with the new Mullard Pre-Amplifier, an undistorted power output of up to 10 watts is obtained. Thoroughly recommended to the "Hi-Fi" enthusiast who contemplates a very high quality home installation. In addition the versatility of the equipment makes it quite suitable for use in small halls, etc. We supply complete to MULLARD'S SPECIFICATION with specified valves and components and including the latest PARMEKO Ultra linear Output transformer. Has power available to drive Radio Tuning Unit.

Price for COMPLETE KIT OF PARTS..... **£10.0.0**

Alternatively we supply ASSEMBLED and TESTED **£11.10.0**

(Carriage and insurance 5/- extra.)

We also offer this "5-10" incorporating the latest PARTRIDGE ULTRA-LINEAR OUTPUT TRANSFORMER for £1/6/- extra.

MULLARD'S NEW 2-STAGE PRE-AMPLIFIER-TONE CONTROL UNIT

A completely new design employing two EF86 valves, and in particular designed to correctly operate with the Mullard range of Power Amplifiers.

Briefly it incorporates:—

- Equalisation for the latest R.I.A.A. characteristics.
- Input for variable reluctance. Magnetic Pick-ups.
- Input for Crystal Pick-ups.
- Input for Tape replay.
  - (a) Direct from High Impedance Tape Head.
  - (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel.
- Wide range BASS and TREBLE Controls.
- Attractive Perspex front control panel.
- Our Kit is strictly to MULLARD'S SPECIFICATION.

Price, COMPLETE KIT OF PARTS **£6.6.0**

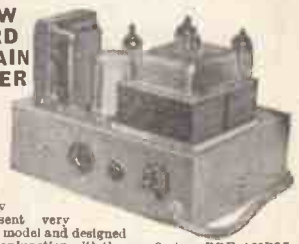
Alternatively we supply ASSEMBLED and TESTED..... **£8.0.0**

(Carriage and Insurance 5/- extra.)

NOTE WE DO *NOT* USE SURPLUS OR CHEAP COMPONENTS IN ANY OF OUR MULLARD KITS or ASSEMBLED UNITS.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required ... alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings etc. are available at 1/6 each.

THE NEW MULLARD "3-3" MAIN AMPLIFIER



Based entirely on the present very popular "3-3" model and designed to operate in conjunction with the new 2-stage PRE-AMPLIFIER (shown here) this providing all the facilities associated with the more expensive "Hi-Fi" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts).

We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMEKO Output Transformer, specified Valves and Components. Has Power available to drive a Radio Tuning Unit.

Price for COMPLETE KIT of PARTS **£7.0.0**

Alternatively we supply ASSEMBLED and TESTED..... **£8.0.0**

(Carriage and Insurance 5/- extra.)

SPECIAL PRICE REDUCTIONS—WE OFFER

HIGH QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST

(a) THE COMPLETE KIT of PARTS to build both the "3-3" MAIN AMPLIFIER and the 2-stage PRE-AMPLIFIER-CONTROL UNIT **£12.10.0**

(a) THE "3-3" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED..... **£15.0.0**

CREDIT TERMS: DEPOSIT £3/15/- and 9 monthly payments of £1/7/6.

H.P. TERMS: DEP. £7/10/- & 9 monthly payments of 19/-.

(b) THE COMPLETE KIT of PARTS to build both the "5-10" MAIN AMPLIFIER and the 2-STAGE PRE-AMPLIFIER-CONTROL UNIT **£15.15.0**

(b) THE "5-10" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED..... **£18.18.0**

CREDIT TERMS: DEPOSIT £4/15/- and 9 monthly payments of £1/14/7.

H.P. TERMS: DEP. £9/9/- & 12 monthly payments of 17/6.

*ALL PRICES QUOTED FOR THE "5-10" ARE SUBJECT TO £1/6/- EXTRA IF THE PARTRIDGE TRANSF. IS REQUIRED.

When ordering please include an extra 7/6 to cover cost of carriage and insurance.

THE NEW COMPLETE MULLARD "5-10" AMPLIFIER

ANOTHER NEW DESIGN ILLUSTRATION NOT AVAILABLE AT TIME OF GOING TO PRESS AMPLIFIERS AVAILABLE EARLY APRIL

This Amplifier is similar to the "5-10" illustrated above, but it has ALL CONTROLS incorporated on the Amplifier Chassis in the same way as the "3-3" (illustrated alongside) finished with our attractive PERSPEX FRONT PANEL, thus forming a complete Amplifier.

We supply it complete to the MULLARD SPECIFICATION including specified Valves and components and incorporating the latest PARMEKO ULTRA LINEAR OUTPUT TRANSFORMER and switched inputs for 78 and L.P. Records plus a Radio Tuning Unit. Extra Power is available to drive the Tuning Unit.

Separate BASS and TREBLE CONTROLS provide excellent range of tone and we recommend the Amplifier to those with limited Cabinet space who require GENUINE HIGH QUALITY at a higher volume level than the "3-3" but without the versatility of the separate Preamplifier-Control Unit with Main Amplifier.

Price COMPLETE KIT of PARTS **£11.0.0**

Alternatively we supply ASSEMBLED and TESTED **£13.10.0**

Credit Sale: Dep. £3/7/6 & 9 monthly payments of £1/4/11.

H.P. Terms: Dep. £6/15/- & 8 monthly payments of 19/3.

Send S.A.E. for ILLUSTRATED LEAFLET or alternatively the COMPLETE ASSEMBLY MANUAL IS AVAILABLE FOR 1/6.

STERN'S "ndelity" PRE-AMPLIFIER-TONE CONTROL UNIT

A versatile 2-State Unit using two ECC 83 Valves and incorporating a Preset Output Control, the function of this Control is to provide for variation of output, thus enabling the Unit to be used with any Amplifier where correct matchings and a good tone range is desired.

Briefly it incorporates: (a) Inputs for all types of MICROPHONES, HIGH or LOW GAIN PICK UPS and RADIO TUNING UNIT (b) STEEP CUT FILTER (c) GRAM EQUALISER (d) Separate BASS and TREBLE CONTROLS (e) Input for TAPE REPLAY (f) Attractive PERSPEX FRONT CONTROL PANEL. The outstanding features of this unit are: correct equalising for Gram reproduction, excellent control of Bass and Treble, extreme simplicity of operation.

Price COMPLETE KIT OF PARTS **£6.16.0**

Alternatively we supply ASSEMBLED and TESTED **£8.10.0**

(Carriage and Insurance is 5/- extra.)

The ASSEMBLY MANUAL, containing Specification and Drawings, etc., is available for 1/6 or send S.A.E. for illustrated leaflet if required.

THE NEW COMPLETE MULLARD "3-3"

A VERY HIGH QUALITY AMPLIFIER PROVIDING EXCELLENT REPRODUCTION AND HAVING AN ATTRACTIVE ENGRAVED PERSPEX FRONT PANEL.

Price for COMPLETE KIT OF PARTS **£7.10.0**
(plus 6/6 carriage and insurance).

Alternatively supplied ASSEMBLED and FULLY TESTED **£8.19.6**
(plus 6/6 carriage and insurance.)

The complete specification is available for 1/6.

Developed from the very popular 3-valve 3-watt Amplifier designed in the Mullard Laboratories. Our kit is complete to the Mullard specification, including supply of specified components, valves and a PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

A COMPLETE KIT OF PARTS, STERN'S 8-10 WATT AMPLIFIER

Has power supply available for Radio Tuning Unit.

Price of COMPLETE KIT OF PARTS (plus 5/- carr. & ins.) **£7.10.0**

WE ALSO OFFER IT ASSEMBLED and READY FOR USE for (plus 5/- carr. & ins.) **£9.10.0**

This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The complete SPECIFICATIONS and BUILDING INSTRUCTIONS ARE AVAILABLE for 1/6.

STERN'S POWER SUPPLY UNIT

Fully smoothed with all output connections terminated to connecting Blocks. Overall size is 9½in. x 3½in. x 4½in. high.

TWO MODELS AVAILABLE, Type "A" provides 250-300 volts up to 70 m/a. and 6.3 volts at 3½ amps. PRICE **£2.17.6**

Type "B" Unit 250-300 volts at up to 100 m/a. and 6.3 volts at 3½ amps. PRICE **£3.3.0.**

(Plus 2/- carr. and ins.).

SPECIAL CASH ONLY OFFER ! !

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6**

(plus 7/6 carr. & ins.). The Amplifier consists of a 2 Stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-Stage (plus Rectifier) AMPLIFIER £4/2/6

(b) The PORTABLE CARRYING CASE..... £3/17/6

(c) 6½in. P.M. SPEAKER 18/9

(Carriage and insurance 4/- extra.)

We also have a smaller PORTABLE CASE ideal for Record Players. PRICE ONLY £3/3/- (plus 3/- carr. & ins.). Attractively finished in high-grade Rexine and robustly constructed with internal measurements at 13½ x 15½in. high. It will therefore accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

"HI-FI" AMPLIFIERS IN STOCK

include STERNS COMPACT "5-2". DULCI D.P.A.10 DULCI H.11. ARMSTRONG A10 Mk11. "Varislope" LEAK "VARISLOPE" PRE-AMPLIFIER. ROGERS "JUNIOR" R.C.A. ORTHOPHONIC. *Send S.A.E. for details.*

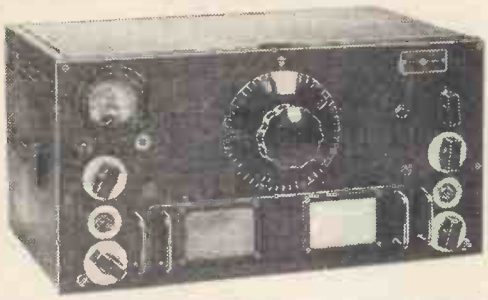
F.M. TUNING UNITS BY MOST OF THE LEADING MANUFACTURERS.

Please enclose S.A.E. with all enquiries

109-115 FLEET ST. LONDON E.C.4

Phone: FLEet Street 5812-3-4

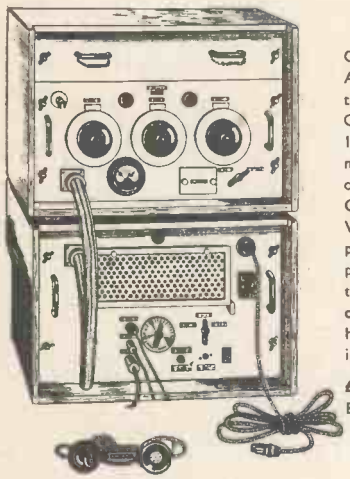
HRO SENIOR MODELS.



Complete with valves, 9 general coverage plug-in coilsets 50 Kc/s. to 30 Mc/s., instruction booklet, and circuit, but less external power supply unit.
Table models, as new condition, **21 GNS.** Rack Mounting, **18 GNS.** Packing and carriage 22/– extra.

Send S.A.E. for further details.

TRANSMITTER TYPE 36.



Complete 110-250 v. A.C. mains operated transmitter for speech, CW or MCW. Covers 10-60 Mc/s. (10-15-20 metre Ham Bands) but only 10-40 coils supplied. Crystal or stabilised VFO. Push-pull 807's plate and screen modulate parallel 807's. Supplied tested, ready to use, with connectors, 16 valves, handset, operating instructions and circuit.

£12 10 0. Carriage England and Wales 30/–.

RCA TE-149 HETERODYNE WAVEMETERS.

Employs V-cut 1 Mc/s. Crystal (0.005%). Overall accuracy better than 0.02%. The dial is DIRECTLY calibrated every 1 Kc/s. between 2.5 and 5 Mc/s., and harmonics may be used up to 20 Mc/s. Provision for fitting internal dry batteries. Supplied as new in special transit case.

£9 19 6, Carriage 5/6.

MULLARD C & R BRIDGE

Resistance	Capacity
1/10th to 10 ohms.	10 to 1000 pFd.
10 to 1000 ohms.	0.001 to 0.1 mFd.
1 K to 100 K ohms.	0.1 to 10 mFd.
100 K to 10 Megohms.	

Minus 20% to plus 25% comparison scale. Provision for "Open Bridge." "Calibrate" position. Large easily read scale. Sensitivity control. Operates from 100-250 v. A.C. mains. In very good condition. Carefully tested and checked before despatch.

£7 10 0, P. & P. 3/6.

TRIPLETT COMBINATION TESTERS.

Brand new, ex-U.S.A. For valve, circuit, capacity, and other testing purposes. In neat black crackled metal case with lid and carrying handle. 15 × 7½ × 5½in. 4in. 100 micro-Amp. meter. Ranges: 0 to 10, 50, 250, 500 and 1,000 v. A.C. and D.C.; 0 to 500, 150 K, 1.5 Meg., and 15 Megohms; 0 to 1, 10, 50 and 250 milliamps, D.C. Valve tester has provision for "short" tests and inter-electrode voltages and currents. Complete with instructions, valve charts and batteries, ready for use on A.C. mains.

£14 19 6, Carr. 7/6.

PARMEKO H.T. TRANSFORMER.

Primary 230 v. 50 c/s. Secondary 620-550-375-0-375-550-620 v. (620 v. at 200 mA., 550 v. at 250 mA.). Two rectifier windings at 5 v. 3 amps. each. Total rating 278 vA. Upright mtg., weight 24lb. BRAND NEW. ORIGINAL BOXES.

45/–, Pkg. & Carr. 5/–.

SANGAMO-WESTON VOLTMETERS, Model S61.

A dual range 0-5 and 0-100 DC Voltmeter. Basic sensitivity 1,000 Ohms per volt. 3in. clearly calibrated scale. Knife-edge pointer. Easily modified for additional ranges and ideal for schools. Of recent manufacture, and supplied in high quality canvas carrying case, complete with test leads. Brand new and boxed.

27/6d. P. & P. 2/6.

FERRANTI VOLTMETERS Model N5.

Flush mounting, moving iron, 6in. scale, 0-300 volts, 25-100 c/s. Latest type hermetically sealed, grade 1N. Date of manufacture 1955. Brand new and boxed.

79/6d. P. & P. 3/6.

MARCONI TF 987/1 NOISE GENERATORS.

Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM AND FM receivers. Fully stabilised HT supply. AC mains operation. Brand new and in original boxes.

£25 0 0.

Best Buy at Britain's

AVOMETER Model D. £8-19-6 (P. & P. 4/-)

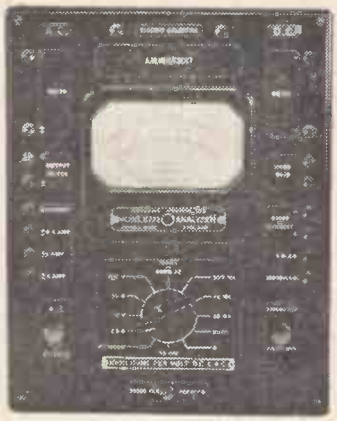
D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mV.	7.5 V.	15 m/A.	75 m/A.
300 mV.	15 V.	30 m/A.	150 m/A.
1.5 V.	75 V.	150 m/A.	750 m/A.
3 V.	150 V.	300 m/a.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	705 V.	15 Amps.	
300 V.	1.5 KV.	30 Amps.	Resistance
750 V.			0-1,000 ohms.
1.5 KV.			0-10 K ohms.

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

SANGAMO WESTERN Model E772
ANALYSER 10 Gns. (P. & P. 4/-)

A.C. and D.C. Volts	D.C. Current	A.C. Current
2.5 V.	100 micro-Amps.	0.5 Amp.
10 V.	1 milli-Amp.	1 Amp.
50 V.	10 milli-Amps.	5 Amps.
250 V.	50 milli-Amps.	
1,000 V.	100 milli-Amps.	Resistance
	500 milli-Amps.	0-100 ohms.
		0-1,000 ohms.
Output meter		0-100 K ohms.
		0-10 Megohms.

Supplied in neat black Rexine covered carrying case, complete with all batteries and instructions. Thoroughly overhauled and in perfect working order.



R1155 RECEIVERS. Model "B" with latest type SM drive. In good condition and perfect working order. Realigned and air-tested. S.A.E. for details of power packs, etc. **£7/19/6.** Carr. 10/6.

TECHRAD AMPLIFIERS (U.S.A.). High sensitivity, suitable for crystal, moving coil, or ribbon microphones/pickups, etc. Output 12 watts into 600-15-7.5-5.2.5 ohms. Complete with four 6J7 met., two 6L6GA, one 5U4G, and ready for use on 200-250 V. A.C. mains. In grey crackled steel case, 17 x 10 x 10in. Absolutely BRAND NEW. **£13/10/-.** Carr. 10/-.

BENDIX MODULATOR/POWER UNITS, Type MP-28-BA, for TA-12 transmitters. With 24 V. D.C. input. 540 V. D.C. 450 m/a. output dynamotor, 6N7met Mic. Amp., 6F6met Driver, and two 807 P.P. Modulators. Complete with Mic. Transf. and Mod. Transf for modulating two parallel 807's. Brand new **79/6.** Slightly soiled **69/6.** Carr. 7/6.
DYNAMOTORS. As used in the above. Brand new **32/6.** Used **19/6.** Wt. 13lb. Carr. 4/-.

MARCONI TF.340 OUTPUT METERS. Perfect working order. **£29/10/-.**

TRIPLETT MULTIMETERS
25 Ranges: 0 to 5, 25, 100, 250, 1,000, and 5 kV D.C. (20,000 OPV); 0 to 5, 25, 100, 250, and 1,000 v. A.C. (1,000 OPV); 0 to 50 microA, 1, 10, 100 and 500 mA 1 and 5 amps. D.C.: 0 to ½, 1, 5 and 10 amps. A.C.; 0 to 1,000, 100 K, and 10 megohms. Square meter, size 4 x 4in. Contained in 11½ x 8 x 5½in. wooden case, weight 10lb. Supplied complete with instruction book, batteries, leads and special high voltage leads. **BRAND NEW** ready for use and fully guaranted. 15 gns. Post 5/-.

VIBRATOR PACKS. Input 6 v. D.C. Output approx. 100 v. D.3. at 30 m/amps., fully smoothed and R.F. filtered. Size 6½ x 5 x 2in. Fitted with Mallory 629C vibrator. **BRAND NEW.** Boxed. **12/6.**
ANOTHER, but 200 v. D.C. 100 m/amps. With OZ4 valve and vibrator. **BRAND NEW.** Boxed. **25/-.**

RCA OUTPUT TRANSFORMERS. As used in MI-11220 Amplifier. Primary for push-pull 6L6's. Secondaries 5, 7.5, 15, and 600 ohms, and tertiary for NFB. 25 watts power rating. Potted construction, with tag connections. Full circuit of RCA amplifier supplied. **BRAND NEW, 27/6.** Post 2/-.

AR77 MAINS TRANSFORMERS. Fully shrouded, drop-through 3½in. x 3½in. Primary 110/125/150/210/240 v. 50-60 c/s. Secs., 325-0-325 v. 100 m/amp., 6.3 v., 3.5 amp., and 5 v. 2 amp. BRAND NEW ex-U.S.A., **29/6.**

MINIATURE STC RELAYS. 250 ohms coil. DP C/O (double silver contacts). 1¼ x ¾ x ¾in. Wt. one oz. 6 v. operation. **7/6.**

METER BARGAINS

RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-100	59/6
100 Microamp.	D.C. M/C	2½in.	Flush circ.	42/6
100 Microamp.	D.C. M/C.	2½in.	Flush circ., scaled "Megs."	39/6
500 Microamp.	D.C. M/C	2in.	Flush Circ. Ex 19 Set	12/6
500-0-500 mic. a.	D.C. M/C	2½in	Flush Circular, scaled 100-0-100 volts	25/-
1 Milliamp.	D.C. M/C.	2in	Flush Square. Fe/NFe.1954	22/6
1 Milliamp.	D.C. M/C	2½in.	Flush Circ. Made 1954	25/-
1 Milliamp.	D.C. M/C	3½in.	Flush Circ.	35/-
1 Milliamp.	D.C. M/C	6in.	Flush Circ. Scaled 0-12 v.	79/6
150 Milliamp.	D.C. M/C	2in.	Flush Square	7/6
200 Milliamp.	D.C. M/C	2½in.	Flush Circular	10/6
1 amp. Thermocouple		2½in.	Projecting Circular	6/9
1 Amp. Thermocouple		2½in.	Flush Circular	7/6
4 Amp. Thermocouple		2in.	Flush Square	6/9
15 Volts	A.C. M/I	2½in.	Flush Circular	8/6
300 Volts	A.C. M/I.	2½in.	Flush Circular	25/-
500 Volts	A.C. M/I	2½in.	Flush Circular	25/-
40 Amperes	D.C. M/C	2in.	Flush Circular	7/6

METER RECTIFIERS. Full wave bridge. Brand new, Salford 1 mA. 6/6. 5 mA., 6/6. STC 2 mA., 5/6.

AMERICAN METERS. Triplett 100 microamp., 4in. meters, scaled as multimeter, exactly as used in Combination Tester shown opposite. Brand new, boxed. **79/6.** Post 1/6.
Triplett 100 microamp, 3in. square, flush mtg. Scaled as output meter, 1.5 and 0-6 volts A.C. Rectifier not fitted. Brand new, boxed, **42/6.** Post 1/-. Westinghouse 0-5 Milliamp D.C., flush mtg., circular, 2in. blank black scale. Brand new, boxed, **8/6.** Post 1/-.

AMERICAN MULTIMETERS
A good general purpose portable meter by Precision, U.S.A. Basic FSD 400 micro-Amps. Ranges: A.C. and D.C. volts 0 to 12, 60, 300, 600, 1,200 and 6,000; D.C. milli-Amps. 0 to 1.2, 12, 60 and 600; Ohms, 0 to 5 K. 500 K. and 5 Meg.; —10 to +16 dB. In polished wooden case with carrying handle and compartment for leads, etc. Size 7½ x 7½ x 5½in. Complete with batteries, tested and guaranteed. **£6/19/6.** Post 2/6.

ADMIRALTY POWER UNITS. Equivalent to AM234. Input 200-250 v. 50 c/s. A.C. mains. Outputs 240 v. D.C. 125 m/Amps. and 6.3 v. A.C. 6 amps. Dual purpose 2½in. panel mounted 300 v. meter reads input and H.T. volts. Double smoothing with paper capacitors. Standard 19in. rack mounting. **BRAND NEW. 79/6.** Carr. 7/6.

MEGGERS
Evershed and Vignoles Wee Meggers. 500 volts. Complete in leather case, with leads and instruction booklet. **BRAND NEW, £12/10/-.** Ditto, but 100 volts. BRAND NEW, **£6/10/-.**
INSULATION TESTERS, by Record Electric. 0-50 Megohms, 500 volts. Tested and guaranteed. **ONLY £8/10/-.**

MINIATURE 373 IF STRIPS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92, and 1 of EB91. A fresh release enables us to offer these once again. **BRAND NEW,** Complete reprint of conversion instructions and circuit supplied free. **42/6.** OR less valves, **12/6.** Post, either, 2/6.

MARCONI SIGNAL GENERATORS
85 Kc/s to 25 Mc/s. A.C. mains operation. In fair condition and working order. **TF144F, £45. TF144G, £50.**

CR100 SPARES KITS

Contents: 15 valves, 2 off U50, DH63, KT63, X66, and seven KTW61 or KTW62. Output transformer, Resistors, Condensers, Potentiometers, FK screws, pilot lamps, drive cord, etc., etc. All BRAND NEW. **59/6.** Post 4/6.

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MARCONI LOOP AERIAL type 696. A small, compact, enclosed loop. On swivel mount with degree scale. **BRAND NEW. 69/6.** Post 2/6. Ideal for R1155, etc.

RT34/APS-13 AMERICAN 70 cm. TRANSMITTER-RECEIVER. Complete with nine 6AG5, five 6J6, two 2D21, one VR105, and dynamotor. Has 34 Mc/s. I.F. strip. **BRAND NEW,** in original cartons. **69/6.** Carr. 5/6.

BATTERY CHARGERS. Input 230 v. A.C. Output 12 v. D.C., 1.5 amps. In neat grey metal case, 7 x 6 x 5in. **BRAND NEW, 35/-.**

SPEAKERS (Eddystone). 3 ohms, 6½in. diam. In grey wrinkled steel cabinet 9 x 9 x 5in. Complete with volume control and transformer for 600 ohms line. **BRAND NEW. 27/6.** Post 2/6.

VHF TRANSMITTERS. BC-950A-130. 100-150 Mc/s., 4 channel, crystal controlled transmitter. Complete with valves, 2 o 1625, 2 of 832A, 1 of 815 (modulator). **BRAND NEW.** In original American packing. (Xtal not supplied.) **£5/19/6.** Carr. 7/6.

RT37/PPN2 BEACON TRANSMITTER-RECEIVER. 214-234 Mc/s. Size 13in. x 10in. x 5in. Contains 5 3A5, 3 1S5, 1 1R5 and 2 2 v. synchronous vibrators. Operates from 2 v. accumulator via 2 built-in vibrapacks. Complete with telescopic mast Antenna system. (9½ft.), lightweight headphones. Technical Manual, super-quality carrying haversack, cords, co-ax cables, plugs, etc. Total wt. 28lb. **BRAND NEW,** boxed. American equipment, **72/6.**

MAINS DIMMERS. 300 ohms, 1 amp., 300 watts, twin ceramic formers, **15/-.**
CRYSTALS. 200 Kc/s. American GEC. 10/- each. 100 Kc/s. RCA bars, 15/-.

DUAL PURPOSE TRANSFORMERS (Gresham). Pri. 230/250 v. Secs., 240-0-240 v. 1.5 amps., 5 v. 12.5 amps., 5 v. 1.75 amps. Ideal for ISOLATING TRANSFORMER, to obtain TWO 240 v. 360 watt lines. Potted, oil-filled, 7 x 7½ x 10½in. high. Wt. 50 lb. **BRAND NEW. £3/10/-.** Carr. 10/-.

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JACK BOXES. A small metal box fitted with 9 miniature insulated Igranic jack sockets. **BRAND NEW. SNIP. 12/6.**

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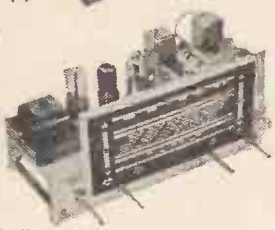
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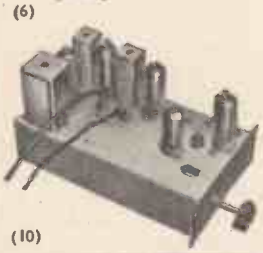
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(1)	New Look " RAMBLER " all dry portable	£7 7 0	2/6	1/6
(2)	" RAMBLER " Mains Unit (suitable for most portables)	£2 7 6	1/6	9d.
(3)	" ECONOMY FOUR " T.R.F. Mains Receiver ...	£5 10 0	2/6	1/6
(4)	" FAMILY FOUR " (our new T.R.F. Receiver) ...	£4 19 6	2/6	1/6
(5)	" SUPERIOR FOUR " (Four valve mains receiver)	£6 9 6	2/6	1/6
(6)	GRAM Chassis 5-valve Superhet	£8 8 0	2/6	1/6
(7)	T.S.L. F.M. Tuner (self powered)	£10 19 6	3/6	2/6
(8)	Standard JASON F.M. Tuner	£6 17 6	2/6	2/–
(9)	Fringe area JASON F.M. Tuner	£7 15 0	2/6	2/–
(10)	JASON " MERCURY " Switch tuned F.M. feeder	£9 19 6	2/6	2/–
(11)	OSRAM 912 Printed circuit F.M. Tuner	£8 8 0	2/6	2/6
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(16)	2-amp. Battery Charger	£1 18 6	2/6	3d.
(17)	R.C. Transistor/Crystal Receiver (with 'Phones)...	£1 17 6	1/3	3d.
(18)	R.E.P. 1-valve Battery Receiver „ „ ...	£2 2 0	2/–	9d.
(19)	" CRY-BABY " ALARM (Baby Alarm) (see below)	£3 12 6	2/6	1/–
(20)	" R.E.P. MINI-7" Transistor Portable (see opp.)	£10 10 0	2/6	1/6
(21)	? ? ?			


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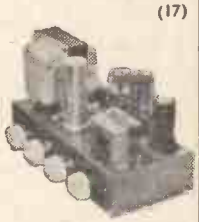
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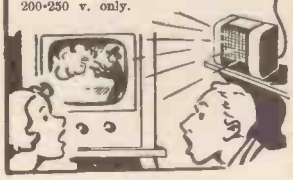
The following are also available assembled and tested:—
(2) " RAMBLER " Mains Unit, £3/5/-; (7) T.S.L. F.M. Tuner, £13/15/-; (14) F.M. Power Pack, 52/6; (15) R.C. 3/4 watt Amplifier, £5/5/-; (16) 2-amp. Battery charger, 45/-; (19) " CRY-BABY" Alarm, 89/6; Instruction Books which contain full description, easy-to-follow practical wiring diagrams theoretical diagrams, itemised price list, etc., are supplied free of charge with all parcels but may be purchased separately if required.

NOTE: (2) The " RAMBLER " Mains Unit is suitable for use with MOST all-dry portables.

THE **CRY-BABY ALARM**

We proudly present this latest addition to our wide range of popular kits to build yourself. Enjoy your leisure free from anxiety. This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely SAFE employing a double wound mains transformer. Attractively finished in Red and Grey (washable) " Lionide " with cream plastic escutcheon. Size only 7¼in. × 3⅛in. × 6⅛in. Supplied in kit form complete with mike at ONLY 72/6 plus 9/6 P.&P. or assembled and tested 89/6 P. & P. 2/6. Suitable mike flex available at 3d. a yd. Instruction book and price list available separately 1/- post free. Note: For A.C. mains 200-250 v. only.

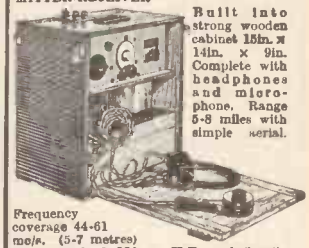


N.B.—All our T.R.F. Kit circuits include specially wound Denco "Max Q" coils on polystyrene formers. Improved performance. Price remains the same.

No. 18 TRANSMITTER RECEIVER UNIT! We have just taken delivery of a quantity of these fine units, brand new and complete. This is a very good portable, self-contained transmitter/receiver designed for short range telephony and C.W. Range, approx. 5 miles. Frequency coverage 6 mc/s.-9 mc/s. All accessories supplied i.e., Headphone, Mike, Morse Key, Aerial, comprehensive instruction book with circuit diagram. Valve line-up: 3 A.R.P.12, 2 AR8, 1 ATP4. Weight approx. 22lb. Dimensions (overall): 8in. × 10in. × 17in. UNREPEATABLE at 99/6 plus 7/6 C. & P.

No. 88 TRANSMITTER/RECEIVER (popular Walkie-Talkie). We have been most fortunate in obtaining a further supply of these complete stations comprising TX/RX unit, headphones, microphone, aerial, junction box, battery satchel and full operating instructions. Range: approx. 5 miles. Frequency coverage 7.4-9 mc/s. ABSOLUTELY BRAND NEW, 65/-. Export enquiries invited.

SPECIAL PURCHASE from MINISTRY BRAND NEW No. 17 Mk. II TRANSMITTER/RECEIVER



Built into strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Frequency coverage 44-61 mc/s. (5-7 metres) Uses standard 120 v. H.T. and 2-volt L.T. batteries. Complete with full operating instructions. 59/6.

CONSTRUCTOR'S NOTE!! RADIO DATA BOOKS AVAILABLE, i.e., Valve guide, Colour code, etc. Send stamp for list.

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6/12 v. ½ a.h.w.	2/9
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6/12 v. 2 a. ..	9/9
6/12 v. 3 a. ..	11/9
6/12 v. 4 a. ..	14/9
6/12 v. 6 a. ..	19/9
6/12 v. 10 a.	25/9
H.T. Type H.W.	
120 v. 40 mA.	3/9
250 v. 50 mA.	5/9
250 v. 80 mA.	7/9
350 v. 60 mA.	7/9
250 v. 250 mA.	10/9

BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6/12 v. 1 a.	27/9
6 v. 2 a.	29/9
6/12 v. 2 a.	38/9
6/12 v. 4 a.	56/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. and packing. 3/6.

BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge. Metal Rectifier, well ventilated steel case. Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp. ..	22/9
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6 v. or 12 v. 2 amps. ..	31/6
6 v. or 12 v. 4 amps. ..	53/9

BATTERY CHARGER KIT Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans. 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps.

Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only 49/9. Carr. 3/6.

Assembled 6v. or 12v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for 75/- use with mains and output leads. Carr. 3/9. Or Deposit 30/- and four monthly payments 13/-.

AM/FM RADIOGRAM CHASSIS, HIGH QUALITY. PUSH PULL. 6-8 WATTS OUTPUT

Current manufacture. 12 months' guarantee. For 200-250 v. mains. Covers L and M. Wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-. Guaranteed 12 months.

CO-AXIAL CABLE. 75 ohms, ¼in., 8d. yard. Twin screened feeder 11d. yard.

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8 mfd. 450 v.	1/9	16 µF 450 v.	2/9
8 mfd. 500 v.	2/6	16 mfd. 500 v.	3/9
16 µF 350 v.	1/11	32 µF 350 v.	2/11
16 µF 450 v.	2/9	32 mfd. 450 v.	4/9
16 µF 500 v.	3/9	100 mfd. 450 v.	4/9
8-16 µF 500 v.	4/11	8-8 µF 450 v.	2/11
25 µF 25 v.	1/3	8-16 µF 450 v.	3/11
50 µF 12 v.	1/3	16-16 µF 450 v.	3/11
50 mfd. 25 v.	1/9	32-32 µF 350 v.	4/9
50 µF 50 v.	1/9	32-32 µF 450 v.	5/9
100 mfd. 12 v.	1/9	100-100 mfd. 350 v.	5/9
100 mfd. 25 v.	2/3	150 mfd. 450 v.	5/9
3,000 mfd. 6 v.	3/9	100-200 mfd. 275 v.	6/11
6,000 mfd. 6 v.	3/11		

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 12/9 plus 2/9 post 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 300 watts, 35/9, plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS

4 mfd. 1,000 v... 3/9 8 mfd. 500 v... 4/6
10 mfd. 500 v. 3/9

THE SKY FOUR T.R.F. RECEIVER

A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

EX GOVT. VIBRATOR UNITS. 12 v. input 280 v. output. Suitable for car radio, etc., 16/6.

VIBRATORS. Oak and Wearite. Synchronous 7 pin 2 v. 7/9, 6 v. 8/9.

EX. GOVT. 50 WATT AMPLIFIERS. Brand new. For 200-250 v. 50 c.p.s A.C. mains. Designed for speech only but with suitable pre-amp, could be used with Gram. or Radio. Valves included. Four 6L6s used for output. Complete with hand microphone with good length of lead. Unused in original transit cases. Only 9 gns. Ready for use. Carr. 15/-.

RE-ENTRANT SPEAKERS. Tannoy 8 watt, 7.5 ohms suitable for above, 25/- each.

EX GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c/s. input.

250-0-250 v. 60 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4½-3½-3in.	11/9
Pr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v. 7 a., 5 v. 3 a.	21/9
230-0-230 v. 80 mA., 12.6 v. 1.5 a. 5 v. 2 a.	11/9
250-0-250 v. 150 mA. 5 v. 3 a.	16/9
350-0-350 v. 160 mA. 6.3 v 5 a. 5 v. 3 a.	27/9
400-0-400 v. 250 mA. 5 v. 2 a., 5 v. 2 a.	18/9
450-0-450 v. 150 mA. 6.3 v. 5 a., 6.3 v. 1 a., 5 v. 3 a.	29/9
450-0-450 v. 250 mA. 6.3 v. 3 a., 6.3 v. 1 a., 5 v. 6 a.	49/9
12.5 v. 3 a., 5 v. 3 a.	12/9

MANUFACTURERS' SURPLUS TRANSFORMERS. Primary 230-250 v. Drop through type 325-0-325 v 100 mA., 6.3 v. 2.5 a., 5 v. 2 a. 17/9. Post 2/9.

EX GOVT. SMOOTHING CHOKES

250 mA., 20 H., 150 ohms	19/6
250 mA., 5 H., 50 ohms	12/9
150 mA., 10 H., 50 ohms	10/11
120 mA., 12 H., 100 ohms	9/9
100 mA., 10 H., 100 ohms	6/9
100 mA., 5 H., 100 ohms, tropicalised..	3/11
50 mA., 50 H., 1,000 ohms	6/9

EX GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14 × 10 × 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post, Size 13½in. × 8in. × 6½in. with undrilled perforated cover finished in stoved grey enamel. 7/9, plus 2/9 post.

SPECIAL OFFERS. Small 2 gangs .005 mfd., 4/9. Electrolytics 32-32-32 mfd. 250 v., 2/9 each or in lots of six, 2/3 each.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5¾ × 4¼ × 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagram. 39/9 or ready for use 46/9.

Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T.2v.ACCUMULATOR8** when connected to A.C. mains supply 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulator. Complete kit with diagrams and instructions, 49/9, or ready for use, 59/6.

JUNCTION TRANSISTORS For R.F. 17/6. A.F. 7/9.

MINIATURE MOTORS. 24/28 v. D.C. A.C. Size only 2½ × 1½in. Spindle 1½in. long, ¼in. diam. Made by Hoover Ltd., Canada. Price only 9/9.

M.E. SPEAKERS. 2-3 ohms R.A. 8in. Field 600 ohms., 11/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED.

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/9
375-0-375 v. 150 mA., 6.3 v. 4 a., 5 v. 2 a.	29/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc.	49/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v., 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 100 mA. 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6.3 v. 2 a. ..	7/9	12 v. 3 a. or	
12 v. 1 a.	7/9	25 v. 1.5 a. ..	17/6

CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/6
Small Pentode 5,000 Ω to 3 Ω	3/9
Standard Pentode, 5,000 Ω to 3 Ω	4/6
Standard Pentode, 8,000 Ω to 3 Ω	4/9
Push-pull 8 watts 6V6 to 5 ohms	8/9
Push-pull 10-12 watts 6V6 to 3 Ω or 15 Ω	15/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15 Ω	16/9
Push-pull EL84 to 3 or 15 ohms	16/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms	21/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc. to 3 or 15 Ω	47/9

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms	11/9
150 mA., 7-10 H., 250 ohms	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms	5/6
60 mA., 10 H., 400 ohms	4/11
1 amp. 0.5 ohm. L.T. type	6/6

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

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensivitity is extremely high. Only 12 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. Cover as illustrated 18/9 extra. Only **£10/19/6** carr. 10/-

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/cs., Tone Controls ± 12 D.B. at 50 c/cs., + 12 D.B. to − 6 D.B. at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc.**

Or Factory built with 12 months' guarantee **£13/13/-**. **TERMS ON ASSEMBLED UNITS. DEPOSIT 36/-** and 9 monthly payments of **31/-**. **etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers.**

EXPORT ENQUIRIES INVITED

LINEAR LT/45 HIGH QUALITY TAPE DECK AMPLIFIER COMPLETE with POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Aspden, Brennell, etc., etc. State make of Deck when ordering. Chassis size 12-7-3in Overall size 12-7-6½in. For 200-250 v. 50 c/cs. A.C. mains. Output for standard 3-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum output required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feed-back equalisation. Linear frequency response ± 3 D.B 50-11,000 c/cs. Facilities for recordings at 15in., 7½in or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Valves type ECC83, ECC83, EL84, EZ80, EM34. Output 4 watts. Unit supplied with maker's 12 months' guarantee. We know of no other make which represents the same exceptional value. Leaflet 6d.

12 Ready for use GNS. Carr. 7/6.

COLLARO JUNIOR 4 SPEED RECORD PLAYER with separate pick-up having dual point sapphire stylus. Brand new, cartoned. For 200-250 v. A.C. mains only **£4/12/6.** Carr. 3/6.

PICKUP ARMS. Acos GP54 lightweight turnover type with HGP59/52 cartridge cream finish. Only 29/9.

LG3 MINIATURE 3 WATT GRAM. AMPLIFIER For 200-250 v. 50 c.p.s. A.C. Mains. Overall size only 6½ × 4½ × 2½in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single playr or record changing unit. Output for 2-3 ohms speaker. Guaranteed 12 months. Only 55/9.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for long playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-. carr. 3/6 or factory built 22/6 extra.

SENSATIONAL OFFER

STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS

A precision manufactured unit with unique finger tip control. Pick-up fitted with dual sapphire tipped stylus. A very compact changer in attractive duo-tone finish. For A.C. mains 110—250v. Brand new, cartoned. £3/19/6. Post 3/9.

COLLARO 4-SPEED AUTO-CHANGERS With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. A.C. mains. Very limited number. Conquest **£8/19/6.** Continental 9 Gns. Carr. 5/6.

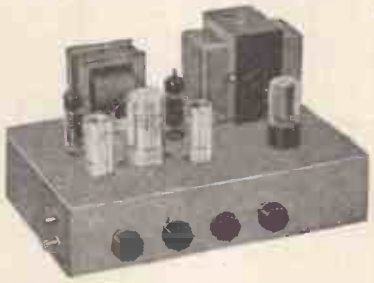
COLLARO RC54 3 SPEED AUTO-CHANGER As above unit but for normal 3-speed requirements. Brand new cartoned but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. 7 gns. Carr 5/6.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER Suitable for use with Garrard B.S.R. or any other record playing unit and most microphones. Total negative feedback 12 D.B. Separate Bass and Treble controls. For A.C mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 6 × 5 × 5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only £5/19/6. Or Deposit 22/-, and five monthly payments of 22/-. Send S.A.E. for leaflet.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/17/6. Or Deposit 13/- and nine monthly payments of 13/-.

A11 ULTRA LINEAR 12-14 WATT AMPLIFIER



NEW 1958 DESIGN HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 5 valves, ECC83 ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut"** Frequency response ±3 DB 30-30,000 c/cs. Six negative feedback loops. Hum level 60 DB down **ONLY 23 millivolts INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. **For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 m.a. and 6.3 v. 1.5. a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied.

Only **8** GNS. Carr. 10/-. or factory built 45/- extra. If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6** and nine monthly payments of **25/6.** Send S.A.E. for Illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones etc., with cash and credit terms.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp For A.C. mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs and outputs for 3 and 15 ohms speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Send S.A.E. for leaflet and credit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/10/9.** Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS. 2-3 ohm 5in. Goodmans **17/9.** 7 × 4in. Elliptical **19/9.** 6½in. Rola, **19/9.** 8in. Rola, **19/9.** 9in. Goodmans **21/9.** 10in. R.A., **28/9.** 12in. Plessey **29/11.** 12in. Plessey 3 ohms, 10 watts, 12,000 lines, **59/6.**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W Ch. 8w. incorporates Gram. position. Controls are Tuning, W. Ch., and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is **£4/15/-.** Point-to-point wiriog diagrams and instructions. 2/6.

Radio Supply Co. (LEEDS) LTD.

Personal Shoppers to **MAUDE ST.** (Opposite Parish Church School) **LEEDS, 2.**
Mail Orders to **29-31, Moorfield Road, LEEDS, 12.**

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra and all orders under £2. 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30. p.m. Saturday until 1 p.m. S.A.E. please with all enquiries.

G.E.C. SELECTEST MULTI-RANGE METERS. Basic movement 1 ma. 1,000 ohms per volt. Resistance ranges, 0 to 1 megohm. D.C. volts from .15 v. to 1.5 kv. A.C. volts from 7.5 v. to 1.5 kv. A.C. current from 75 ma. to 15 amps. D.C. current from 1.5 ma. to 30 amp. Incorporates safety cut-out. Supplied in perfect working order, complete with leads. £9/19/6 each. P/P. 3/6.

CRYSTAL MICROPHONE INSERTS. Sensitive, ideal for amplifiers, tape recorders, etc., 4/6 each. P/P. 6d.

12 - VOLT MIDGET ROTARY TRANSFORMERS. Type H.T.11, size 4½ × 2¾in. Output 310/360 volts 30 ma. New and boxed 22/6. P/P. 1/6.

EX NAVY SOUND-POWERED TELEPHONES. This type requires no batteries to operate and can be fitted in moments to give complete inter-communication between two points. Hand generator calling. Only 45/- each. P/P. 4/6.

MINIATURE H.T. TRANSFORMERS. Input 220/240 v. Output type 1. 220 v. 25 ma. 6.3 v. 1 a. 10/6. P/P. 1/-. Type 2. 220 v. 45 ma. 6.3 v. 1.5 a. 11/6. P/P. 1/3. Midget contact rectifiers, 250 v. 50 ma. 7/6. P/P. 6d.

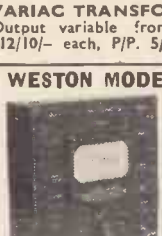
METER BARGAINS

50 microamps, 2½in. PJ.M.C.	49/6
500/0/500 microamp, 3½in. F.M.M.C.	49/6
500/0/500 microamp, 2½in. PJ.M.C.	19/6
50/0/50 microamp, 2½in. F.M.M.C.	69/6
50 microamp, 2½in. F.M.M.C.	59/6
30 ma., 2½in. F.M.M.C.	9/6
1 ma., 2½in. F.M.M.C.	25/-
200 ma., 2½in. F.M.M.C.	9/6
1 amp. 2½in. F.M.M.C.	10/6
1.5 amp., 2in. F.M.M.I.	6/6
7.5 amps. 3½in. PJ.M.I.	10/6
300 volt A.C., 2½in. F.M.M.I.	25/-
5/0/5 ma. 2in. F.M.M.C.	12/6
300 ma. 2½in. F.M.M.C.	9/6
15 volt 1½in. F.M.M.C.	10/6
20 volt 2in. F.M.M.C.	8/6
120 volt 3½in. F.M.M.C.	32/6
500 volt AC/DC 2½in. F.M.M.I.	25/-

AMERICAN No. 19 Mk. II TRANSMITTER RECEIVERS. Brand new, complete with all valves, only 65/- each. P/P. 10/-.

VARIAC TRANSFORMERS. Input 230 volts, Output variable from 0/250 volts, 9 amps. £12/10/- each, P/P. 5/-.

WESTON MODEL 722 TESTMETER



An ideal bench or portable instrument. Incorporates 5 A.C. or D.C. volt ranges, 2.5 v. to 1,000 volts, 6 D.C. current ranges 100 microamps. to 500 ma. A.C. current, 500 ma., 1 amp., 5 amps. Resistance, 100 ohms 1 K., 100 K. and 10 megohm. Supplied thoroughly tested in rexine covered carrying case with instructions and leads. £10/10/- each. P/P. 4/-.

EDDYSTONE MAINS POWER PACKS

Supplied brand new and unused. Mains input 200/250 volts. Output 175 volts 60 ma. and 12 v. 2.5 a. Double choke and condenser smoothed. 5Z4 rectifier. Housed in grey metal case. Only 32/6 each. P/P. 3/6.

CR.100 SPARES KIT

Complete set of new valves 2 X66, 2 U50, 2 DH63, 2 KT63, 6 KTW61. Also set of resistors, condensors, pots toggle switch and output transformer. Supplied new and boxed 59/6 each. P/P. 4/6.

PORTABLE PRECISION VOLTMETERS Brand new and boxed instruments by famous manufacturer. Housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges. 0-160 v. and 0-320 v. 8in. mirror scale. Accuracy within 2%. Supplied at a fraction of original case. Only £5/19/6 each. P/P. 3/6.

R.1155 COMMUNICATION RECEIVERS MODEL "N"

Incorporating the trawler band. Frequency coverage: 200-250 kc/s., 600-1,500 kc/s. 1.5-3 mc/s 3-7.5 mc/s. and 7.5-18 mc/s. Supplied in perfect working order, aerial tested, with illustrated leaflet, £12/19/6 each. P/P. 7/6. Standard models available but fitted with improved dial drive as above model, £8/19/6 each. Combined A.C. mains power packs and output stage available. 85/- each. P/P. 3/6.

SPECIAL OFFER

OF MARCONI SIGNAL GENERATORS TF-517. Frequency coverage 10 to 18 mc/s. and 33 to 58 and 150 to 300 mc/s. Operation 200/250 volts A.C. Supplied in good condition at the ridiculous price of £12/10/- each. P/P £1.

PARMEKO TABLE TOP TRANSFORMERS. Input 230 v. 50 cycles. Output 620/550/375/0/375/550/620 volts 250 ma. Also 2-5 volt 3 amp. windings. Size: 6¾ × 6¼ × 5¼in. Brand new only 45/- each. P/P. 5/-.

SPECIAL OFFER

NO. 19 SETS MKII

Complete with all valves new condition, only 65/- each. P/P. 10/-

300ft. **COPPER AERIAL WIRE.** Ex U.S.A. Brand new. 3/6 reel. P/P. 1/-.

HEAVY DUTY SLIDER RESISTANCES 1 ohm 12 amp. 6/6 each. P/P. 1/-.

AMERICAN TRIPLETT MULTI-RANGE TESTMETERS. 1,000 ohms per volt. Incorporates the following ranges. Volts A.C. 10 to 5 kv. Volts D.C. 10 to 5 kv. Current D.C. 10 ma. to 500 ma. and 2 resistance ranges, 300 ohms and 250 K. ohms. Supplied in working order with leads. £4/17/6 each. P/P. 2/6.

HEAVY DUTY MAINS ISOLATING TRANSFORMERS. Specifications: Primary 230 volts 3 amps. Secondary 230 volts 3 amps (service rating, OK 5 amps.). Ideal for laboratory or workshop use. Supplied brand new in original transit cases. £6/10/- each. P/P. 10/-.

RCA. OUTPUT TRANSFORMERS. Completely potted. Centre-tapped primary, 8,000 ohms. Secondary tapped 3, 7.5, 15 or 600 ohms. Separate feedback winding. 15 watts rating. Suitable for 6L6, EL84, etc., unused, 27/6 each. P/P. 2/-.

EVERSHED AND VIGNOLES MEGGER OHMMETERS

Ideal for all polarity and continuity tests. Supplied brand new with all leads and instructions, only 59/6 each. P/P. 2/-.

CHARGING AND MODEL TRANSFORMERS

1. Pri 200/250 v Sec. 3.5, 9 or 17 v. 1 amp., 9/9
2. Pri. 200/250 v. sec. 3.5, 9 or 17 v. 2 amp., 14/3
3. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 4 amp., 16/6

Postage 1/6 all types.

L.T. METAL RECTIFIERS. Full wave and bridged. 12 v. 1 amp., 6/3; 12 v. 2 amp., 9/3; 12 v. 4 amp., 13/9., 24 v. 1 amp., 12/6; 24 v. 4 amp., 22/6; 36 v. 4 amp., 27/6. P/P. 1/- all types.

MARCONI TF.144G. STANDARD SIGNAL GENERATORS. 85 kc/s. to 25 mc/s. Reconditioned as new, £65 each. P/P. £1. Marconi TF-853-854 10 cm. signal generator brand new, £100. P/P. £2. TF-390 G., from £12/10/-.

AMERICAN AUTO TRANSFORMERS. 110/230 volts, 40 watts. Small size, fully shrouded. Ideal for instruments, shavers, etc. Brand new, boxed, 12/6 each. P/P. 1/9.

INSTRUMENT POTENTIOMETERS. 3¼in. dia. 10W. rating 5K, 25K, 50K or 100K ohms. New, boxed, 10/6 each. P/P 1/-.

BARGAIN GRAM. MOTORS. Garrard centre-drive motors complete with turntables 200/250 volts A.C. Adjustable mechanically from 0 to 45 r.p.m. Only 22/6 each. P/P. 3/-.

SMOOTHING CHOKE BARGAINS. 10H, 60 ma., 4/6; 15H, 60 ma., 5/6; 8H, 100 ma., 8/6; 9H, 100 ma., 7/6; 10H, 100 ma., 8/6; 5H, 200 ma., 5/6; 20H, 120 ma., 10/6; 50H, 120 ma., 15/6; swinging choke 3.6-4.2 H, 250 ma., 10/6. 3H, 100 ma., 6/6; 20H, 50 ma., 7/6. P/P. 1/- to 2/6.

DYNAMO EXPLODER UNITS. Used for detonating explosive charges. Operation is by hand generator, giving 1,800 volts across output terminals. Ideal also as photo flash. Brand new, only 29/6 each. P/P. 3/-.

MIDGET RECORDER MOTORS. Size 1¼×1×2¾in. Operates from 4.5 to 24 v. D.C. Fitted with reduction gear. New and boxed. 12/6 each. P/P. 1/-.

PARMEKO TRANSFORMERS. Input 230 volts. Output 350/0/350 volts 150 ma. 6.3 v. 4 a. 5 v. 4 a. Brand new, 32/6. P/P. 3/6. Also 350/310/0/310/350 volts 220 ma. 6.3 v. 5 a., 2 × 6.3 v. 3 a., 2 × 6.3 v. 1 a., 5 v. 3a., potted, 49/6. P/P. 3/6.

POST OFFICE JUMPER LEADS. Fitted with 2 standard jack plugs, brand new 3/-. P/P. 6d. Panel jacks to fit 9d.

LEACH AERIAL CHANGE-OVER RELAYS

12 v. Double Pole, Ceramic Insulation, New and Boxed, 7/6 each. P/P. 9d.

UNIVERSAL AVOMINOR TEST-METERS.

Small, compact, accurate instrument. Resistance measurements from 0 to 20 k. ohms, D.C. volts from 0 to 500 v. A.C. volts from 0 to 500 v. D.C. current from 0 to 500 ma. Supplied in perfect working order, complete with leather case and leads. £5/10/- each. P/P. 2/6.

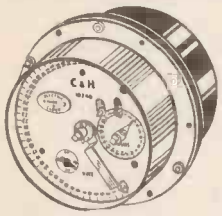
PROOPS BROTHERS LIMITED

ROOM THERMOSTATS
By a famous manufacturer. Voltage 0/250v., maximum current 15A. Temperature control range 50°F to 80°F. Contemporary design in cream hammer finish, complete with wall fixing plate and full installation instructions. Brand new. 15/- Carr. 2/-

12 VOLT SOLENOID

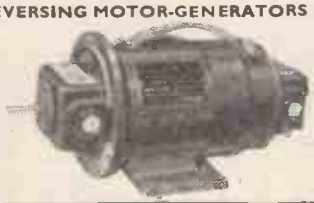
Powerful solenoid with lever mechanism giving a mechanical advantage of approx. 4 : 1 (¾in. travel, = 3¾in. arm). Consumption 350 mA. Ideal for remote controls, model railways and mechanical indicators. Bargain offer. 3 for 10/- p.p.

ELECTRIC TIME SWITCH



4½-6v battery driven precision clock. Current negligible. Can be set to operate at any period between 15 minutes and 44 days. Ideal for automatic "lighting-up" of parked cars etc. and many other uses. In plastic case. 12/6 p.p.

VELODYNE REVERSING MOTOR-GENERATORS TYPE 74



Motor Armature 5A, Field 80 mA. Generator Armature 56v D.C., Field 24v D.C. Size 8 × 3¾in. × ¾in. dia. spindle. £1.15.0. p.p.

EXCLUSIVE OFFER OF Low-voltage Halogen-Quenched GEIGER-MUELLER TUBES

Large contract purchase from famous manufacturer enables us to make an exclusive offer of these highly sensitive gamma counters.
Straight from production, individually tested fully guaranteed at 55/- each.

SPECIFICATION

Effective length 11.8 cm. Standard British 4-pin base.
Background count 90/min.
Plateau: Minimum length 80 v. Slope 5% per 100v.
Working potential: 400-450v.
Current: .001 μA to 1μA at 100 to 6,000 c/min.
Response: Exceeds 30,000 c/m.
Dead time: 100μ sec. at 6,000 c/m Rise Time 5 to 10μ sec. at 6,000 c/m.
Temperature range—55°C to + 60°C. Gamma Efficiency 1%. Stainless iron electrode.

PORTABLE 70 cm. PRECISION FOR ONLY 57/6
Carriage paid

TS184 A/AP

Precision 70 cm. test gear for Mobile Hams, Amateur T.V. and Radio Control enthusiasts. RESONANT CAVITY WAVEMETER calibrated 400-430 Mc/s. Tuning stops adjustable to any 30 Mc/s band within the 400 to 470 Mc/s coverage.
Calibrated scale rack and pinion drive piston input attenuator and alternative fixed coupling loops input provides facilities for use as a signal generator. Plug-in "Telescopic Probe Antenna", and 6J6 detector and Monitor amplifier, 2-600 ohm phone jacks for modulated signals. Panel output terminals for metering 6J6 output current. Power required = 6 volts at 300 mA and 30 volts at 0.5 mA.
24-page booklet supplied with each unit giving comprehensive circuit description, diagrams and suggested modifications etc.

RECEIVERS

BEACON RECEIVER BC1206A

Covering 200-400 kc/s. Valve line-up: 6K7 RF; 6SA7 frequency changer; 6SK7 I.F. amplifier; 6SQ7 det; 28D7 O/P. This was designed to run on 24/28V D.C. HT/LT. Excellent basis for car radio; size 6 × 5 × 4in. Good working order.
£3.5.0. each, plus 5/- carr.

AR88 KNOBS. 2¾In. skirt. Brand new. **3 for 10/-,** post paid.

R.1392

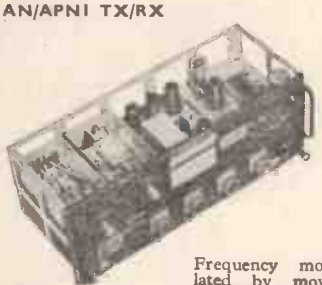
95-150 Mc/s (2-3 Metres). 15 Valve Superhet. 1st and 2nd RF. EF54, 1st Local Oscillator SP61, 2 Oscillator Multipliers EF54, 3 IF's EF.39, AGC. 6Q7, Output 6J5, Muting EA.50, Noise Limiter EA.50, BFO.6J7, Mixer EF.54, Detector 6Q7. Normally Crystal Controlled, but can be tuned over 95 to 150 Mc/s. Power supply required = 240-250 volts at 80 mA. 6.3 volts at 4A. Standard Rack Mounting, 19 × 10in. Complete with valves and circuit diagram. Air Tested. £6.19.6. Carriage 10/-

ARR3
13 Valve 60 Mc/s. FM Receiver which can easily be converted to receive B.B.C. transmissions—many supplied by us to B.B.C. engineers for their personal use. 1st and 2nd RF, Mixer, Osc., 1st, 2nd and 3rd IF's all 12SG7's. Limiter and Detector 12H6. 1st AF 12SQ7. Output 12A6. A.F.C. 2 × 12SH7. Magic eye 12U5G. Utilizes Foster Seeley discriminator. Complete with circuit diagram and full conversion instructions. £6.0.0. Carriage 7/6

RECEIVER UNIT EX.1143A

Suitable for conversion to 2 Metres or Wrotham FM transmissions Valve line-up: Four EF.50's; One EL32; Two EF.39's; One EBC.33; One EA.50. Circuit diagram supplied with each unit. Complete with valves. £1.5.0. Carriage 3/6

AN/APN1 TX/RX



Frequency modulated by moving coil transducer—heart of famous W.W. Wobbulator. Freq: Receiver, 400-450 Mc/s. Transmitter 418-462 Mc/s. Easily converted for radio control or 70 cms. Complete with 14 valves, 4-12SH7, 3-12SJ7, 2-12H6, 2-955, 2-9004 and 1-VR150. Contains a host of first class components including relays and close tolerance resistors. Brand new, at less than breakdown price. £1.10.0 Carriage 7/6

'S' BAND PRECISION WAVEMETER

2,900 to 3,150 Mc/s. TEST SET 288 A.M. Ref. 10SB/6161.
Comprising exceptionally rugged silver-plated Wavemeter Type 1665, resiliently mounted and directly tuned by 1¾in. dia. calibrated micrometer with 6½in. thimble scale. Temperature correction for micrometer attached. Resonance indicated on 100 microamp meter. Equally suitable for laboratory using milliwatt power or, with loose coupling, for high powers. UR21 connecting cable and coupling probe supplied. Brand new in robust moisture-proof case with jacking-off screws and tool.
Price £15, plus £1 packing and carriage.

SIGNAL GENERATOR Type 52A

Complete in transit case with four calibration charts, leads, dummy antenna and circuit. Spec.: Input, 230v 50 c/s. Freq.: 6-52 Mc/s. in Four ranges. Coarse and fine attenuators. Int. and Ext. Mod. Output, 0.5 v to 100 mV. Impedance 70 and 100 ohms. Brand new.
£10.0.0. Carriage 10/-
Complete photostat handbook supplied on request for 4/6 extra.

SIGNAL GENERATOR AND WAVEMETER Type W 1649

In copper lined case. Freq.: Sig. Gen. 140-240 Mc/s. (tolerance 0.5 Mc/s.). Wavemeter 150-235 Mc/s. (tolerance 0.2 Mc/s.). Complete with valves 4 VR91 and 1 VR135, and 5 Mc/s. crystal. Requires 6.3v and 120v power supply. £2.10.0. Carriage 10/-

The Walk-Around Shop

BARGAIN PRICE TABLE-TOP TRANSMITTER

No. 36 SENDER

£12.10.0

complete

Carriage 30/-

GET THIS NEW RIG ON THE AIR IN 5 MINUTES FLAT

The best ham buy for a very long time

A unique opportunity to obtain a complete AIR TESTED 10-60 Mc/s 50 watt transmitting station at an unrepeatable price.
In two units, each housed in a handsome solid oak cabinet with slide out front. Supplied complete with circuit diagram, all connecting cables, hand-set and dummy aerial packed in RF Unit stowage drawer. In excellent condition.
Check this specification against cost.
Frequency coverage: 10-20 Mc/s, 20-40 Mc/s and 40-60 Mc/s by plug-in coils. CW, M.C.W. or R/T Coils supplied cover 10-40 Mc/s only, but third set can easily be made up.
Power Supply: 100-110 volts and 200/250 volts, 40-60 cycles.
Power required, approximately 350 watts.
R.F. Unit: Contains Master Oscillator (with or without crystal control), Frequency Doubler and Power Amplifier. Valves: M.Osc. 807, Intermediate 807, PA2× 807, Voltage regulation 2×S130. Also 2×EM1 magic eye tuning indicators and osglim neon lamp modulation depth indicator. 0-200 m/A PA anode current meter. Size 24½×16½×16½ in. Weight 90 lb.
R.F. Unit: Contains Power Pack, Speech Amplifier and Modulator. 3×FW4/500 rectifiers provide separate H.T. supplies for RF Unit, Bias, and Modulator. Speech Amplifier 6C5G, Modulator 2×6C5G drivers and 2×807 output. Size 24⅛×16⅛×14⅜ in. Weight 120 lb.

INFRA RED VIEWING MONOCULAR

See in the dark with equipment specially developed for night-driving, reconnaissance, sniping etc. Sealed unit with focussing eyepiece and incorporating Caesium cell and push-button operated Zamboni pile. Brand new in superb hide binocular type carrying case.

£1.0.0. p.p.

VIEWING LAMP

Weatherproof car spotlamp providing a powerful source of infra-red rays through easily removable filter. Takes standard 12v. bulb. Swivelling single-point bumper fitting. Brand new. **17.6.** p.p.

PROOPS BROTHERS LIMITED

DEPT. W, 52, TOTTENHAM COURT ROAD, LONDON, W.1.

Shop hours 9 a.m. to 6 p.m. Thurs. 9 a.m. to 1p.m. **OPEN ALL DAY SATURDAY**

Telephone: LANgham 0141. *Carriage prices quoted apply to England & Wales only.*

TRANSFORMERS 230-250 volts 50 c/s.
Heater 6.3v, 1.5A, 6/6, plus 1/- carr. **Miniature mains** 230v at 40 mA and 6.3v at 1.5A, 12/6, plus 1/- carr. **Charging** 9v and 17v at 3A, 15/6, p.p. **Mains isolating** 250v/220v or 250v/110-0-110v out OR double wound auto 250v in, 110v out, 5/-, carr. 1/6. **Heavy duty mains** changing (Admiralty Pattern), Primary screened from secondary. Totally enclosed in 7×6×8in. black steel case—terminals inside lid. £1.0.0. p.p.

OUTPUT TRANSFORMERS
Plessey standard miniature output transformers. Ratio 45 : 1 and 55 : 1 4/6 p.p. Please state ratio required.

FULL-WAVE CHARGING RECTIFIERS—
12v 4A. 14/- p.p. 24v 1.5A. 12/6 p.p.

LOUDSPEAKERS
Tannoy waterproof external 8 watt unit 7½ ohm impedance. Complete with matching transformer. Brand new, £1.0.0, plus 3/6 carr.

HEADPHONES
High resistance balanced armature £1.0.0. p.p.
Low resistance balanced armature 8/6 p.p.

MICROPHONES
Acos crystal inserts 4/6 p.p. American throat microphones type T.S.300 including socket 3/- p.p. Aircrew type electro magnetic microphones with switch 2/- p.p. Carbon type in black crackle case 12/6 p.p.

RELAYS
Carpenter type 5C9 polarized 1685 ohms each coil. Current 100-200 μA. 22/6 p.p. Sensitive U.S. type single pole changeover relay. Heavy duty 12/6. p.p.

R.F. UNIT
Freq: 200 Mc/s. With 3 956 valves. Size 8×3×4in. 15/- p.p.

ELECTROLYTICS
8+8 mfd. 450 vW. 3/6. 16+16 mfd. 450 vW. 4/3. 32+32 mfd. 350 vW. 4/6. 16 mfd. 450 vW. 3/-. All post paid.

MINIATURE I.F. STRIP—9.72 Mc/s.
Complete and unused with circuit, less valves—2 EF92, 3 EF 91, 1 EB 91. 12/- p.p.

MULTI-RANGE TEST METER
Ranges 0–1.5v, 0.3v; 0–60mA; 0–500 and 0–5000 ohms. Easily read open scale. Simply extended to provide useful pocket fault finder. Size 2½×3½×3¾in. Brand new 8/6. Carr. 1/6.

APN1 TRANSDUCER
The heart of the W.W. TV wobbulator (described on page 252 of June 1956 issue). Brand new 7/6 p.p.

RADIO ALTIMETER
5 mA panel mounting with 3in. dia. 8in. circular scale. Basis for sensitive multimeter. Brand new, boxed. 7/6 p.p.

VALVE BARGAINS. 6K7, 3/- p.p. 6B8G, 3/- p.p. IN21A Silicon crystal 1/6 p.p.

GYRO UNIT AND INVERTER
Can be used as 12v DC motor for models; ideal also for experimentation and gyro demonstration purposes. Inverter: 12v DC input, 3-phase 190 cycle output. Size 4×4×3in. Gyro unit: operates on 3-phase output from inverter. Peak speed 11,400 r.p.m. Caged. Precision made equipment. 12/6 per pair. Carr. 3/-.

ANTENNA RELAY UNIT
Contains 2½in. panel mounting 2 mA meter with separate thermocouple for measuring R.F. and changeover relay. In metal case 3½×4½×3½in. with ceramic stand-off terminals 12/6 p.p.

BOLT CROPPERS
9in. long, extremely powerful 2/6 p.p. Folding type 18in. long—will cut through ¾in. bolt or cable 7/6 p.p.

DYNAMOTOR
Brand new, boxed U.S. Dynamotor. 28v DC input, 330v 170 mA output. Fully smoothed by screened choke/condenser filter unit in base. Dynamotor size 3¾×6in. Black crackle finish 17/6 p.p.

CO-AXIAL ADAPTERS
British to American or American to British co-axial adapters. Plug or socket fittings 1/6 p.p.

MORSE KEY
Plastic moulded base. Size 3½×1¾in. 2/6 p.p.

CONNECTOR BLOCKS
G.E.C. Standard 12 way "chocolate block" connectors. 3 for 6/6 p.p.

POCKET MARCHING COMPASS
In black plastic case with sighting reflector inside lid and automatic pointer lock. Luminous dial, pointer and sighting lines. Brand new, with instructions 12/6. Carr. 1/-

TANK PERISCOPES
American type—7/6 p.p.

SIGNAL LAMPS
24v Sealed Beam Units. 16/6 p.p.

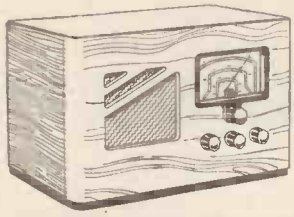
ASTRO COMPASSES
Brand new in transit case. 23/- p.p.

DRIFT SIGHT Mk. 4A
13in. long × 1¾in. dia. In wooden case 12/6 p.p.

GROUND POSITION INDICATORS
Contains 24v. motor and follower motors, large quantity of gearing, etc. 35/- p.p.

TERMS AVAILABLE

(END OF SEASON BARGAINS)



HOME RADIO 79/6

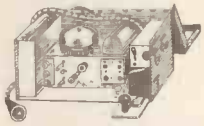
AC/DC. Universal mains. 5 valves octal superhet. 3 w/band receiver, can be adapted to Gram P.U. In attractive wood cabinet. 18½in. x 11½in. x 8½in. Ins./carr. 7/6.

ATTRACTIVE EXTENSION SPEAKER, 29/9

Complete, fitted with 8in. P.M. speaker "W.B." or "GOODMANS" of the highest quality. Standard matching to any receiver (3-5 ohms). Flex and switch included. Money refunded if not completely satisfied. Ins./carr. 3/-.

TELEPHONE SETS, 7/9.

Ex-W.D. Wireless remote control unit, E.Mk.II. New condition. Morse tapper, switched, jack plugs, etc., less phone. P. & P. 3/6.



TRANSFORMERS

MAINS POWER TRANS 350-0-350 v., 9/9. 250 mA. 6 v. heater at 5 amp., 4 v. at 5 amp. 4 v. centre tapped. Drop through type. Prim. 200-250 v. (4½in. x 5in. x 5in.). Post 3/9.
MAINS TRANS. 350-0-350 v. 80 mA. 4 v. 4 v. heaters. 200-250 v. Prim Post 3/9
MAINS TRANS. 350-0-350 v. 80 mA. 12 v. 4 v heaters, 200-250 v. Prim. Post 2/9.
MAINS TRANS. 280-0-280 v. 80 mA. 6 v. 4 v. 200-250 v. Prim. Post 5/9.
O.P. TRANS., 1/3. Std. size 2-5 ohms. Post 1/-. 20 for £1. Post 5/6.

T.V. AERIALS, 25/6.

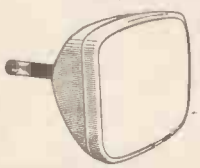
For all I.T.A. channels. For outdoor or loft. 3 elements Famous manufacturer. Sold at half the normal cost. P & P. 2/6.

AERIALS. 15/9. B.B.C Indoor type. Folded dipole with 12ft. of Co-Ax. Cable fitted. Post 1/9.

RECTANGULAR T.V. TUBES

(USED)

As supplied for past 8 years.

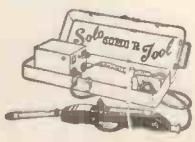


14" £5.10.0
17" £7.10.0
Ins. Carr. 15/6

Set tested. Reclaimed. Shown working to personal shoppers.

SPECIAL OFFER of 14in., 15in., 16in. round T.V. tubes at £5. Convert your 9in. 10in., 12in. to these sizes. Full instructions in our FREE catalogue.
12in. TV TUBES, £6. 3 months' guarantee on all round tubes. Ins./carr 15/6.
TUBES WITH BURNS, £1, incl. carr. Perfect picture. Get one now while stocks last. Enquiries invited.

SELF FEED SOLDERING TOOL, 19/6.



6-12 volt. 110-125 volt. Made for the American market. Car battery or mains. **Export quality.** Complete in light carrying case. Reel of solder and spare parts. Post 2/9. 200-240 volt adaptor 10/- extra.

CO-AX. CABLE, 6d. yard. Good quality. Cut to any length. 1/6 post on 20 yards. 45/- per 100 yards. Post 3/6.

INSULATION TAPE, 1/6.

Finest quality 75ft. x ½in. wide. Post 9d.

17" T.V. CHASSIS. TUBE & SPEAKER, £19.19.6.

Latest improved circuits, higher E.H.T. (brilliant picture). Improved sensitivity (for greater range). Chassis easily adapted to any cabinet. 17in. Rectangular tube on adapted chassis. Channels 1-5 less valves. With all channel TURRET TUNER, 50/- extra. Chassis size: 14½in. x 11½in. deep. With 5 valves, 6SN7GT, 6V6, EV51, 2—6D2's. £21/19/6 With all valves including 6L18, EL38 7—6F1's, £25/19/6. 12 months' guarantee on tube, 3 months on valves and chassis. State B.B.C. channel and I.T.A. if TURRET TUNER ordered. Ins /carr. 25/6.

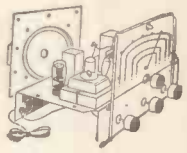
14" T.V. CHASSIS TUBE & SPEAKER, £13.19.6.

As above with 14in. round tube. Guaranteed 3 months. With 5 valves, £15/19/6. With all valves, £19/19/6. All channel TURRET TUNER, 50/- extra. Ins /carr 25/6.

HEADPHONES, 1/9

Single earphone and band C.L.R. Ideal for crystal sets, extension on radio, etc., Post 1/3.

SUPER CHASSIS, 99/6



5-valve s/het chassis, including 8in. speaker. 4 Control knobs (Tone volume, Tuning, w/change sw.), 4 w/band with position for gram. P.U. and extension speaker. A.C. Ins./carr. 5/6.

(BARGAINS.)

CONSTRUCTOR T.V. CHASSIS.

SOUND AND VISION STRIP, 10/6. S/het. Complete vision strip, less valves. Free drawing. P. & P. 2/6.

TIME BASE, 4/9. Including scanning coil, focus unit, etc., less valves. P. & P. 2/6.

POWER PACK AND AMPLIFIER, 29/6. R.F. E.H.T. Not tested. Amplifier stage 6V6 with O.P. trans. 3 ohms matching. Smoothed H.T. 350 volt at 250 mA., 6.3 v. at 5 amp., 22 v. at 3 amp., 6.3 v. at 4 amp. and 4 volt centre tapped. Less valves. Drawings free. Size: 14½in. x 8in. x 7in. Ins./carr. 5/6.

POWER PACK AND AMPLIFIER, 19/6. Output stage PEN 45 O.P. trans. choke. Smoothed H.T. 325 volt at 250 mA., 4 v. at 5 amp., 6.3 v. at 5 amp., 4 v. at 5amp. centre tapped, valve base for rectifier. Octal or 4 pin. Output is taken from standard plugs. Less valves. Ins. and carr. 5/6.

POWER PACK AND AMPLIFIER, 19/6. Output stage 6V6 with O.P. trans. 3 ohms. Choke. Smoothed H.T., 350 at 250 mA., 6.3 v. at 5 amp., 22 v. at 3 amp., 6.3 v. at 4 amp. and 4 v. centre tapped. Less valves. Not tested. Ins. and carr. 5/6.

T.V. CHASSIS. 25/6. Ideal only for spares. Although this chassis has a wealth of components, it is considered uneconomical to attempt rebuilding. This chassis is in three separate units, Power Pack, Time Base, and S/Vision strip. I.F.'s 16-19.5 Mc/s. Drawings FREE. Ins. and Carr. 10/6.

T.V. MASKS

T.V. MASKS, 3/9. 12" New White rubber. Post 1/9.

T.V. MASKS, 14/9. 17" Brand New in GREY, WHITE & Halo Lighting. Post 2/-.

GANG CONDENSERS 1/6. 2 & 3 Gangs ·0005. P. & P. 1/3.

8" P.M SPEAKER, 8/9.

Ideal for kitchen and bedroom extension. Let the lady of the house listen to that Radio or TV programme. Complete with O.P. trans., 10/-. P. & P. 2/9.

POPULAR RADIO OR RADIOGRAM CHASSIS, 30/6.

3 w/band and gram. 5 valve s/het. International octal. Ideal table gram, but still giving high quality output. 4 knob control. 8in. P.M. Speaker, 7/9 extra. Set of knobs, 2/-. Chassis size: 12in. x 6in. x 9in. Less valves. Ins./carr. 4/6.

VALVES SALE. *3 MONTHS' GUARANTEE.*

2C22	2/9	12K7	8/9	ECH42 ...	8/9	EF92	3/9
4D1	2/9	12BE6	6/9	EF39	3/9	EF36	5/9
6B8	3/9	451U	10/9	EF91	7/9	KTW61 ...	5/9
6F12	5/9	77	1/9	EF37	4/9	PEN45 ...	6/9
6H6M	1/9	CV188.....	1/9	ECH81 ...	8/9	RL37	1/9
6P28	10/9	DF66	5/9	EF50	2/9	SP61	2/9
6SG7	2/9	EB34	1/9	EL32	4/9	TT11	4/9
8D2	3/9	ECC81 ...	8/9	EL91	3/9	Z77	7/9

American types U.X. All at 1/9 each.
18, 42, 75, 38, ID6, 6D6, 6C6, 6A7. Barretters 301.

Closed Thurs. 1 p.m. *Open ALL DAY SATURDAY* *FREE 1958 Catalogue.*
L' POOL St. to Manor Park Stn., 10 mins. Only.

DUKE & CO. (Dept. 6), 621/3 ROMFORD ROAD, MANOR PARK, E12. ILFord 6001/2/3.

INFRA-RED TELESCOPE complete with 3-section zamboni pile, image converter tube and full optical system. Brand new complete with hide carrying case. **17/6** each. P. & P. 2/6.

NEPTUNE SERIES DOUBLE POTTED CHOKES by Parmeko, C. Core twice four Henry x 70 mA. Brand new and boxed, **10/6** each. P. & P. 1/6.

NEPTUNE SERIES POTTED TRANSFORMER, C. Core by Parmeko. Tapped primary from 110 v. to 250 v. secondary 500-450-0-450-500 v. 110 mA. Brand new and boxed. **32/6** each. P. & P. 3/-.

METERS Brand new, guaranteed perfect

5 amp. D.C. M.I. 2½in. Fl. Rnd.	11/6
7½ amp. D.C. M.I. 3½in. Rnd. Pr.	12/6
1 mA. M.C. 2½in. Fl. Rnd.	22/6
200 mA. M.C. 2½in. Fl. Rnd.	9/6
25 v. D.C. M.C. 2in. Fl. Rnd.	7/6
300 v. A.C. M.C. 2½in. Fl. Rnd.	22/6

Dual range pocket volt meter 0–25 and 0–250 v., in wallet. **12/6.**
Ex equip. 500 microamp. 2in. M/c. scaled. 0–15 and 0–600 v. **14/6.**
Ex equip. 50 mA. M.C. 2in. sq. **7/6.**
P. & P. on all meters 1/– each.

HEADPHONES

4,000 ohms, imported, new	15/–
2,000 ohms, "Ivalek," Brit. New	12/6
L.R. M/c. S. G. Brown	12/6
H.S. 30 L.R. U.S.A., min. ear pcs.	15/–

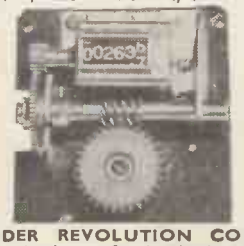
P. & P. on above 1/6 each.

MICROPHONES—NEW

Throat, British, magnetic	4/6
Throat, carbon, U.S.A.	3/6
No. 8 carbon with switch	7/6
Type 48, ex oxy. mask	3/6

P. & P. on above 1/– each.

Morse Practice Set, polished wooden base, tapper, adjustable buzzer, battery clips and terminals. Brand new, original manufacturers' packing. **8/6** each. P. & P. 2/–.
Morse Keys. 8-ampere Service patt. New. **2/6** each. P. & P 1/–.



VEEDER REVOLUTION COUNTER. 6 columns, fitted reduction drive, built inside small unit. New. **8/6** each. P. & P. 2/–.

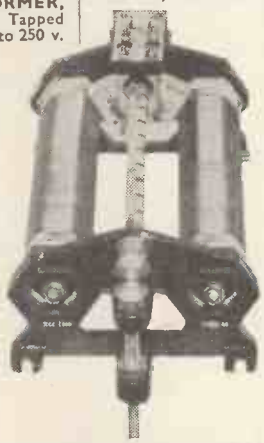
EVERSHED AND VIGNOLES NEW TEST EQUIPMENT offered at fraction of makers' price. **"WEE MEGGER,"** complete in leather case, brand new and perfect. 100 volt **£6** each. P. & P. 2/6. 250 volt **£10/10/-** each. P. & P. 2/6.

EVERSHED AND VIGNOLES CIRCUIT TESTING OHMS METER. Pattern "S," complete with test prods, inst. book, etc. Two ranges 0–3 and 0–30 ohms. Brand new, guaranteed perfect, as illustrated. **£4/17/6**. P. & P. 2/6.

EVERSHED AND VIGNOLES Series II metal cased meggers, 500 volt. Used, but in perfect working order, complete with leather carrying case. **£20** each. P. & P. 5/–.

SPECIAL OFFER 3½in. round flush fitting 250 v. A.C. rectifier m/c meter with linear scale from 0-250 v. **35/-** each. P. & P. 1/-.

SLIDER RESISTANCE, heavy duty type, 79 ohms, two barrels with gear drive; 2.9 amp–.65 amp. New, **22/6** each. P. & P. 3/6.



CONTROL PANEL containing 50 ohms 50 watt Rheostat and toggle switch, in crackle finished metal case. New. Ideal for model control. **8/6** each. P. & P. 2/6.

DYNAMOTOR 6 volt in 250 volt out at 100 mA. ex new equipment. **25/-** each. P. & P. 3/–.

U.S.A. GENERATORS TYPE PP77D. Briggs and Stratton petrol driven motor driving generator supplying 115 volts 250 watts direct current. New. Original cases. **£25** each. Carr. £1.

AUTO TRANSFORMERS, step up, step down 110 v.–200–220–240 v. Fully shrouded. New 300 watt type **£2/2/-** each. P. & P. 4/6. 500 watt type **£3/3/-** each. P. & P. 4/6. 1000 watt type **£4/4/-** each. P. & P. 4/6

Photo Multiplier. Type 931A, for Alfa counting, film scanning, spectography, etc., new. **£2/5/-** each. P. & P. 1/–.

WHEATSTONE BRIDGE UNIT. 4-stud switches 0–10, 0–100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16×7½×6in. **40/–** each. P. & P. 3/6.

MUIRHEAD VERNIER DRIVE. Scaled 0–180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete with lampholder. In manufacturers' original packing. New. **8/6** each. P. & P. 1/6.

INSULATION TESTER BY HIVOLT. Breakdown insulation tester with variable voltage from zero to 45 kV. Reads in microamp as leakage, incorporates adjustable trip control. Normal Mains input, complete with all leads, etc. As new. Maker's price over £200. Our price **£40** plus carr. In England £1.

MUIRHEAD PRECISION STUD SWITCHES, brand new and boxed, two banks each bank 24 position heavy duty contacts. Price **12/6** each. P. & P. 1/6d.

HIGH SPEED RELAY, Siemens, two bobbins 1,000 ohms, each. New, **10/6** each. P. & P. 1/–.

NEON LIGHT, 230 v. A.C. M.B.C. Clear, **1/9** each. P. & P. 6d.

TRIPODS. Solid wooden legs 38in. long, metal top and metal toes. As new. Price **10/6** ea., plus 3/– carriage.

DOUBLE ENDED P.O. TELEPHONE LEADS about 36in. long each with two type 301 Jack Plugs. New **3/6.** P. & P. 6d.

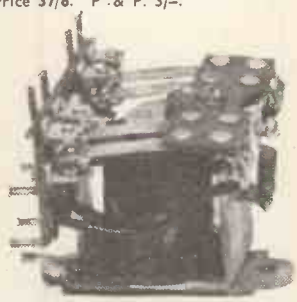
TELEPHONE HANDSETS, sound power, pair will work by simple connection without batteries. Good condition **22/6** each. P. & P. 1/9.

TELEPHONE HANDSETS U.S.A. Similar to G.P.O. with switch, carbon insert. New, **12/6** each. P. & P. 1/6.

L.T. Transformer. Input 230 v. Output 50 v., 50 ampere, with meter voltage regulator switch on primary. In steel case fitted with mains switch, will take 100% overload. Grs. wt. 150lb. Wound at 800 amps. per sq. in. New, in manufacturers' cases. **£15** each. Carr. in Eng. £1.

A.R.B. U.S.A. RECEIVERS, 24 volt, covering 195–9,050 kc in 4 bands. As new, suitable for use on boats, etc. Price **£7/10/-** including carriage.

ADMIRALTY VOLTAGE REGULATORS. Input 200/250 v. A.C., output set to 200 v. A.C. Complete with meter in metal case. Current approx. 1½ amp. Price **37/6.** P. & P. 3/–.



U.S.A. 27 volt 4-Pole CHANGE-OVER RELAYS. Brand new and boxed. **5/6** each. P. & P. 6d.

200/250 v. A.C. MOTORS. New. 1/80 h.p., 2 drives, direct 6,000 r.p.m., reduction 300 r.p.m. **22/6** each. P. & P. 2/6.
ADMIRALTY 220 v. A.C. MOTOR. Most conservatively rated at 1/10 h.p. 1,430 r.p.m. Brand new in original boxes. Price **50/–** each. Carr. Eng. 6/–.

ASK FOR EXPORT QUOTATIONS **WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!**

SERVICE TRADING Co.

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CONVERTORS

Easily the most useful units released by the Ministry. Within minutes you can extend the frequency of any receiver to cover the following:—

R.F. 26 50–65 Mc/s Variable tuning **20/-**. R.F.25 40–50 Mc/s. switched tuning 8/6. R.F.24 Shop soiled, switched tuning **7/6**. All Brand New with circuit 3/6 postage on each.

RCAF AMPLIFIER UNIT. 12 v. input Vibrator Pack. 250 v. output OZ4. Microphone transformer into a 6K6 GT output valve with negative feed back, size 8 × 5½ × 8¼in. Brand new, **30/-** each. P. & P 3/-.

500 MICROAMPS METER. 2in. circular calibrated 0–15 and 0–600 volts, resistance 500 ohms. New and unused **17/6**. P. & P. 2/6.

COMMUNICATION RECEIVER RA 1B. Covers 150 kc/s-15 Mc/s. in 6 bands, 12 or 24 operation. S.A.E. for details.

LUMINOUS MAGNETIC MARCHING COMPASS. Pocket size. Brand new with instructions. ONLY **12/6**. P & P. 1/-.

WIRELESS SET No. 19 MK. II. As described and recommended for amateur use in April and May issues of "Practical Wireless," this famous Trans./Receiver incorporates "A" set—TX/RX covering 2-8 Mc/s (37.5-150 metres). "B" set V.H.F. TX/RX covering 230-240 Mc/s (1.2-1.3 metres) and intercomm. amplifier. Complete with 15 valves, 500 microamps check and tuning meter, circuits and instruction book (American manufacture). In magnificent condition. **60/-**, carr 10/-. Attachments for above: Variometers **20/-**. Headphone and Microphone assembly **13/6**. Morse key assembly **4/6**, 12ft. aerial **7/6**.

GOODMAN OUTPUT TRANSFORMERS. Impedance 5,000 ohms to 3 ohms, 3 watt, suitable for 6V6's, 6BW6, etc., 4/6 each. Post 1/-.

WESTON 1 AMP. H.F. METERS. 2in. circular. Brand new, **5/6**. P. & P. 1/-.

DIPOLE AERIAL No. 4A. 52 feet hard drawn 7/22 copper wire with centre insulator, fitted with feeder sockets. Both ends have 3 link insulators and slotted wire adaptors. Brand new, price **9/-**. P. & P. 2/-.

ARMOUR RECORDING WIRE. U.S.A. top quality on original reels, length 3,700 yds. **10/-**. P. & P. 1/6.

BENDIX RECEIVER RA 10. A 4 wave-band superhet covering 150 kc/s-10 Mc/s. Valves 6SK7 1st R.F., 6K8 Mixer, 6SK7 1st and 2nd I.F., 6R7 2nd Det., 6C5 B.F.O., 6K6 output. Size 6½in. x 15½in. Easily converted to mains operation as described on page 453 of the September "Practical Wireless." **£5/10/-**, carr. 7/6.

RELAYS. 6,500 ohms and 3,500 ohms. 8/- pair, post paid.

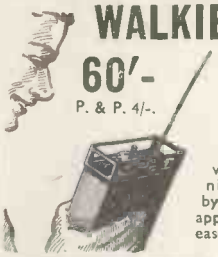
HIGH RESISTANCE HEADPHONES. Type No. 2 4,000 ohms., Brand new **11/6** each. P. & P. 1/6.

INDICATOR UNIT ILC No. 5. Ideal for conversion into an Oscilloscope using a 139A or ACR 10 tube. Unit consists of 2-VR65's, 1-VR66, various resistors, condensers and pots. Size 11 × 6 × 3in. Brand new, complete with modification circuit (less tube), **20/-**. P. & P. 3/-.

COMMUNICATION RECEIVER R1155

This magnificent 10 valve, 5 waveband receiver gives worldwide reception over a coverage of 75–200 kc/s., 200–500 kc/s., 600–1,500 kc/s., 3–7.5 Mc/s., 7.5–18.5 Mc/s. (4,000–13.5 metres), incorporating Medium, Long and Shortwave bands. Requires 250 v. and 6 v. Fully tested and dispatched in full working order complete with super slow motion drive, circuit and instruction book. OUR PRICE ONLY **£8/10/-**. Carr. 10/-.

WALKIE/TALKIE SET



60/-

P. & P. 4/-.

Consisting of transreceiver covering 7.4–9 Mc/s. range approx. 5 miles, complete with five valves, headphones, microphone, junction box and 6ft. telescopic aerial. Set only requires 120 v. and 3 v. dry battery. These magnificent Walkie/Talkie sets (as used by H.M. FORCES) are ideal for any application and can be operated with ease by young and old alike.

TWO FOR **£6** POST FREE.

SATELLITE RECEIVER

Receive Radio Signals being transmitted by the U.S. Satellite on approx. 108 Mc. This Receiver is AM and Crystal Control on six pre-set frequencies in the 108.3 to 110.3 Mc. range. Provides audio and band pass filter output of 90 and 150 cycles for aircraft instrument landing, for which it was originally used. Complete with ten valves: 1/12AH7, 2/12SG7 2/12SR7, 1/12SQ7, 3/717, 1/12A6. Crystals: Voltage required: 12 or 24 VDC and 220 VDC 80 MA. Size: 13⅜in. × 5in. × 7in. Also can be converted to FM Receiver 80 to 108 Mc. Price **£4**, carriage 7/6.

WHEATSTONE BRIDGE

Consisting of four stud switches: 0–10 ohms, 0–100 ohms 0-INF. Galvanometer centre zero F.S.D. 2.5mA. Ranges easily extended. Housed in oak cabinet 16 × 7½ × 6in. Complete with instructions, **40/-**.

P. & P. 4/-.

SIMPLE 2-WAY TELEPHONE KIT

Install your own intercomm.!!! with this brand new kit consisting of 2 "press to talk" hand telephones, long life battery, 100ft. of cable and simple wiring details. Ideal for garage, office, workshop, factory, farm, camping, and home. Will give endless hours of pleasure and has proved reliable under all conditions. Complete kit sent for only **25/-**. P. & P. 3/6.

POCKET VOLT TEST METER

Two D.C. ranges 0–250 v. and 0–15 v. Complete with test prods. Brand new. Very limited quantity. Only **10/6**. P. & P. 1/6.

INFRA-RED MONOCULAR

Ideal for night viewing, etc. Complete with push-button power unit and focus lenses. Brand new in beautiful leather carrying case. Originally cost Govt. £40. OUR PRICE **25/-**. P. & P. 3/6.

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Also at 32A, Coptic Street, London, W.C.1. *MUSeum* 9607

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All post orders and correspondence to (Dept. "W") 32A, Coptic Street, London, W.C.1.

AMERICAN GEARED MOTOR

24 v. D.C. with built-in precision gearbox. No. 1 drive 24 R.P.M. No. 2 drive 6 R.P.M. On 12 v. No. 1 drive 16 R.P.M. No 2 drive 4 R.P.M. Overall size of motor and gearbox 7½ × 3½ × 3in., weight 11b. 14 oz., Brand new. **17/6**. P. & P. 3/-.

RCA MAINS TRANSFORMERS. Input 110-240 v. Output 245-0-345 at 150 mA. 6.4 v. at 4.5 amps., and 5 v. at 2 amps. Brand new, fully shrouded. Write now. Only **35/-** . P. & P. 3/-.

LEAD ACID ACCUMULATORS (unspillable). 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new original cartons. Size 4in. × 7in. × 2in. 5/6 each, P.P 2/6; 3 for **15/-**, P.P. 3/6; 6 for **27/6**, P.P. 5/-.

S.T.C. RECTIFIER UNIT. Input 100-250 v. A.C. Output 115 v. D.C. at 1 amp. Provision for adjustment of 3 and 12 volts either side of mean voltage. **55/-**, carr. 5/-.

0-25 AMPS. 2½in. ROUND FLUSH MOUNTING METERS. New and boxed, 8/6. Post 1/6.

SIGNAL GENERATOR AND WAVEMETER. Type W.1649. Frequency of Signal generator: 140 to 240 Mc/s. Accuracy +0.5 Mc/s. Frequency of Heterodyne Wavemeter: 155-255 Mc/s. Accuracy + 0.2 Mc/s. Containing VR 135 and 4VR91, 5 meg. crystal. Retractable aerial. Power requirements: 6.3 volts and 120 volts. Unit housed in copper lined wooden case. Size 15½in. × 13in. × 14½in., **45/-**, plus 10/- carr.

FERRANTI TRANSFORMER. Input 225 volts, output 4 volts at .5 amps. Potted type with ceramic bushes. Brand new, 7/6 each. P. & P. 1/-.

VIBRATOR PACK. 12 volt input 300 volts output at 150 mA. As a bridge rectifier will handle 450 volts RMS at 120 mA. Pack consists of 12 volt vibrator, 4 metal rectifiers, chokes and smoothing condensers. ONLY **30/-**. carriage 5/-.

TANNOY AMPLIFIER. With 4 6L6's in parallel, push-pull handling from 30 to 60 watts. 200-250 v. input. Complete with all leads, hand microphones, plugs and spares. Housed in wooden transit case 17½ × 15¾ × 21½in. With full operating instructions and circuit. Fully tested. ONLY **£20**. Speakers for above **25/-** each.

AMERICAN MIDGET ACCUMULATORS. 36 volts, lead acid type. **2/6** each. P. & P. 1/-.

COLVERN WIRE WOUND POTENTIOMETERS. 25 watts 50k and 100k. Price **6/-** each.

HEADPHONE & MICROPHONE ASSEMBLY. Consisting of padded headphones and No. 7 moving coil hand microphone with cord and plug. Brand new. Price **10/-**. P. & P. 3/6.

PYE 45 mc/s. I.F. STRIPS. Complete with seven valves, 6-EF50, 1-VR92, 6 tunable I.F. transformers. Only **30/-**, post paid.

COMMAND RECEIVERS. 190-550 kc/s., fully valved, **55/-**. P. & P. 3/6.

LOOP ASSEMBLY CRV. 69365. Suitable for use with communication Receivers with aural D/F. Loop is for manual operation and fitted with calibrated scale and 28 inch drive extension. Weight 15 lb. Height 4 feet. R.C.A. manufacture and brand new in original cartons **£6/10/-**, carriage 20/-.

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1 : 1.25 giving 25% boost on Secondary.

2 volt	10/6 each
4 volt	10/6 each with Tag
6.3 volt	10/6 each Panel and
10.8 volt	10/6 each Solder Tags
13.3 volt	10/6 each
Ditto with mains primaries	12/6 each

Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each. Ditto for 6 volt Tubes only 17/6.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 220/240 volts. Output 2-2½-2½-3 volts at 2 amps. 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. recievers having series connected heaters.

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

5 watt	WIRE-WOUND RESISTORS	1/3
10 watt		1/6
15 watt	25 ohms—10,000 ohms	2/-
15,000 ohms—50,000 ohms	5 w., 1/9; 10 w.	2/3

WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC.
Pre-set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-.
Standard size Pots., 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K., 6/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.
O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 7 watts, 15/6. "510" 6k or 8k 30/-
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H., 120/150 mA., 12/6; H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a. 5 v. tapped 4 v. 2 a., ditto 250-0-250 80 mA., etc., 22/6. Bargain 300-0-300 v. 65 mA., 6 v. 4 a., 4 v. 2 a., 15/-.

I.F. TRANSFORMERS 7/6 pair

465 kc/s slug tuning miniature can 2½ × 1 × 1in. High Q and good band width. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. transformers 465 kc/s, 12/6 pair.
Wearite 550 I.F. transformers 465 kc/s, 12/6 pair.

HEATER TRANS. Tapped 200/250 v. 6.3 v. 1½ amp., 7/6.
ALADDIN FORMERS and cores. ½in., 8d.; 1in., 10d. .3in. FORMERS 5937/8 and Cans TV1/2. ½in. sq. × 2½in. and ¾in. sq. × 1½in., 2/- complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 16/9. SOLON INSTRUMENT IRON. 25 w., 24/-.
MAINS DROPPERS. 3 × 1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms per foot, 2 way, 6d. per foot. 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos

Precision engineered. Size only 1¼ × 3/16in. Bargain. Price 6/6. No transformer required.

MIKE TRANSF. 50 : 1, 3/9 ea.; 100 : 1, Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 2½in. square, 17/6.
5in. R.A., 17/6. 7in. × 4in. Goodmans 21/-.
3½in. Square Elac., 21/-. 8in. Plessey, 19/6.
6½in. Goodmans, 18/6. 10in. R.A., 30/-.
4in. ELAC TWEETER, 25/-. 12in. Plessey, 30/-.
8in. M.E. 2.5 k. field tapped O.P. transformer 24/6.
15 ohm Plessey 10 wt. 12in. with Tweeter, 97/6.
CRYSTAL DIODE G.E.C. 2/-. GEX34, 4/-. 40 Circuits, 3/-.

TELETRON AJAX CRYSTAL SET

Complete kit with cabinet 4½ × 3 × 1½in. All components and instructions. 15/- or 30/- with pair of lightweight H.R. headphones to match.

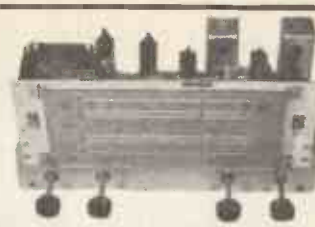
H.R. HEADPHONES. 4,000 ohms, brand new. 16/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 p.f. Miniature, 1½in. × 1½in. × 1½in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 p.f., 2/6. Solid Dielectric 100, 300, 500 pf., 3/6 each.
VALVE HOLDERS. Pax int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/-.
MOULDED Mazda and Int. Oct., 6d., B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6, VCR97, 2/6. B9A with can, 2/6.
CERAMIC, EF50, B7G, B9A Oct., 1/-. B7G with can, 1/9.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-. 25in. × 35in., 10/-. Expanded metal, Silver 15½in. × 9½in., 2/-. Tyran 4ft. 8in. wide, 10/- ft.; 2ft. 3in. wide, 5/- ft.
WAVECHANGE SWITCHES

2 p. 2-way 3 p. 2-way, short spindle	2/6
5 p. 4-way 2 wafer, long spindle	6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle	3/6
3 p. 4-way, 1 p., 12-way, long spindle	3/6

Wave change "MAKITS." 1 wafer 8/6; 2 wafer 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES. S.P., 2/-; D.P. 3/6; D.P.D.T., 4/-.
MORSE KEYS, good quality 2/6. Buzzers 3/6.

MULLARD "3—3" AMPLIFIER

A really first-class 3-valve 3-watt Amplifier giving Hi-Fi quality. Valve line-up: EF86, EL84, EZ80. H/duty mains trans. giving extra HT and LT for Tuner Unit addition. Variable treble cut and bass boost controls, 3-watt output. Complete amplifier wired and tested with output transformer to Mullard specification. £7.17.6. Carr. and ins. 2/6.



1958 RADIOGRAM CHASSIS

THREE WAVEBANDS FIVE VALVES
S.W. 16 m.—50 m. LATEST MULLARD
M.W. 200 m.—550 m. ECH42, EF41, EBC41,
L.W. 800 m.—2,000 m. EL41, EZ40
12 month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial 10½ × 4½in. horizontal or vertical available. 2 Pilot Lamps. Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

BRAND NEW £10.10.0 Carr. 4/6.

TERMS: Deposit £5/5/- and 6 monthly payments of £1. MATCHED SPEAKERS FOR ABOVE CHASSIS: 8in., 17/6; 10in., 25/-; 12in., 30/-.

★ COLLARO ★
HIGH FIDELITY AUTOCHANGER
MODEL RC456

For 7", 10", 12" Records 16, 33, 45, 78 r.p.m.
4-SPEEDS—10 RECORDS
WITH STUDIO "O" PICK-UP
BRAND NEW IN MAKER'S BOXES
OUR PRICE £9.15.0 Post free.
TERMS: Deposit £5/5/- and 6 monthly payments of £1
SUITABLE PLAYER CABINETS 49/6
AMPLIFIER PLAYER CABINETS 63/-

IMPORTANT NOTICE

THESE RECORD PLAYERS AND AUTO-CHANGERS ARE GUARANTEED FOR TWELVE MONTHS AND SPARES ARE AVAILABLE.

GARRARD 4-SPEED SINGLE RECORD PLAYER 4SP

£8 AUDIO PERFECTION POST FREE

Designed to play 16, 33, 45, 78 r.p.m. Records, 7in., 10in., 12in. Lightweight Xtal pick-up, GC2 turnover head, two separate sapphire styli, Standard and L.P.

EXCEPTIONAL OPPORTUNITY

COLLARO 4-speed Single Record Player, including heavyweight turntable and lightweight Studio O Pick-up with turnover Xtal mounted on baseplate. Autostop fitted. **OUR PRICE 6 gns.** Carr. 4/-
Amplifier Player Cabinets, 45/-.

BUILD THIS REPRODUCER BARGAIN
SPECIAL SINGLE PLAYER KIT

FAMOUS MAKER'S SURPLUS STOCKS

4-speed Collaro "Junior" Unit...	£4	12	6
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1,200 ft. on standard fitting 7in. metal reels. Spare Reels 5½in. plastic, 3/-; 7in. plastic, 4/-.
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TUBULAR		TUBULAR		CAN TYPES	
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4/350 v.	2/-	16+16/500v.	6/-	6,000 mfd. 6 v.	6/6
8/450 v.	2/3	CAN TYPES		32+32/350 v.	4/6
8/500 v.	2/9	Clips	3d.	32+32/450 v.	6/6
16/450 v.	3/6	16/450 v.	3/6	64+120/275 v.	7/6
16/500 v.	4/-	16/500 v.	4/-	60+100/350 v.	11/6
32/450 v.	5/6	32/350 v.	4/-	100+200/275 v.	12/6
25/25 v.	1/9	100/275 v.	5/6		
50/25 v.	1/9	50+50/350 v.	7/-	1,000+1,000/6 v.	6/6
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CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a. 17/6; 4 a., 22/6.

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1S5	8/6	6L6	10/6	EAB30	8/6	E1148	1/6
1T4	8/6	6Q7	10/6	EB91	6/6	HABC80	12/6
3S4	8/6	6SA7	7/6	EBC33	8/6	KT32A	7/6
3V4	8/6	6SN7	8/6	EBC41	10/6	MS/4	10/6
5U4	8/6	6V6G	7/6	EBF80	8/6	P61	6/6
5Y3	8/6	6V6GT	8/6	ECC84	12/6	PCC84	12/6
5Z4	10/6	6X4	7/6	ECF80	10/6	PCF80	10/6
6AM6	8/6	6X5	7/6	ECF82	10/6	PCF82	10/6
6B8	5/6	787	8/6	ECH42	10/6	PCL82	10/6
6BE6	7/6	12A6	7/6	ECL82	12/6	PEN25	6/6
6BH6	10/6	12AH8	10/6	EF39	7/6	PL82	10/6
6BW6	8/6	12AT7	10/6	EF41	10/6	PY80	10/6
6BW7	8/6	12AU7	10/6	EF50	5/6	PY81	10/6
6CH6	10/6	12AX7	10/6	Equip.		PY82	10/6
6D6	7/6	12BE6	10/6	EF50	8/6	SP61	5/6
6F6	7/6	12BH7	10/6	Sylv.		UBC41	10/6
6H6	3/6	12K7	8/6	EF80	10/6	UCH42	10/6
6J5	6/6	12Q7	8/6	EF92	5/6	UF41	10/6
6J6	7/6	35Z4	10/6	EL32	5/6	UL41	10/6
6J7	8/6	80	8/6	EL84	10/6	UY41	10/6
6K6	6/6	807	6/6	EY51	12/6	U22	10/6
6K7	5/6	954	1/6	EZ40	10/6	X79	10/6

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ELECTRONIC ENGINEERS
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Candidates must be fully experienced in handling normal test gear (other than for VHF) and have a sound theoretical knowledge of electronics. The situations are permanent and the work is both interesting and varied.

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WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

SHIRLEY LABORATORIES, Ltd., 3, Prospect Place, Worthing, Sussex. Tel. 30536. THE TWA/1515 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts O/P each channel. 96gns. TWA/15 tape recording and reproducing amplifier, 13watts O/P, for Wearite and Collaro decks, 45gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

AM/FM radiogram chassis and feeders, model A/F834, an 8-valve AM/FM R/G chassis; 4 watts output; attractive coloured dial, latest type valves; model A/F73, a 7-valve AM/FM feeder; both models at keen prices; 3d stamp for literature; trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [7800

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

1143A equipment less valves and crystals, receiver type 71, 3/6 ea., post 3/6; transmitter type 50, 2/6 ea., post 3/6; amplifier type 165, 3/- ea., post 3/-; enquiries and lists, s.a.e. please.—Annakin 25, Ashfield Place, Otley, Yorks. [7772

TV RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

MURPHY V1116 chassis, 12in. B.B.C. T.V., tube U.S., sound O.K., complete with facia controls; £8.—507, Croydon Rd., Beckenham. Tel. 2611, evenings. [7769

PHILIPS 17in projection televisions available, as taken in part exchange, complete, but not guaranteed; £9/15, originally £92-£120 each.—Tomlins, 127, Brockley Rise, Forest Hill, S.E.23. [0343

TELEVISIONS needing attention, 9in-10in. nearly all makes, 45/- each, carriage paid: 12in televisions, needing attention, £5/10; 15in. £9/10; write for list.—Tomlins, 127, Brockley Rise, Forest Hill, S.E.23. [0344

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECOND-HAND

9KVA ex-W.D. alternators, B.T.H., 230 volts, single phase.—Box No. 4798. [7771

ROTARY converter, 220/240 v. DC output 230 v., 150 watts at 50 cycles; recently rewound and overhauled by makers; £11 o.n.o. —Thompson, 21, Wellwood Rd., Goodmayes, Essex. [7804

DYNAMOS, MOTORS, ETC., WANTED

WANTED, aircraft type generators, 29 volts 3000 watts and 24 volts 500 watts, required in large quantities at keen prices.—Box No. 4848. [7777

TEST EQUIPMENT—SURPLUS AND SECONDHAND

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NEW COMPONENTS

A BRAND new list for May that will make your eyes pop! Free and post free to dealers; send your bill head; trade and export only supplied.—A.W.F., 10, Sackville St., Bradford, 1. [0132

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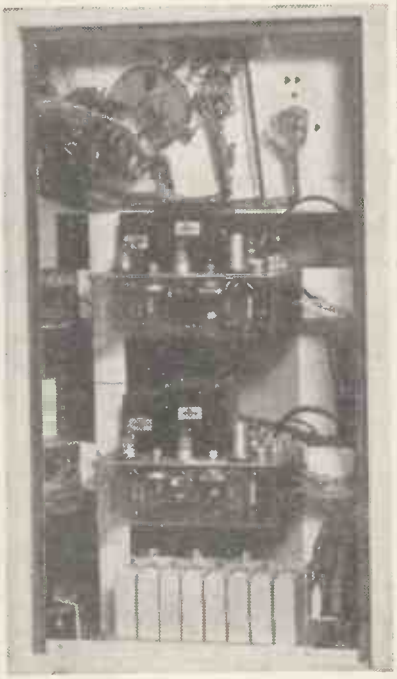

Photographs are reproduced by courtesy of Messrs. Dunford & Elliott (Sheffield) Ltd., suppliers of the electronic equipment.

At top is shown an overall view of the telescope.
Below is a section of the interior of the control equipment.

This Radio Telescope situated at Jodrell Bank and the first of its kind, attracted world fame in tracking the "earth satellites." For work of this nature reliability in operation and in the results achieved are of paramount importance. That is why Partridge Transformers were specified and many hundreds employed in the equipment.

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HOW to use ex-Gov. lenses and prisms. Nos. 1 and 2 2/6 ea; vertical enlarger plans for 35mm to 2¼sq 3/6 ea; optical condensers and Achromatic lens to suit 33/-; lists, s.a.e.—H. W. English, Rayleigh Rd., Hutton, Essex. [0126

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TAPE recorders, Ferrograph, Vortexion, Brenell, Telefunken, M.S.S., Truvox, and Reflectograph.
TAPE decks, Wearite, Brenell, Truvox, Dulci Harting, Sonomag Adaptatape (Collaro).
AMPLIFIERS and tuners, Leak, Quad, R.C.A., Dulci, Dynatron; microphones, Reslo, Acos, Philips, Labor, etc.
ALL tapes and accessories; audio service dept., and recording studio, hire-purchase facilities available.
LAMBDA RECORD Co., Ltd., 95, Liverpool Rd., Liverpool, 23. Great Crosby 4012. [7749

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FERROGRAPH, Harting and Vortexion tape recorders for sale or hire; may we arrange to demonstrate these superb instruments to you; easy terms available.—"Grifhano" Studios (See below.)
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GLASGOW.—Recorders bought, sold, exchanged, cameras, etc., exchanged for recorders or vice versa.—Victor Morris, 406, Argyle St., Glasgow, C.2. [0201

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TAPE RECORDING, ETC.

RENDEZVOUS RECORDS offer comprehensive 78/LP tape to disc recording facilities. —Leaflet from 19 Blackfriars St., Manchester, 3. [7402

FACTORY fresh, guaranteed 1,800ft LP tape from 37/6, 1,200ft std., from 25/-, post free; orders in strict rotation.—Sound News, 10, Clifford St., W.1. [0199

TAPE to disc recording.—L.P. (30 mins.), 27/6; 78s, 13/6, 48-hour service, s.a.e. leaflet.—Marsh, Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. Aug. 3102. [7782

TAPE RECORDING, ETC.

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BRAND new recording tape, 1,250ft 7in reels, boxed at 17/6 ea.; p. and p. 1/3; money refunded if not satisfied.—A. Marshall, 18, Cricklewood Brdwy., N.W.2. Gla. 0161. [7764

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VALVES, all at 5/6 each, cannot be repeated, 1S4, 10F1, 10C2, 10P13, 20L1, 20F2, 20P1, 20P4, 807, CBL1, EF55, ECL80, GZ32, KTZ41, MS4B, Pen25, PL83, TP22. TP25, U25, U281, U301, X31, Z66.—Jackson, 3, Terminus Place, Eastbourne. [7746

VALVES WANTED

P.E. Cells CY31, CL33 and other types of amplifier valves wanted for cash.—Harringay Supplies, 423, Green Lanes, London, N.4. Mountview 5241/2. [7774

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place. Euston Rd., N.W.1. [6985

WANTED, EXCHANGE, ETC.

DECCA corner loudspeaker with or without unit, cabinet unaltered; inspect London or Birmingham; state price.—Box 5288.

VALVES (new), tape recorders, test equipment, any quantity.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [7079

WANTED, HRO coils, Rxs., etc., A.R.88s, BS348s, S27s, etc.—Details to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

A BETTER cash offer for brand new valves, speakers, components, test instruments, etc., that are surplus to your needs.—R. H. S., 155, Swan Arcade, Bradford, 1. [0190

URGENTLY required, scrap platinum wire, contacts, etc.; spot cash for any quantity; £24 per oz troy.—The Scientific Metal Co., 50, Old Brompton Rd., London, S.W.7. [7667

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [7508

WANTED, BC610 Hallicrafters, E.T.4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above: best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [7074

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MAINS transformers rewound, new transformers to any specification.
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BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, R. J. Houlgate, A.M.I.E.E., 12, Strongbow Rd., Eltham, S.E.9. [0031

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WELL-KNOWN firm of precision engineers and instrument makers (London area) are desirous of entering into a licence agreement or purchasing outright, Patents relating to electrical and/or mechanical devices of a precision instrument character, or of a consumer goods nature; adequate capital and production facilities are available to develop, produce and market suitable devices.—Communications should be addressed, in the first instance, to Major S. F. M. Neill, Louis Newmark, Ltd., Croydon, Surrey. [7770

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LONDON COUNTY COUNCIL.

SOUTH East London Technical College. LEWISHAM Way, S.E.4.—Required for September, 1958, visiting lecturers (day and evening) for possible vacancies in following subjects:—
PHYSICS (heat) up to hons. standard.
ELECTRONICS and Control Systems A1-A2.
ELECTRICAL Engineering and Science S1-S3.
RADIO and Television Service, inter and final.
APPLICATION forms and details of payment from Secretary at College. (518.) [7799

EXPEDITION TO ANTARCTICA

SCIENTIFIC assistant (Ionospheric) required by the Falkland Islands Dependencies Survey for the operation and maintenance of special electronic Ionospheric recording apparatus at an Antarctic base for two years. Commencing salary according to age in scale £400 rising to £540 a year with all found including food, clothing and canteen stores. Free passages. Liberal leave on full salary. Candidates, preferably single and aged 21-28 years, must be of good education, of high physical standard, and experienced in the servicing of radio or radar equipment. Genuine interest in life at an Antarctic Base essential. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/44628/WF. [7783

SUNDERLAND Education Committee.

TECHNICAL College.
APPLICATIONS are invited for the post of electronics technician for the repair, maintenance and construction of electronics equipment; applicants should have considerable experience of such equipment, and possess an appropriate qualification, e.g., National Certificate in Applied Thermionics, National Certificate in Applied Physics, City and Guilds Radio or T.V. Servicing Certificate.
SALARY £620×£20 to £660×£25 to £760.
APPLICATION forms, and further particulars, may be obtained from the Registrar, Technical College, Sunderland, Co. Durham, and should be forwarded to the undersigned as soon as possible after the appearance of this advertisement.
CANVASSING will be a disqualification.
W. THOMPSON,
DIRECTOR of Education.
Education Offices,
15, John Street,
Sunderland. [7778

TECHNICIANS for development—testing and service work.
HILGER & WATTS, Ltd., makers of a wide range or scientific instruments seek to engage several young men with O.N.C. or G.C.E. standard in maths and physics for interesting work in their laboratories and testing departments, which will include a certain amount of service and installation work away from home. TRAINING will be given in the specialised aspects of the work including optics. The posts are permanent and pensionable and offer an interesting career in an expanding company.
APPLICATIONS stating age, and giving full details of education, experience and qualifications should be addressed to the Personnel Officer, Hilger & Watts, Ltd., 98, St. Pancras Way, Camden Road, N.W.1. Please quote Ref. B.31. [7747

BUCKINGHAMSHIRE EDUCATION COMMITTEE.
HIGH Wycombe College of Further Education. (PRINCIPAL: W. J. Davies, J.P., B.Sc.).
REQUIRED for 1st September, 1958, Laboratory Assistant for Electrical Department. A suitable candidate would require to be of Ordinary National Certificate standard and have had some general experience of light current laboratory work. Duties would include repair and maintenance of experimental equipment and test gear.
SALARY will be paid on the scale £235 to £620 and the starting point will be fixed according to age and previous experience.
APPLICATIONS, together with copies of two recent testimonials, should be forwarded to the Principal at Queen Alexandra Road, High Wycombe, within 14 days of the date of the appearance of this advertisement. [7795

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REQUIRED by War Department in MIDDLE East and East Africa.
DUTIES include operation and maintenance of medium power M.F. or H.F. transmitters; Radio II of City and Guilds or equivalent normally required; three-year tour initially; salary £500 to £691 per annum, starting point according to age and experience+foreign service allowance ranging from £110 to £1,230 per annum depending on station and marital status; outfit allowance £35.—Apply any Employment Exchange quoting Reference 2/OS.269/58 Sheet No. 19/58. [7773

HI-FI laboratory of well known company has vacancies for engineer and lab. assistants in South London.—Address replies: Box 4849. [7776

DUE to further expansion, indoor and outdoor T.V. engineers required; top rates of pay with pleasant working conditions; permanent positions.—Please apply Vincent Television, 139, Peckham Rd., S.E.15. Rodney 2966. [7767

SITUATIONS VACANT

AEROPLANE and Armament Experimental Establishment, Boscombe Down, requires SKILLED men to serve as
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RADIO/RADAR and electronic craftsmen for fitting and maintenance of aircraft and ground installations.
AIRFRAME and engine fitters, fitter/armourers for aircraft servicing and fitting of special equipment.
INSTRUMENT makers and precision machinists.
RATE of pay for 44-hour, 5-day week, 182/4 plus 10/- merit lead or 182/4 plus 38/- merit lead according to experience; prospects of re-assessment of rate within three months, any increase back-dated to date of entry; merit lead can rise to £0/-; two weeks (88 hours) paid annual leave; paid sick leave scheme; hostel accommodation available for single or unaccompanied applicants.
Apply, giving details of apprenticeship and experience, to Air Commodore (Civil) Administration Officer, (WW), A. & A.E.E., Boscombe Down, Amesbury, Wiltshire. [7794

BRITISH Aviation Services (Engineering) Ltd., Blackbushe Airport invite applications for an immediate vacancy for a Licensed Radio Engineer, for their base at Hamble.
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ELECTRONIC Engineers are required for an extensive development programme on Radar Navigational aids; applicants should have experience in this field and preferably also in working with the Ministry of Supply; Senior Engineers are needed to act as project leaders whilst juniors are also required for detail design work.
THE laboratories are situated in a new town giving easy access to London and the countryside; the nearby Hatfield Technical College offers excellent facilities for study; amenities include pension scheme and a wide range of sports club activities. Applications giving full details of experience, qualifications and age will all be seen by the Chief Engineer, Electronics Division, but should be addressed initially to the Personnel Manager (E.48), Murphy Radio Limited, Welwyn Garden City. [7785

RADIO Engineer, also T.V. Engineer required; not necessary driver for radio work; good wages; permanent position accommodation arranged if necessary; all main agencies held; Murphy-Pye-Bush-Eros; established 50 years.—Apply giving particulars of experience; all applications answered.—Victor Freed, 1 and 60, Cardiff St., Aberdare. Tel. 749. [7718

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SITUATIONS VACANT

SENIOR Electronic Engineer required by Louis Newmark, Ltd., for work at their New Addington Laboratories on design problems in relation to control systems with particular emphasis on the development of new components and transistor circuitry; applicants should possess a degree and should have had considerable industrial experience; pension scheme.—Apply in writing to: Personnel Officer, Louis Newmark, Ltd., Purley Way, Croydon, Surrey. [7802

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SERVICE Engineers: Hilger & Watts, Ltd., makers of a wide range of scientific instruments invite applications from young men interested in a career as full time service engineers; applicants must have a knowledge of physics and maths up to G.C.E. or O.N.C. standard or previous experience of fault finding and adjustment on complex electronic equipment; training in the specialised aspects of the work including optics will be arranged; applicants must also possess a current driving licence and be willing to spend a large part of their time away from home; the posts are permanent and pensionable and offer a progressive career in an expanding company of international repute.
LETTERS giving full details of experience and qualifications and stating age, should be addressed to the Personnel Officer, Hilger & Watts, Ltd., 98, St. Pancras Way, Camden Rd., N.W.1. [7742

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