Wireless World

ELECTRONICS, RADIO, TELEVISION

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MAY 1958

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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.

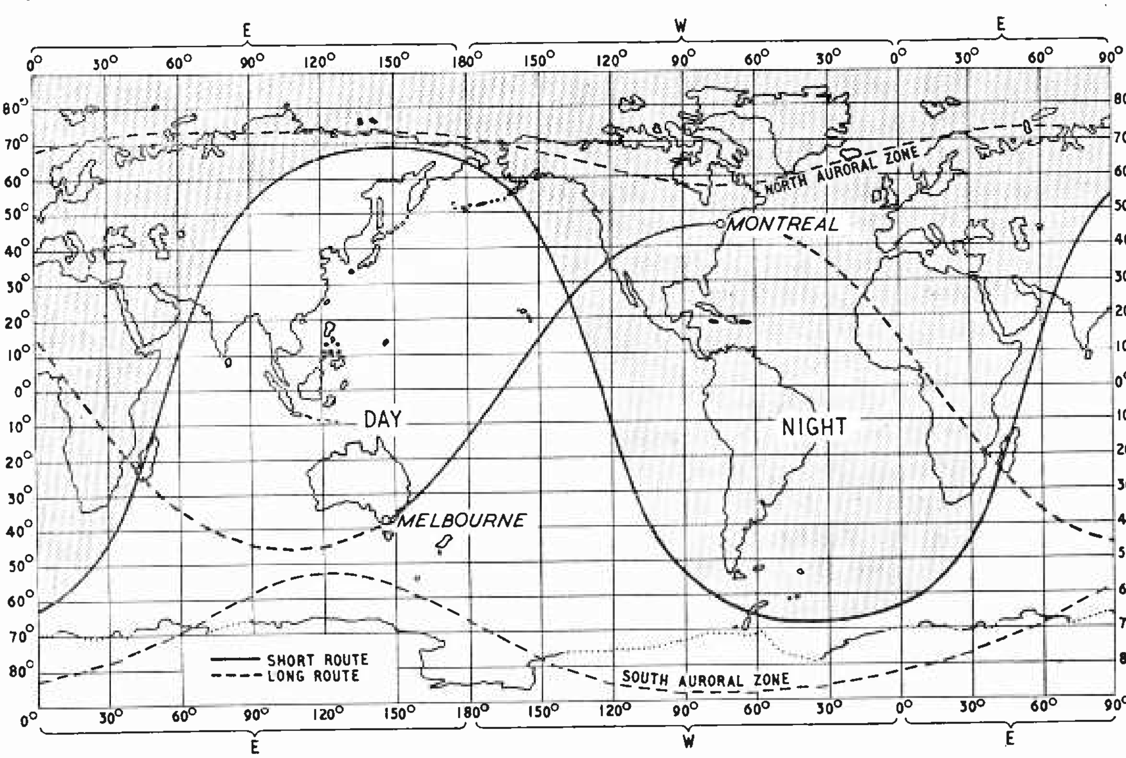
The main purpose of the present article is to examine the performance of trans-equatorial circuits which (in contrast to those previously reported on) are mainly over sea, convenient examples, being those from Montreal to Melbourne (short and long paths). Between these two terminals the short route is 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).

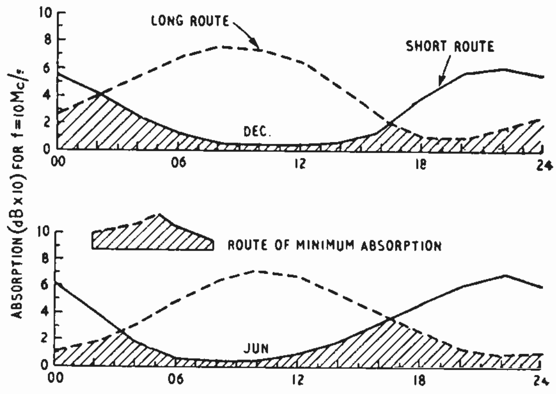
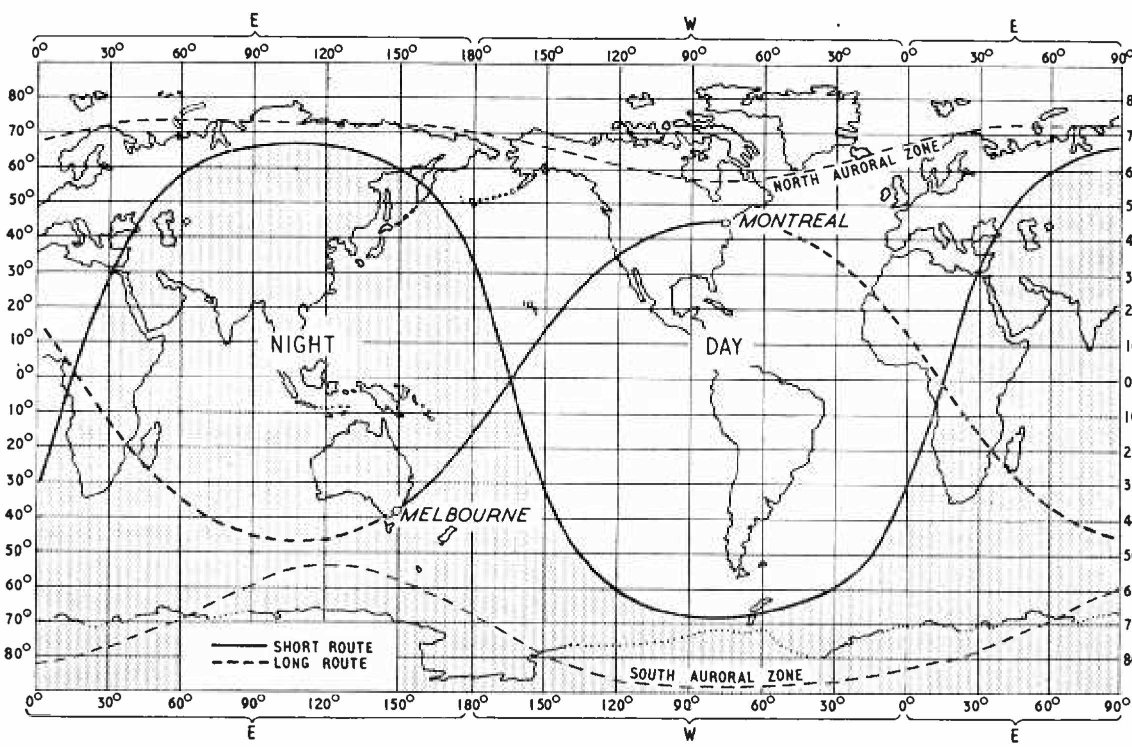


Fig. 3 Diurnal and seasonal values of absorption over the Montreal-Melbourne path.

* Royal Naval Scientific Service.

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



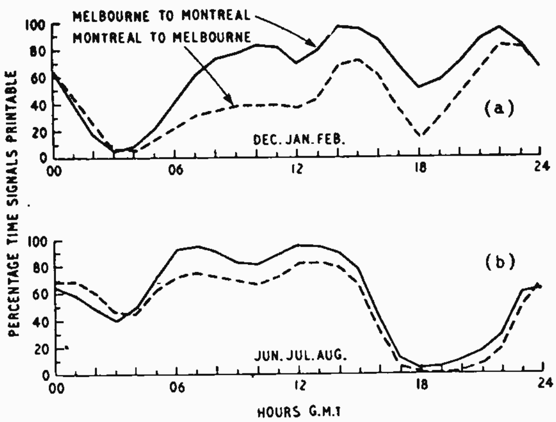
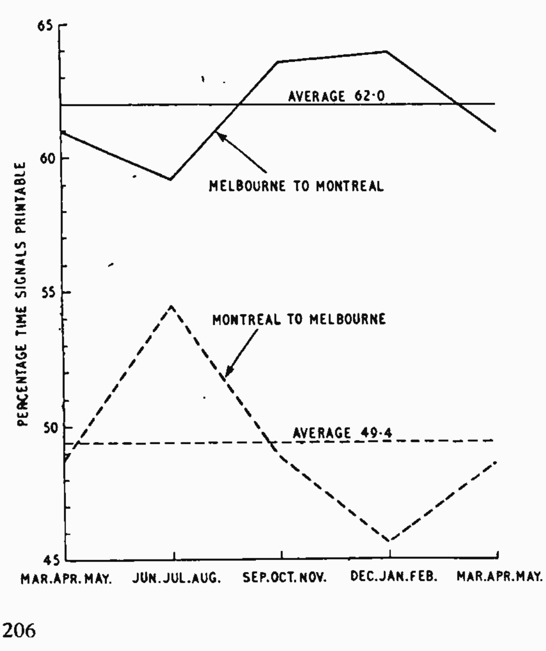


Fig. 4 Diurnal variations in performance over the Montreal-Melbourne path during 1941 to 1955 inclusive.

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.

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



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..

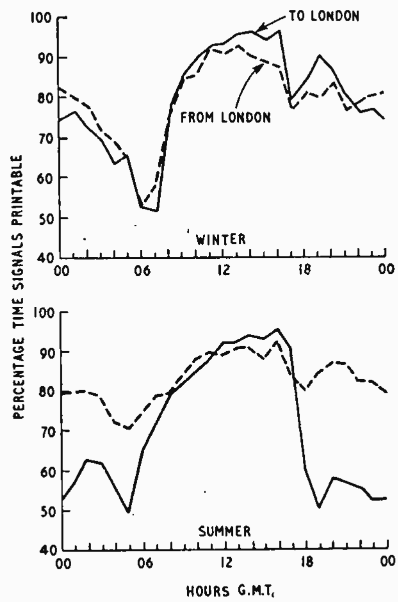


Fig. 6 Diurnal variations in performance of the Capetown-London path during 1951 to 1954 inclusive. (Reproduced from Proc. I.E.E. *July 1956 Part B.)*

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 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.

REFERENCES

[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.

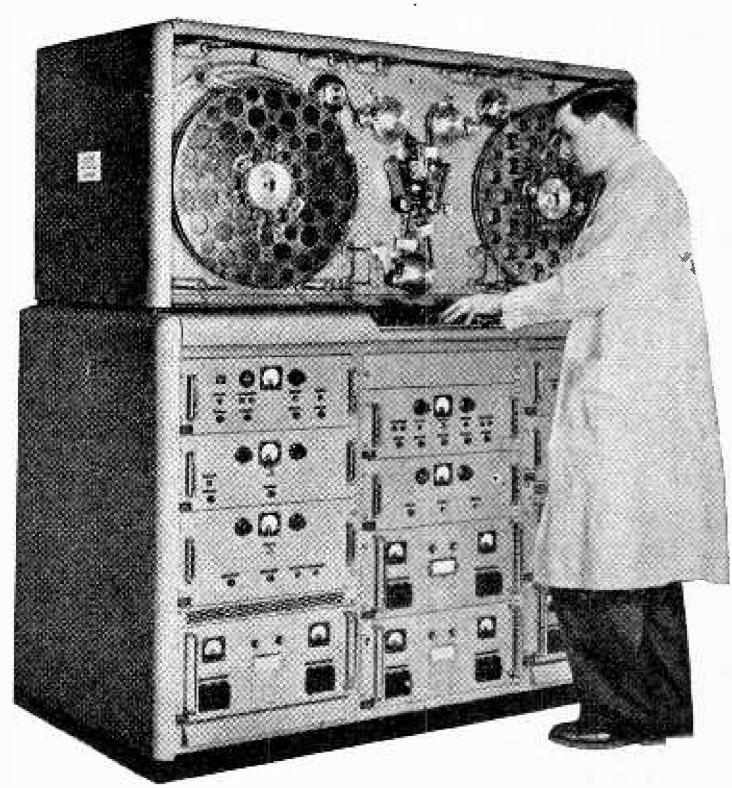
This f.m. carrier system has been adopted mainly to avoid the effects of tape imperfections and spurious amplitude modulation, which experience has shown to be more noticeable in the low-frequency components of the television picture (for example, as fluctuations in large-area brightness). It also avoids 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 fluctuations 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 wave-guides 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

Radio 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 Ubertragern, 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 inter-related 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.

$$t_o = KCR$$

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

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

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:—

$$V_{a1} = +250\text{V}, \quad V_{a2} = +100\text{V}, \quad E_g = +250\text{V},$$
$$R_5 = 2.7\text{K}\Omega, \quad R_3 = 82\,\text{k}\Omega, \quad R_3/R_5 = 30.4$$
$$\text{and } i_3 = 92.5\text{mA}$$

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

$$i_1 = 2.6\text{mA at } -1\text{V bias}$$
$$i_2 = 16.6\text{mA at zero bias}$$

$$\text{hence, } K = \log_e \left\{ \frac{92.5 + 2.6 \times 30.4 - 16.6}{92.5 - 2.6} \right\}$$
$$= \log_e (1.72)$$
$$= 0.542$$

Let t_o = 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.

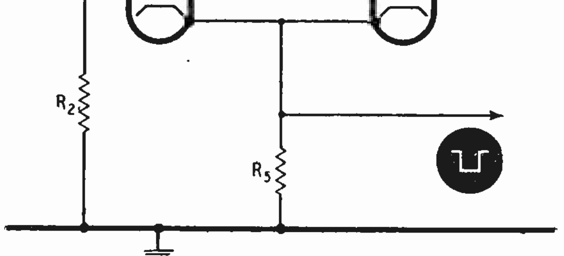


Fig. 1. Basic flip-flop circuit used.

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.

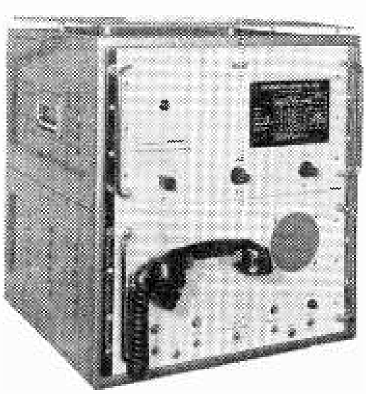
A further test was completed in which the circuit was modified by increasing R_3 to 470 kΩ and modifying R_2 appropriately, other circuit components being left unchanged. Thus R_3/R_5 became 174. It may be noted that for such a value of R_3 the valve V_1 becomes virtually a constant current device for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



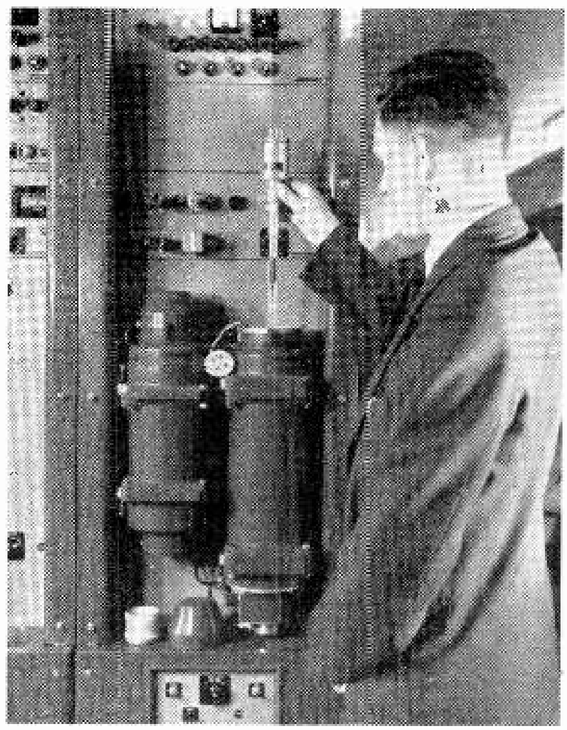
Racal Type TRA55, single-sideband radiotelephone.

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 $20\frac{1}{2}$in $\times$ $20\frac{1}{2}$in $\times$ $24\frac{1}{2}$in 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.

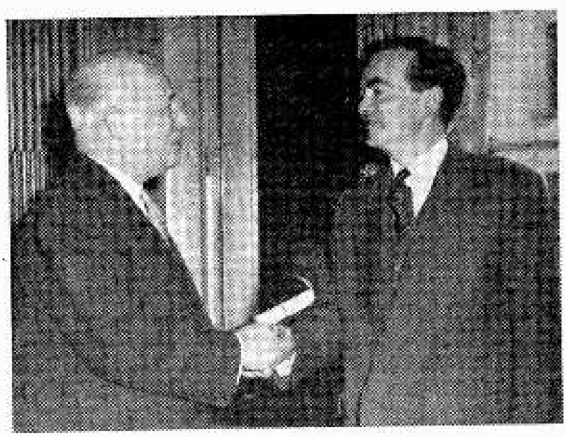
S.E. Coast TV

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 Committee 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.

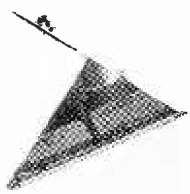
Multichannel R/T Equipment.—A further order—making three in all—for multichannel radio-telephone equipment for the Azores inter-island communication system has been placed with Marconi's by the Portuguese Postal and Telegraph Authorities. Twelve sets of terminal equipment for the radio paths will be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

Ph cal Society's Exhibition

NTS IN ELECTRONIC DEVICES AND TECHNIQUES



:ions of al exhi- actically of the ted, not ıvailable ıt in re- interests ..nd agricul- .. and medicine. ..owing pages a selec- .s been made of items ..n 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.

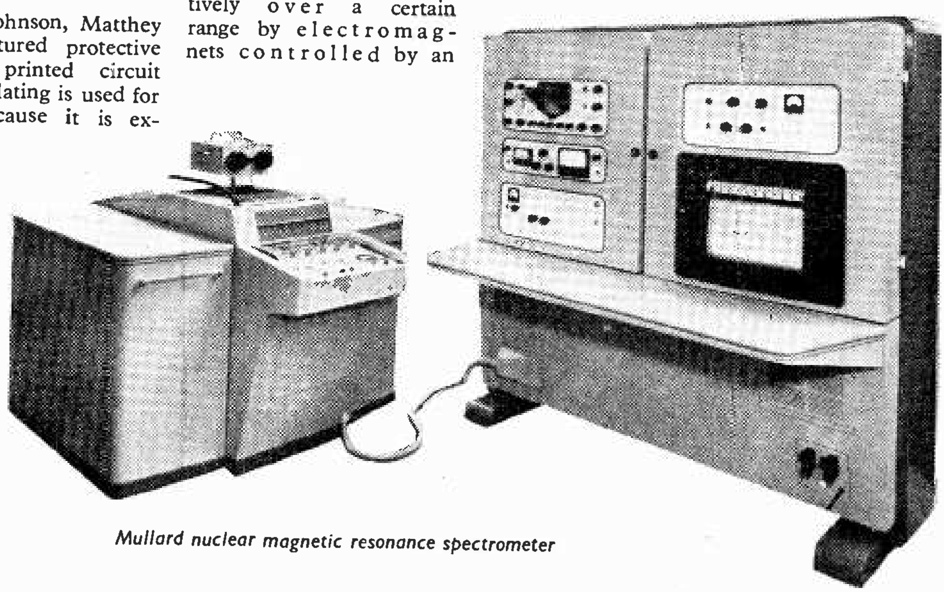
Magnetic Materials. The magnetic properties of the platinum-cobalt series have been known for some years, but the high cost has not made the use of these alloys an economic proposition. Now, as equipment shrinks even further, the limiting factors on miniaturization are often the basic physical properties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

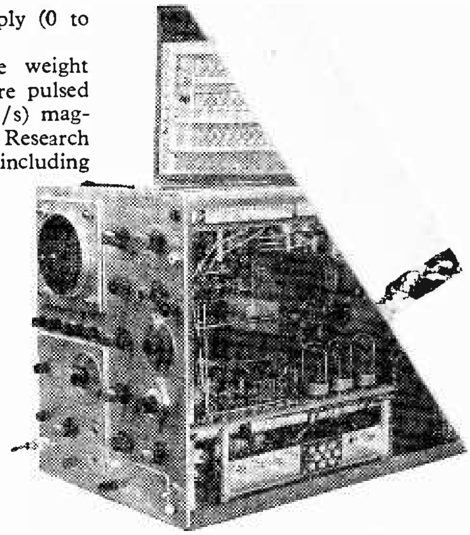
Semiconductor Transducers of indium antinomide for converting magnetic fields and infra-red radiation into electrical voltages were shown in commercial form by Plessey. The magnetic field detectors are based on the Hall effect and magneto-resistance effect respectively. They are particularly advantageous 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.

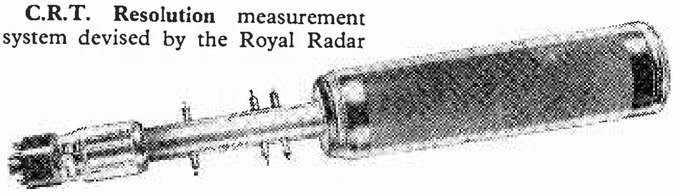
Two-Colour Radar Tube, also exhibited by Ferranti, has two phosphors, one of which lights up blue with relatively few sweeps of the spot while the other lights up magenta after a greater number of sweeps. This makes it possible to distinguish moving objects from fixed objects by colour differentiation. 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.

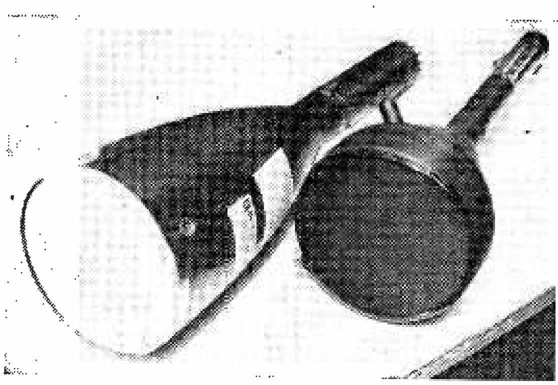
C.R.T. Resolution measurement system devised by the Royal Radar Establishment is based on a new parameter called "spatial frequency response." It avoids the uncertainties resulting from the common practice of specifying resolution in terms of spot size (arising from the spot's lack of sharply defined 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.

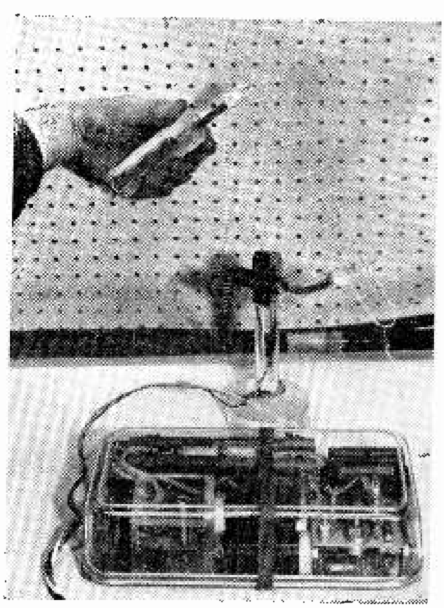
A wide variety of sweep, trigger and measurement facilities are available in the new E.M.I. WM7 prototype. Either a squared graticule or calibrated deflection dials may be used to measure voltages and times to within ±2%. Triggering at frequencies up to 50Mc/s at a variable level is also possible. The 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.

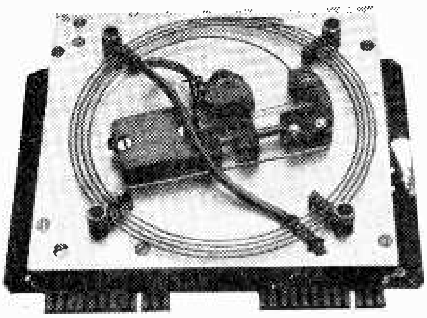
R, C and L Measurement.—Two-way switches in each of the probes allow selection of any of the 4 ranges up to 100 MΩ in the Rank-Cintel prototype resistance and insulation tester. An aural alarm indicates a short circuit between the probes.

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 ±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.

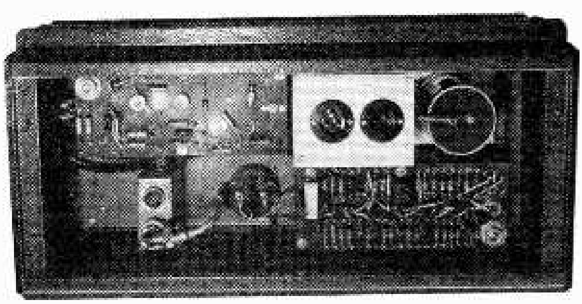
An r.f. multi-ratio transformer arm admittance bridge (Type LE 300) was shown by Hatfield Instruments. Input frequencies from 15 kc/s to 15 Mc/s may be used.

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

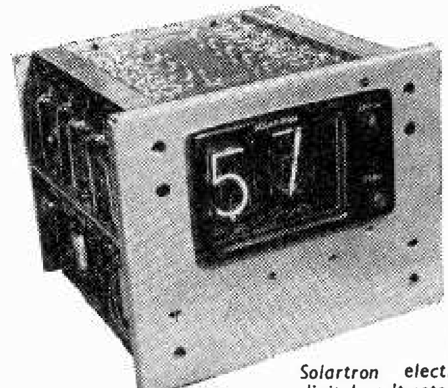


Torsional-wave wire acoustic delay line (Ferranti).

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.

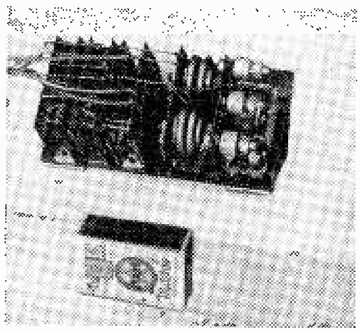
number. The unknown voltage is compared with the digital voltages in a suitable electronic switching sequence until a minimum or zero difference is obtained, the display number set up then being the nearest to the unknown number of volts. This was basically the arrangement used by Ferranti and Metropolitan-Vickers. 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

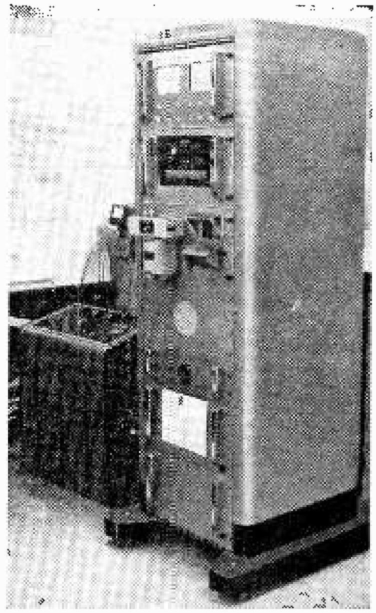


Fortiphone miniature transistor radar marker generator.

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.

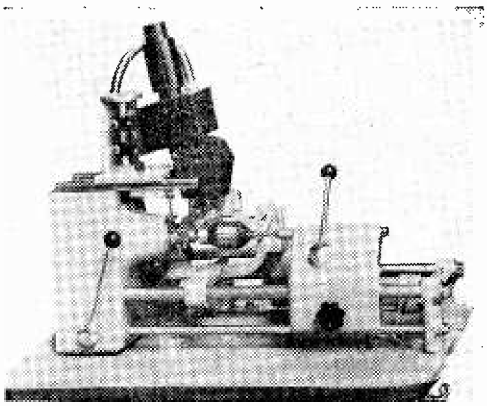


Magnetic recording electromyograph (St. Thomas's Hospital).

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 ¼ 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.

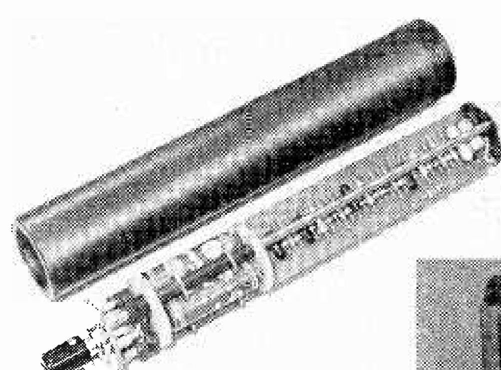
Transistorized Metal Locator.—Particularly notable for neat construction was the Rank-Cintel metal detector and cable route or pipe route tracer.

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.

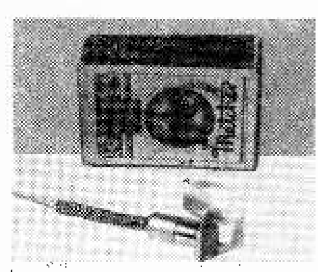
Ultrasonics. The Ultrasonoscope Company have produced some small probes for their flaw-detecting equipment primarily for use in situations where space is very limited, e.g., between turbine blades.

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



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

Below: Miniature ultrasonic flaw detector probe (Ultrasonoscope).



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.

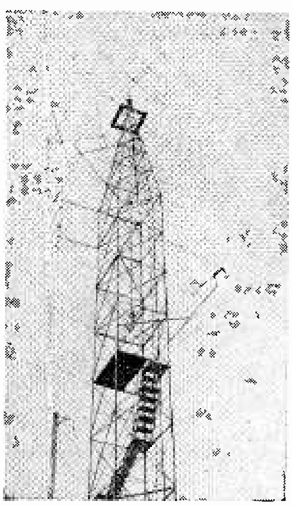
LETTERS TO THE EDITOR

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

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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

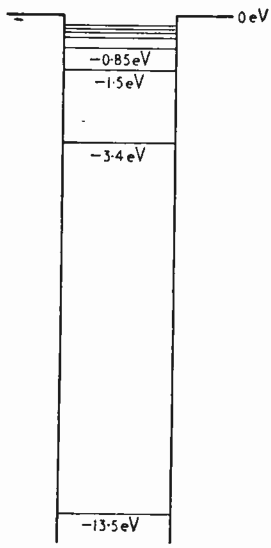


Fig. 1. In this "well" form of diagram are shown the possible energy levels in the "spherical" series of electron states of a hydrogen atom, which are terms in the series $-13.5/n^2$, n being any whole number. The negative sign is used because the most convenient zero level is the energy that parts the 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.

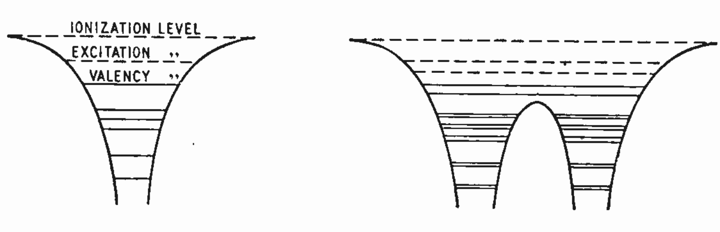
to a higher level by the arrival of the appropriate amount of energy from somewhere. It usually stays at the upper level for only a fraction of a microsecond (there are some exceptions) before dropping back and giving up the extra energy. Such energy is radiated as a "photon", and because the amount 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.

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).



(a) (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.

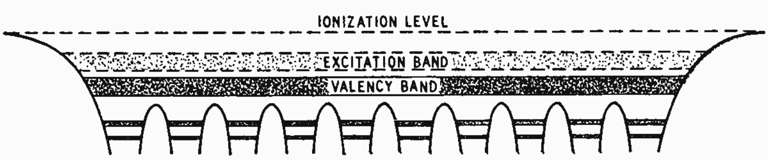


Fig. 3. In solids, enormous numbers of atoms (represented here by a mere ten) are close together, and the single energy levels are multiplied into practically continuous bands, of which those from the valency level upwards can be regarded as common to the whole piece.

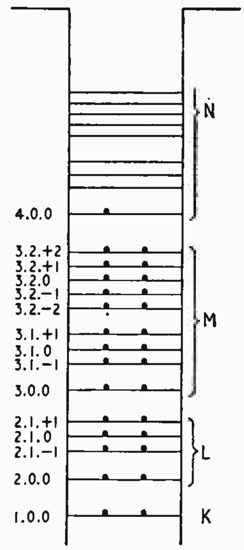


Fig. 4. Occupied energy levels (not to scale) in a single atom of copper at a low temperature. The markings on the left are the quantum numbers; on the right, the "shell" designations.

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

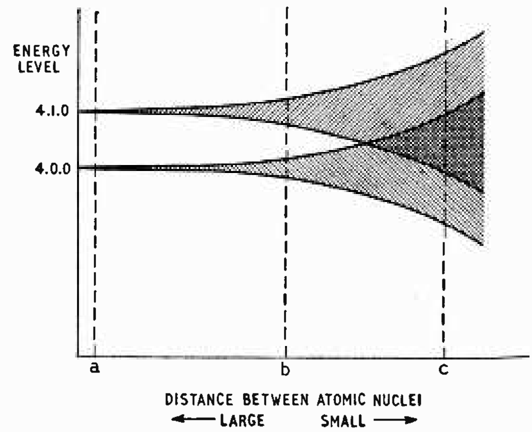


Fig. 5. Another way of showing how bringing very many atoms close together, as in solids, broadens the discrete energy levels (a) of the separate atoms into bands (b). If the spacing is close enough, bands may overlap (c).

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.

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

	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

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.

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 α_{cb} = 70 was used in practice.

*For the component values given in Fig. 9 it can be shown by calculation[3] 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.

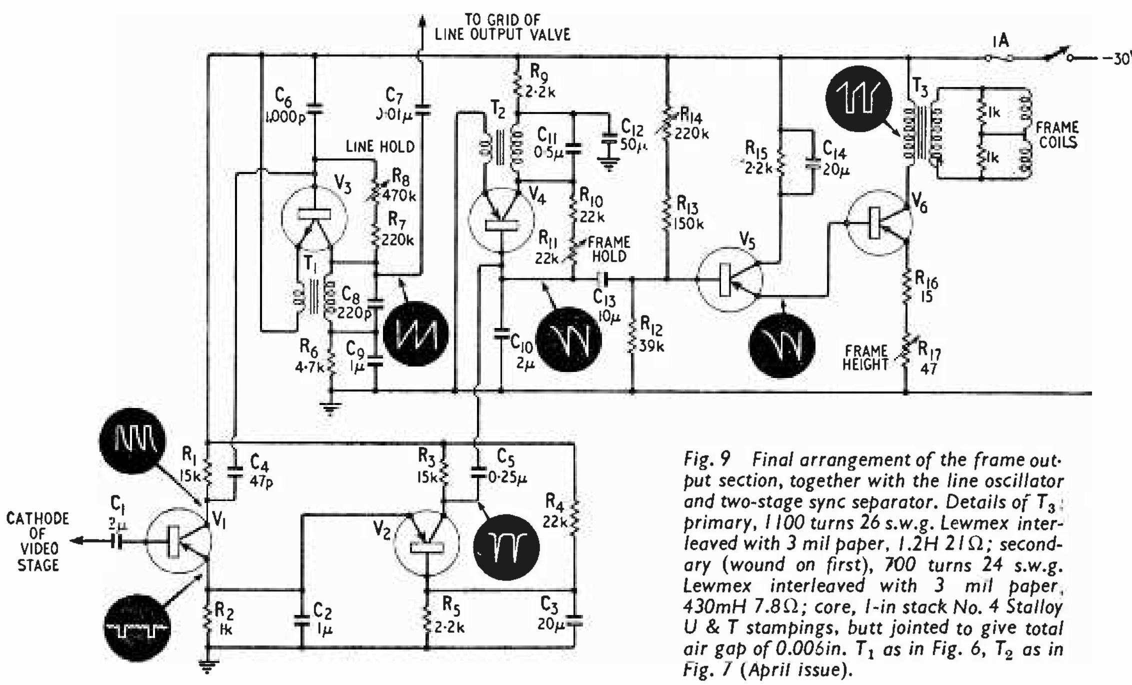


Fig. 9 Final arrangement of the frame output section, together with the line oscillator and two-stage sync separator. Details of T_3: primary, 1100 turns 26 s.w.g. Lewmex interleaved with 3 mil paper, 1.2H 21Ω; secondary (wound on first), 700 turns 24 s.w.g. Lewmex interleaved with 3 mil paper, 430mH 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.)

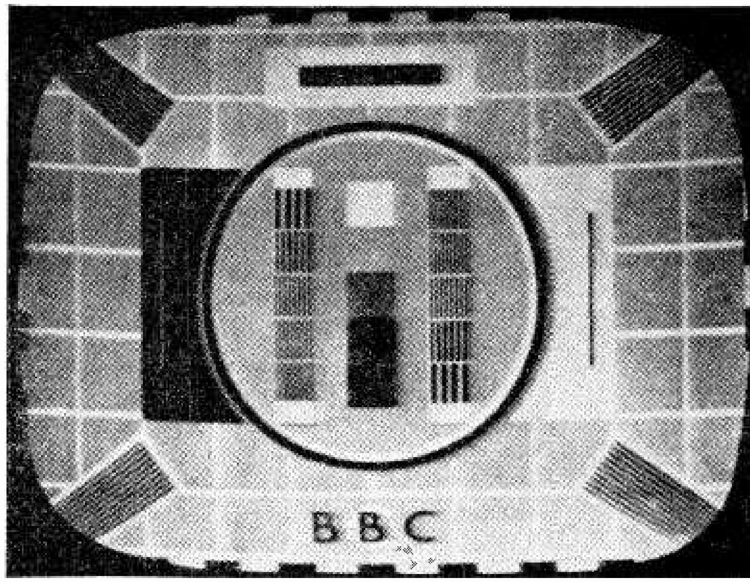


Fig. 10. Picture of Test Card C obtained with the Fig. 9 transistor circuits in the modified 17-inch receiver.

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:

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

[6] "Circuit Techniques Associated with Transistor Broadcast Receivers," Part II, by J. N. Barry. *Electronic Engineering*, October 1957, pp. 478-483.
[6] "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.
[7] "Retrace Driven Deflection Circuit," by W. B. Guggi. *I.R.E. Transactions on Broadcast and Television Receivers*, No. 3, October 1956.

[8] "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, $I_c = 1$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 back-biases 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.

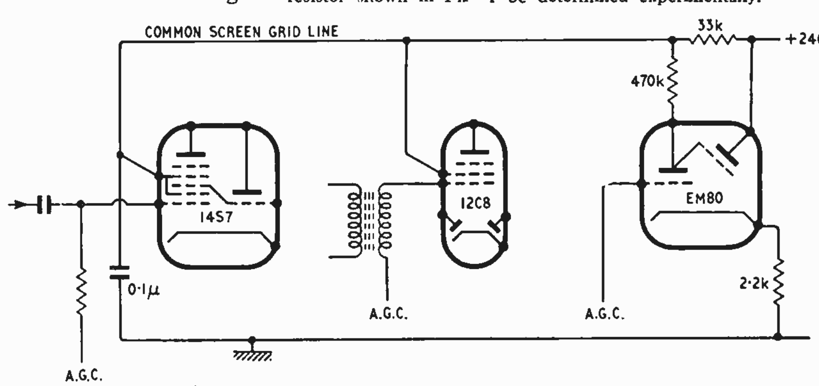


Fig. 1. "Sensitive" connection for the EM80 in an a.m. receiver

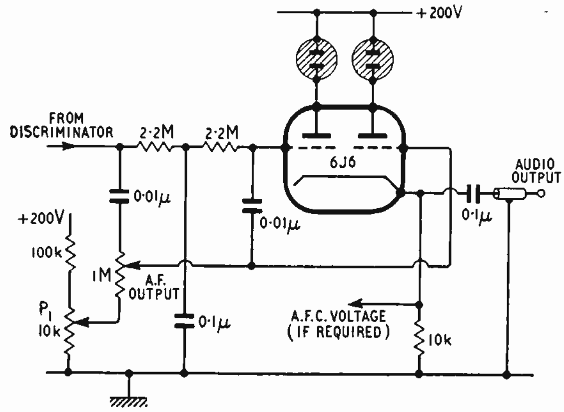


Fig. 2. Combined f.m. tuning indicator and output cathode follower.

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.

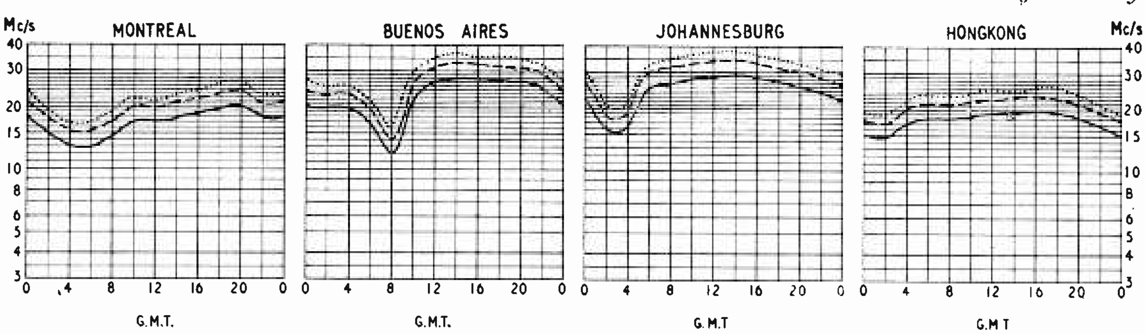
It occurred to the writer that to use a double triode for the tuning indicator alone was rather wasteful, especially when another triode is used as a cathode follower to feed the audio output cable. Therefore an effort was made to use the tuning indicator amplifier as the output cathode follower. The 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.

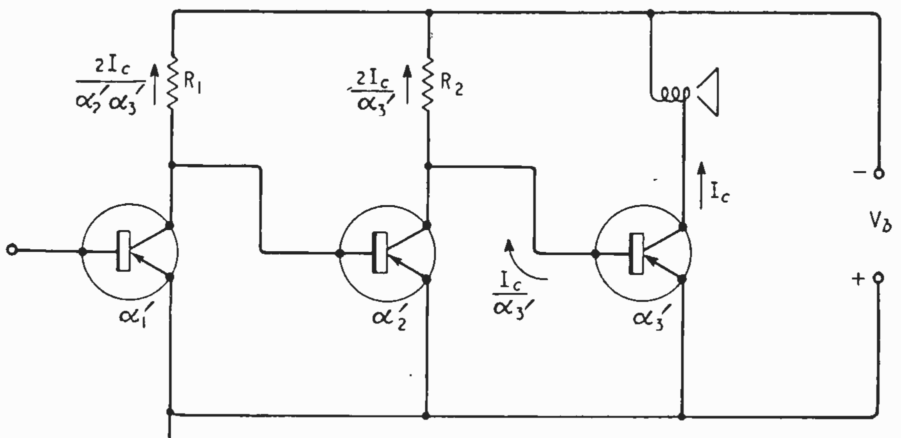


Fig. 1. Basic circuit of direct-coupled amplifier.

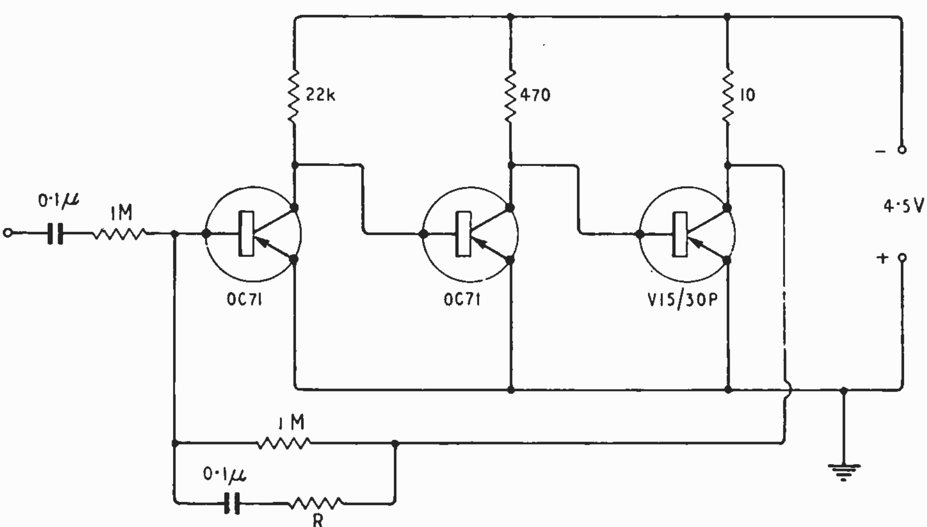


Fig. 2. Practical direct-coupled amplifier with feedback.

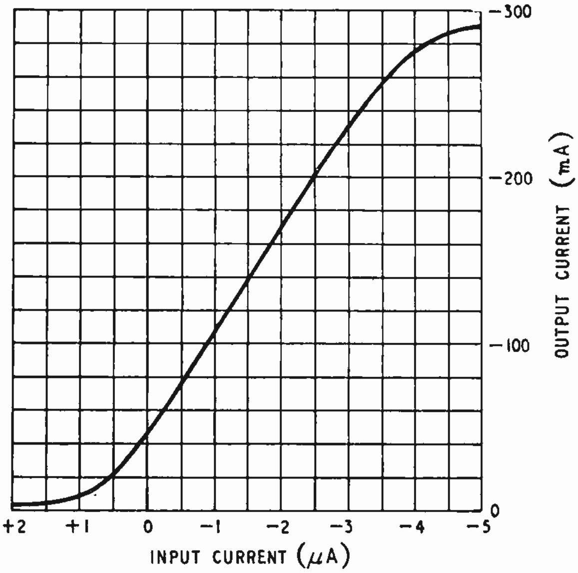


Fig. 3. Overall current transfer characteristic of the amplifier of Fig. 2 with no feedback.

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:—

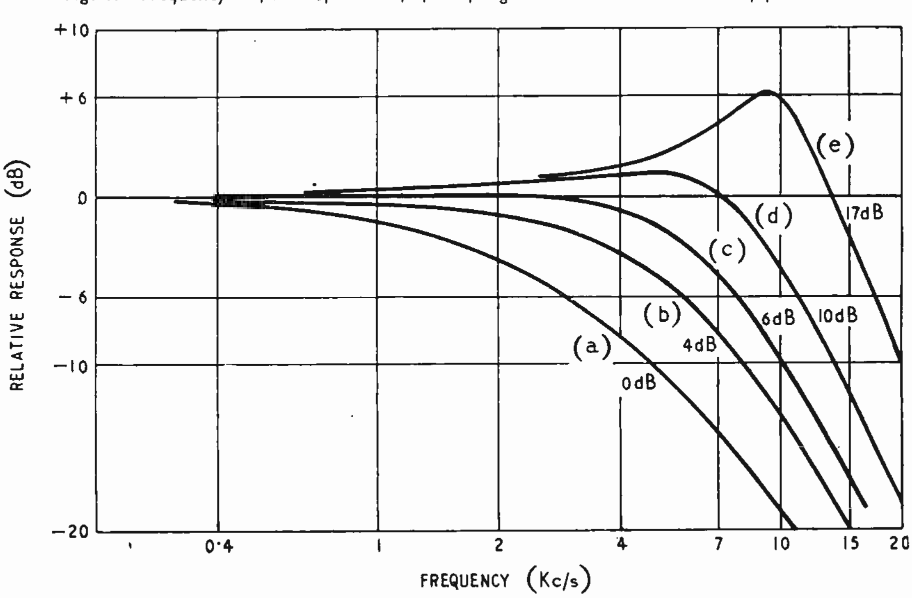
Curve (a) Feedback path broken.
„ (b) With d.c. feedback, equivalent to 4dB gain reduction.
„ (c) With R=1MΩ, equivalent to 6dB gain reduction.
„ (d) With R=330kΩ, equivalent to 10dB gain reduction.
„ (e) With R=100kΩ, equivalent to 17dB gain reduction.

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!

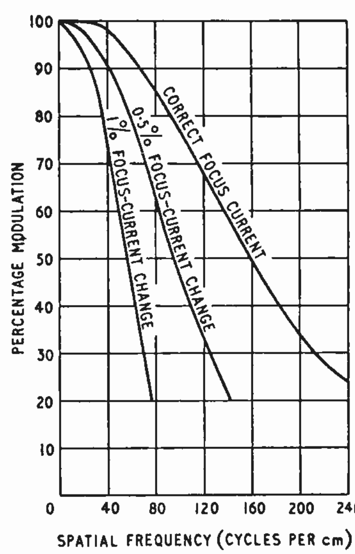
Technical Notebook

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

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

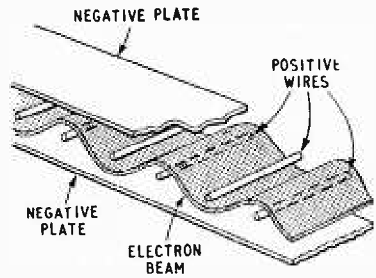
where q is the charge of the anode-cathode capacitance; $v = V \sin \omega t$, the applied input voltage; and f_c is the "critical" frequency $\frac{1}{2}\pi RC$ (where RC is the time-constant of the charge of the capacitance). This upper limit of mutual conductance was suggested in the curve given in 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_4C_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

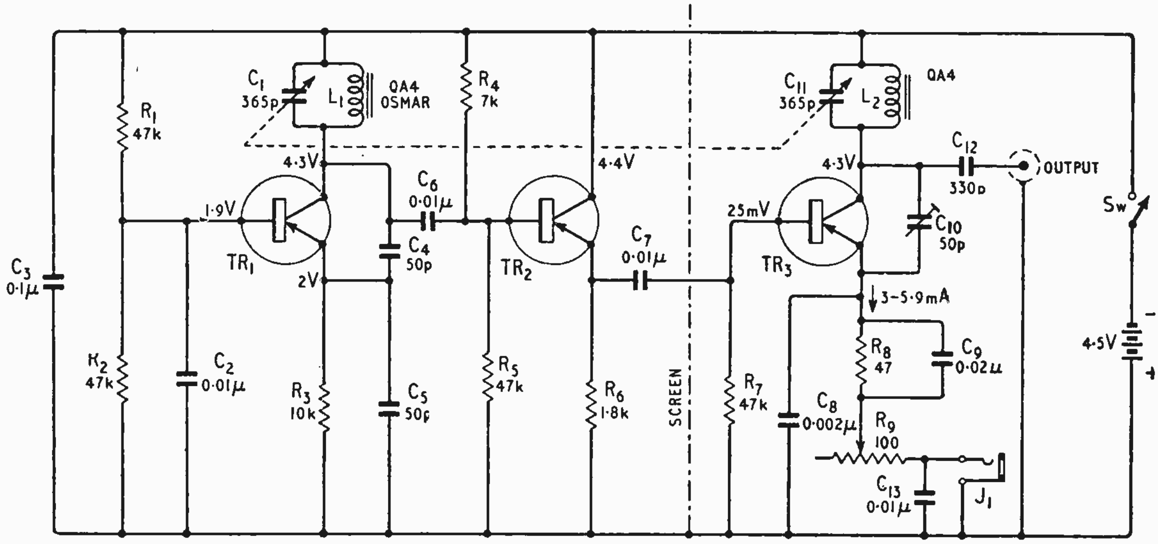


Fig. 1. Circuit of the transistor transmitter. Resistors can be ¼-W type and capacitors the lowest rating obtainable above 6 volts.

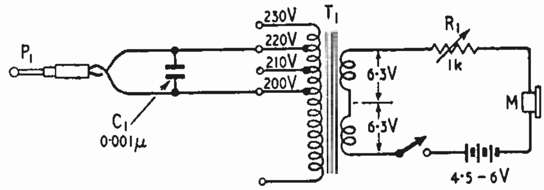


Fig. 2. Circuit of a simple R/T modulator for the transmitter.

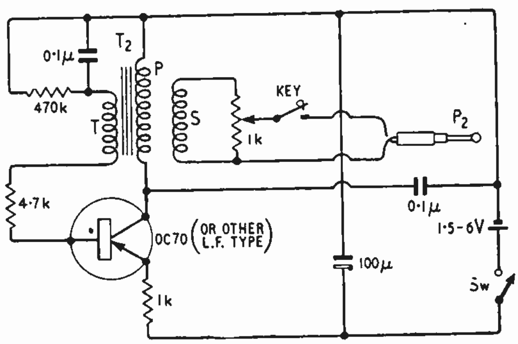


Fig. 3. Transistorized m.c.w. modulator for the transmitter. Details of the transformer T_2 are given in the text.

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

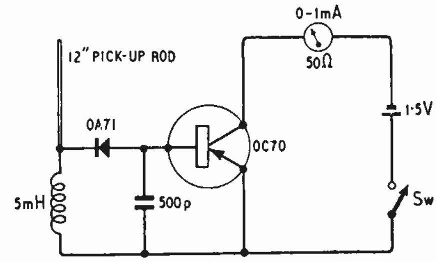


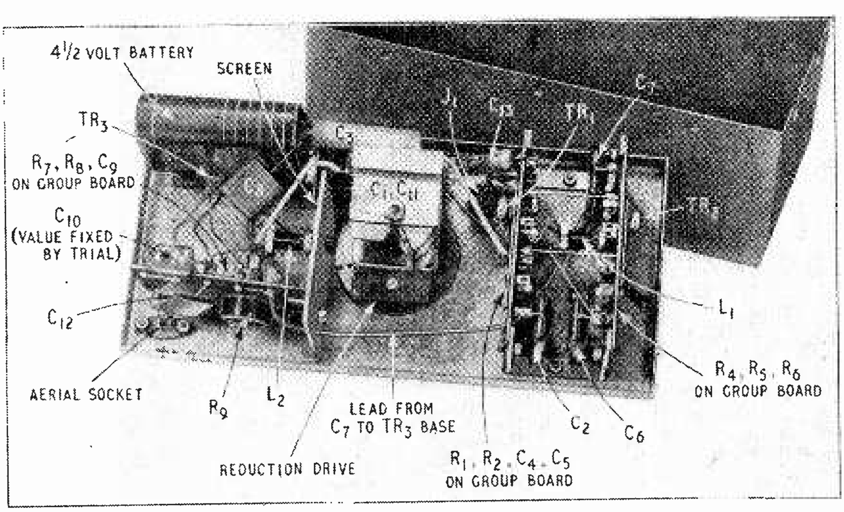
Fig. 4. A simple transistor field-strength meter can be made with this circuit.

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



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.

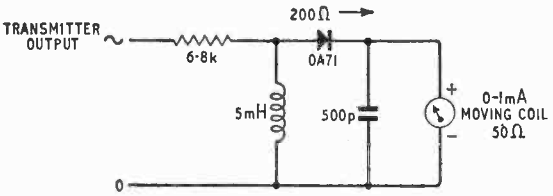


Fig. 5. Simple output meter for aligning the transistor transmitter.

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.

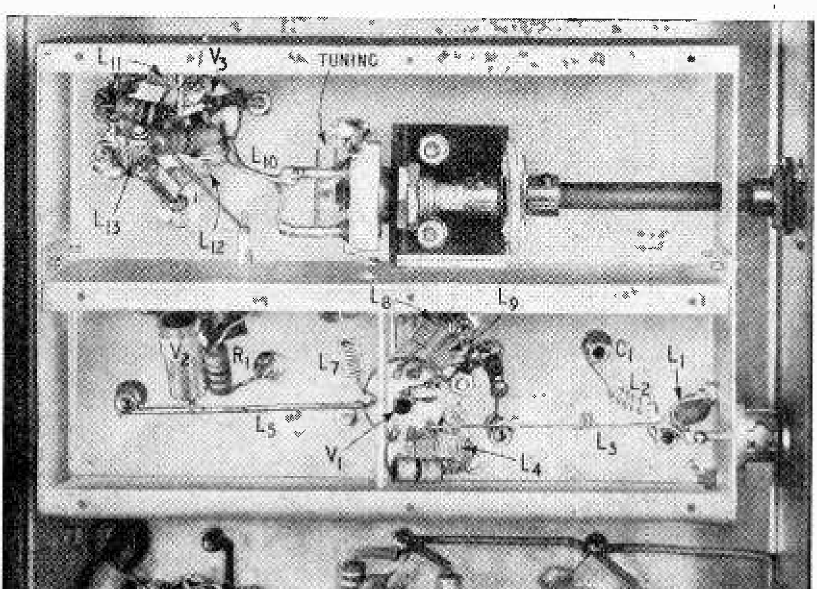
The use of Lecher lines or resonant cavities for the u.h.f. circuits, and a separate u.h.f. oscillator, would give an improvement in the noise factor of 16 to 18dB. Experimental models have been described which are much better than this, down to 10 to 11dB, but these are not in commercial use at present.

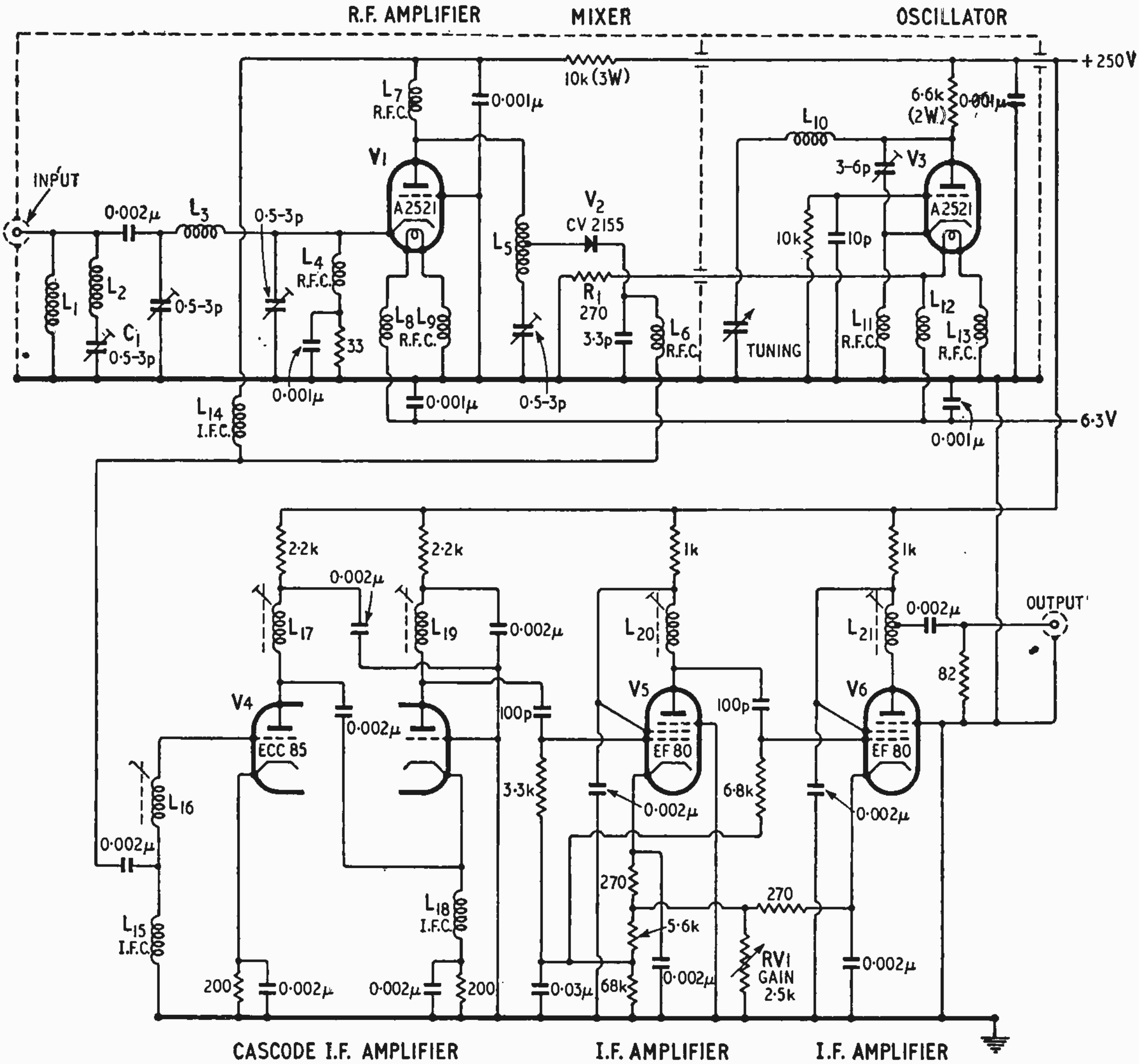
The addition of an r.f. amplifier stage will permit a worth-while improvement in the noise factor, but only a few valves really suitable for this application are available. The older disc-seal triodes achieve their performance by running with high anode currents, and it is necessary to use them in conjunction 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, ⅜in 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 5/16in diameter moulded former.
L_{16}	18¼ turns No. 28 s.w.g. En. closewound on 5/16in 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.

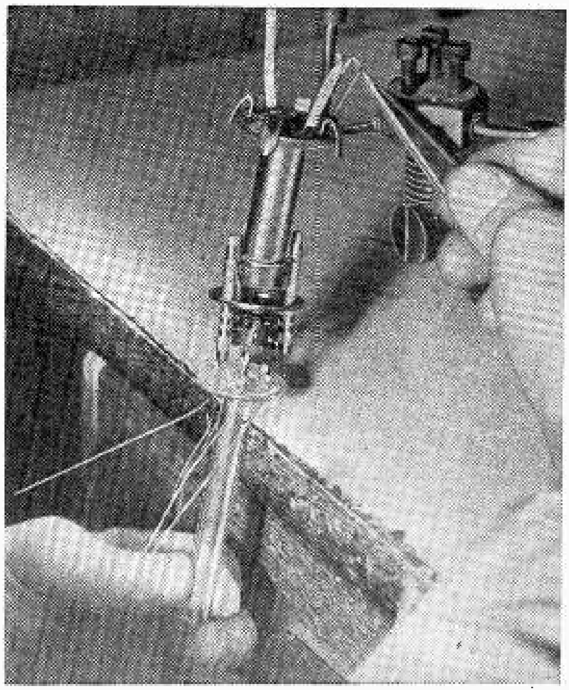
Stockport-Manchester Rally.—A joint rally is being organized for May 18th by the Stockport Radio Society and South Manchester Radio Club. It is planned to include a mobile field-strength competition and a "walking" d.f. contest. Particulars are obtainable from C. M. Denny, 18, Willoughby Avenue, Didsbury,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

"NEW TUBES FOR OLD"

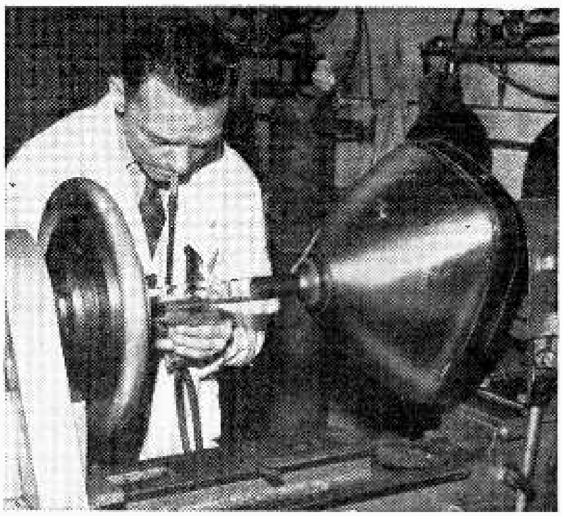
THE cry of the modern versions of Aladdin's magician uncle who offer to renovate worn-out cathode-ray tubes may be regarded with some suspicion by the more technically-minded television viewers. Terms like "reconditioning" and "renovating" in advertisements can mean various things, and even the more 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



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



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

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.

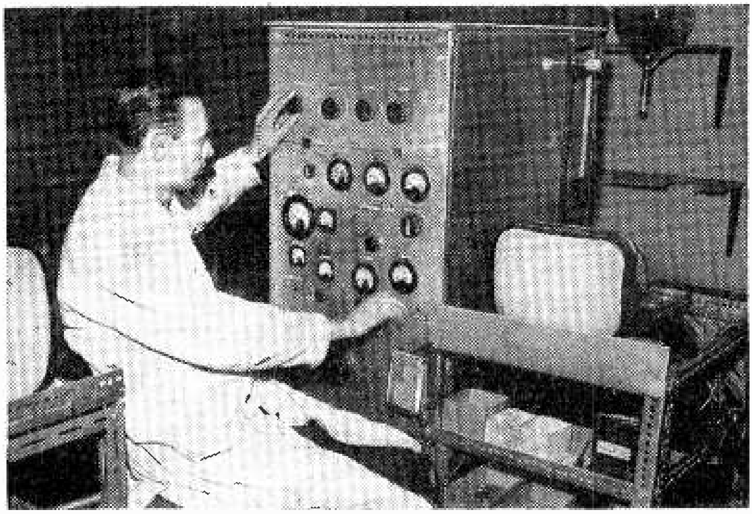
When the inside and outside pressures have been equalized the glass pinch is parted from the tube neck and the electrode assembly mounted on it is withdrawn. The glass pinch itself is removed from the electrode support wires and the cathode and heater assembly is taken out of the electron gun. The coiled 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).

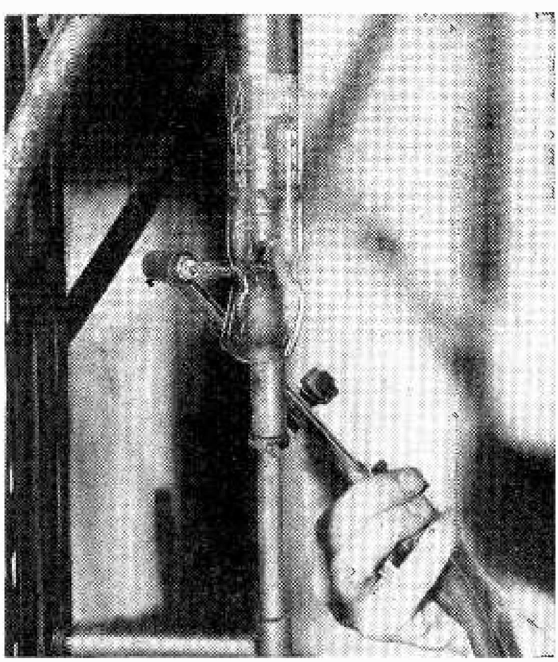


Test equipment for the completed tubes.

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.

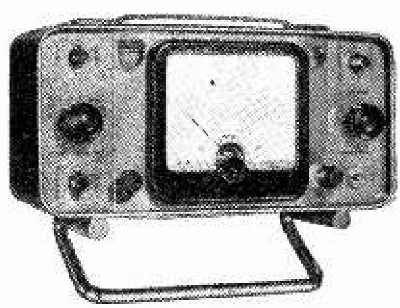
One point which particularly impressed *Wireless World* was the high degree of individual skill and craftsmanship required in this sort of work. The reconditioned tubes are virtually hand-made jobs, comparable with those produced in the early days of television. There seems no reason why they should 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!

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 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.



Amos of Exeter transistor d.c. voltmeter.

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.