MARCH 1956 Hardie. TWO SHILLINGS

Wireless World

ELECTRONICS
Radio · Television

FORTY-FIFTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

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Slowing Down Television

ANTI-inflationary measures recently imposed by the Government have borne heavily on radio and allied interests. The increase in hire-purchase deposits has already had an appreciable effect on the sales of domestic sound and vision broadcast receivers. But, though it has had less publicity, the reduction in capital expenditure in television transmission may, in the end, prove of greater significance. As the Postmaster-General has announced, the Government have decided to defer for two years consideration of the applications from both the B. B. C. and I. T. A. for permission to start alternative television programmes.

This probably represents a heavier cut in capital expenditure than that imposed on any comparable activity. But, taking the long view, the slowing-down of television development may prove to be a blessing in disguise. If a four-programme national service were established, it would be even more difficult than at present to make any change in transmission standards. There is always the possibility that a radical change from present standards may become desirable for transmission in colour.

National Electronics Show

THE idea of a large-scale "professional" electronics exhibition, covering all aspects of radio and its offshoots except domestic broadcast receivers, seems to have been brought a stage nearer fulfilment. The Radio Communication and Electronic Engineering Association, representing the "heavy" side of the industry, recently stated that they had invited other associations within the industry to consider the organizing of a "comprehensive electronics exhibition" worthy of all the important interests that it would represent.

As things are at present, there is no regular exhibition that covers the products of many of the member-firms of R. C. E. E. A. For instance, the makers of radio communication equipment can only show their products at exhibitions devoted to shipping, aviation and various other acivities. The broadcast receiver industry is already well catered for by the annual National Radio Exhibition and it seems to us that the other applications of electronics could between them well support a show of similar calibre.

Frequency Allocations

IT was recently announced that R. C. E. E. A. has formed a Frequency Planning Advisory Committee, with the object of putting forward a scheme for the allocation of frequencies in the United Kingdom. The committee has already had a meeting with the Post Office authorities, and, among other things, has been asked to state its views on what frequencies should be reserved for "scatter" transmissions.

In our opinion, direct representation of the industry in matters of frequency allocation has been long overdue. In particular, there is a growing feeling that, under the present system of Post Office allocation, the Armed Services get more than their fair share of the available radio channels. There seem to be some slight grounds for hoping that this co-operation between the Post Office and industry may lead eventually to a less autocratic system of frequency allocation.

EXPLANATION TO OUR READERS

As *Wireless World* is normally printed in London, production of the journal has been seriously affected by the printing trade dispute which resulted in a complete stoppage in that area.

Arrangements for the present issue, which has had to be printed in France, were inevitably difficult and complicated. We offer our sincere apologies to those who may have been inconvenienced by the long delay in publication but hope they will appreciate that no effort has been spared to keep faith with our readers.

COMPONENTS SHOW

A STILL greater number of firms (see below) are exhibiting at this year's exhibition of components, valves and test gear organized by the Radio and Electronic Component Manufacturers' Federation. It will again be held at Grosvenor House, Park Lane, London, W.1, and will be open daily from April 10th to 12th at 10.0 a.m. It will close at 6.0 on the first two days and at 5.0 on the last. There will be a preview on the 9th.

Admission is restricted to wearers of an official badge obtainable by engineers and technicians in the "user" industries, research and the Services, on application to the R.E.C.M.F., 21, Tothill Street, London, W.1.

A B Metal Products
A.K. Fans
Advance Components
Aerialite
Aero Research
Allan Radio
Anglo-American Vulcanized Fibre
Antiference
Automatic Coil Winder
B I. Callenders Cables
Bakelite
Belling and Lee
Bird, Sydney S.
Bray, Geo
British Communications and Electronics
British Electric Resistance
British Moulded Plastics
British Physical Laboratories
Bulgin
Bullers
Carr Fastener
Clarke and Co. (Manchester)
Collaro
Colvern
Connollys (Blackley)
Cosmocord
Creators
Daly Condensers
Darwins
Dawe Instruments
De La Rue
Diamond H. Switches
Dubilier
Duratube and Wire
Edison Swan
Egen Electric
Electro Acoustic Industries
Electro-Methods
Electronic Components
Electronic Engineering
Electrothermal Engineering
English Electric
Enthoven Solders
Erg Industrial Corp.
Erie Resistor
Ever Ready
Ferranti
Film Industries
Fine Wires
Fortiphone
G.E.C.
Garrard
Goldring
Goodmans
Gresham Transformers
Guest, Keen and Nettlefolds
Haddon Transformers
Hallam, Sleigh and Cheston
Hassett and Harper
Hellermann
Henley's
Hunt (Capacitors)
Igranic
Imhof
Insulating Components and Materials
Jackson Bros.
J. Beam Aerials
Labgear
Langley
Linton and Hirst
Lion Electronic Developments
London Electrical Mfg.Co.
London Electric Wire Co.
Long and Hambly
Lustraphone
Magnetic and Electrical Alloys
Mallory Batteries
Marconi Instruments
Morrison and Catherall
McMurdo Instrument Co.
Measuring Instrument (Pullin)
Mica and Micanite Supplies
Micanite and Insulators
Minnesota Mining and Mfg.Co.
Morganite Resistors
Mullard
Multicore Solders
Murex
Mycalex and T.I M.
Neill and Co., James
N.S F.
Oliver Pell Control
Painton
Parmeko
Partridge
Permanoid
Plannoir
Plessey
Pye
Radio Instruments
Reliance Electrical Wire Co.
Reproducers and Amplifiers
Rola Celestion
Ross, Courtney and Co.
S.T.C.
Salford Electrical Instruments
Salter, Geo.
Sankey, Joseph
Scott, Geo. L.
Simmonds Aerocessories
Sims, F.D.
Spear Engineering Co.
Stability Radio Components
Standard Insulator Co.
Static Condenser Co.
Steatite and Porcelain Products
Stocko
Stratton
Suflex
Swift, Levick and Sons
Symons and Co., H. D.
Taylor Electrical Instruments
Technical Ceramics
Telcon-Magnetic Cores
Telegraph Condenser Co.
Telegraph Construction and Maintenance Co.
Telephone Mfg. Co.
Telerection
Thermo-Plastics
Truvox
Tucker Eyelet Co.
Tufnol
United Insulator Co.
Vactite Wire Co.
Vitavox
Walter Instruments
Wandleside Cable Works
Wego Condenser Co.
Welwyn Electrical Laboratories
Westinghouse
Weymouth Radio Mfg. Co.
Whiteley Electrical Radio Co.
Wiggin and Co., Henry
Wimbledon Engineering Co.
Wingrove and Rogers
Wireless Telephone Co.
Wireless World and *Wireless Engineer*
Woden Transformer Co.
Wolsey Television
Wright and Weaire
Zenith Electric Co.

BOOKS RECEIVED

Colour Television Standards by Donald G. Fink. Collection of papers and records of the National Television System Committee of America dealing with basic principles and field tests of compatibility, colour performance and practical transmitters and receivers. Pp. 520; Figs. 272. Price 64s. McGraw Hill Publishing Company, 95 Farringdon Street, London, E.C.4.

Reproducing Equipment for Fine-groove Records by G. V. Buckley, A.M.I.E.E., W. R. Hawkins, Grad. I.E.E., H. J. Houlgate, A.M.I.E.E. and J.N.B. Percy, M.Sc., A.M.I.Mech.E. B.B.C. Engineering Monograph, No. 5 describing the Type DRD/5 reproducing desk which incorporates an optical magnifying position indicator and a quick-starting mechanism for the turntable. Pp. 19; Figs. 8. Price 5s. B.B.C. Publications, 35 Marylebone High Street, London, W.1.

Magnetic Recording Handbook by R.E.B. Hickman. A practical manual of magnetic recording as applied in domestic, business and professional machines, including sound film projectors. Pp. 176 + VII; Figs. 109. Price 21s. George Newnes, Ltd., Southampton Street, London, W.C.2.

Electrical Interference by A.P. Hall, Grad.I.E.E. Discusses the origins, nature and measurement of radiation from electrical appliances and the design and construction of suppression filters. Pp. 122 + VII; Figs. 100. Price 15s. Heywood and Company, Ltd., Tower House, Southampton Street, London, W.C.2.

Radio Amateur Operators' Handbook, 3rd Edition, 1956. A compendium of useful information including codes and current abbreviations, amateur prefixes, zone boundaries etc. Pp. 46; Figs. 9. Price 3s. Data Publications, Ltd., 57 Maida Vale, London, W.9.

Points on Pickups by F. Wilson. Revised edition of an illustrated guide to the principal pickup cartridges available in this country with details of replacement styli and their cost. Pp. 34. Price 3s. A.C. Farnell, Ltd., 15 Park Place, Leeds, 1.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

Balance of Trade

ANNOUNCING the radio industry's exports for 1955 the Radio Industry Council states that the provisional figure £32.93M, which is more than three times the 1947 figure, is an increase of £3.75M on the 1954 total.

By far the largest contribution towards this record figure was made by the " heavy " side of the industry; transmitters, radio navigational aids and industrial electronic equipment accounting for £12.91M. The value of components and test gear exported was £7.51M, about £800,000 up on 1954.

The increase of recent years in the export of sound reproducing equipment was continued and last year's figure £5.73M was over £2M more than 1954.

Overseas sales of sound and television receivers and radiogramophones were valued at nearly £4M, some £300,000 more than the previous year, and valves and parts rose by £200,000 to £2.82M.

There is, however, the other side of the picture. Whilst direct exports of radio and electronic equipment produced in the United Kingdom rose by £3.75M, imports of radio equipment increased by over £5M. It will be seen from the following figures, taken from the Customs and Excise accounts, where the greatest increase occurs.

	1954	1955
Valves	1.69	2.49
Cathode-ray tubes	1.64	1.17
Communication and navigation gear	1.65	1.54
Sets, components and parts of valves and c.r. tubes	2.97	7.89
	£7.95M	£13.09M

Amateur 7-Mc/s Band

AS from March 1st amateur operation in the 40-metre band in the U.K. is limited to 7.0-7.15 Mc/s. The first 100 kc/s is now exclusively for amateur use and the remaining 50 kc/s is shared with other services, mainly broadcasting stations. The frequencies between 7.15 and 7.30 Mc/s are no longer available to amateurs. These changes are in conformity with the Atlantic City agreement, and this is the last amateur band to be regularized.

The Radio Society of Great Britain has asked the Post Office for an assurance that 7.0-7.1 Mc/s is kept exclusively for amateurs. If this is forthcoming then amateurs will have gained considerably from what at first appears to be a curtailment. The fact is, of course, that up to now the 7-Mc/s band has been of little or no value to amateurs because of "intrusions".

Audio Fair

AS already announced London's first Audio Fair will be held in April at the Washington Hotel, Curzon Street, W.1. Below we give the final list of exhibitors who, with the exception of the journals, have all booked demonstration rooms which will now occupy three whole floors.

Admission to the Fair, which will be held on the 13th, 14th and 15th, is by invitation card obtainable free from radio dealers or from the organizing committee at 17, Stratton Street, London, W.1. The opening hours are from 11 to 9.

Acoustical
Armstrong
Collaro
Cosmocord
Decca
E.M.I.
Garrards
G.E.C.
Goldring
Goodmans
Grampian
Gramophone Record Review
Grundig
H.M.V.
Leak
Lowther
Lustraphone
M.S.S. Recording
Mullard
Pamphonic
Philips
Plessey
Pye
Record News
Reslosound
Rogers Devlopment
Rola Celestion
R.C.A. Photophone
Simon
Specto
Sugden
Tannoy
The Gramophone
Thermionic
Trix
Truvox
Vitavox
Wharfedale
Whiteley
Wireless World and *Wireless Engineer*
Wright and Weaire

South Devon TV

ALTHOUGH the high-power transmitters have now been brought into service at the B.B.C. North Hessary Tor television station the e.r.p. is still considerably below the ultimate 16 kW. This is because the temporary aerial on the 150-ft mast is still being used; the completion of the permanent aerial on the 750-ft mast is being held up by manufacturing delays. It is understood the permanent mast and aerial — which will be directional — will be installed by the late spring.

North Hessary Tor radiates in Channel 2 (vision 51.75 Mc/s, sound 48.25 Mc/s) with vertical polarization.

PERSONALITIES

Professor G.W.O. Howe, D.Sc., LL.D., M.I.E.E., who has been technical editor of, and latterly technical consultant to, our sister journal *Wireless Engineer* for thirty years, has been awarded the Faraday medal by the I.E.E. for "his pioneering work in the study and analysis of high-frequency oscillations and on the theory of radio propagation; and for his outstanding contributions to engineering education". Dr. Howe, who was apprenticed to Siemens at Woolwich, went to Imperial College as a lecturer in 1905 and in 1921 was appointed James Watt Professor of Electrical Engineering at Glasgow University, a position he held until his retirement in 1946 when he was granted an emeritus professorship.

Sir Stanley Angwin, K.B.E., D.Sc. (Eng.), has been elected to honorary membership of the I.E.E. "in recognition of his outstanding life's work in the field of telecommunication, both national and international, and of his distinguished services to the Institution". Sir Stanley, who is now chairman of the Commonwealth Telecommunications Board, was engineer-in-chief of the Post Office from 1939 to 1946. During his forty years with the Post Office he was closely associated with radio communication development, playing a leading part in the design and construction of the Leafield, Cairo and Rugby radio stations and in the inauguration of the transatlantic telephone service.

Having reached retiring age, **W. S. Barrell** has relinquished the position of manager of the E.M.I. Studios which he has held for nearly ten years. His wide technical knowledge and long experience of recording — he has been with the company for thirty years — will, however, continue to be available to E.M.I. for he has been appointed group-recording technical liaison officer and will cover all technical matters common to E.M.I. recording studios overseas. He is succeeded by **E. Fowler**, who joined the company in 1924 and has been assistant manager for nine years. The new assistant is **B. Waite**, who joined E.M.I. in 1927.

L. C. Jesty, B.Sc., M.I.E.E., chief of the Television Research Group at the Marconi Research Laboratories, has been elected a Fellow of the American Institute of Radio Engineers for his "leadership and personal contributions in the development and evaluation of television systems". Before joining Marconi's in 1949, where he has been closely associated with the Anglicized versions of the N.T.S.C. colour television system, Mr. Jesty was for three years head of advanced research at the Cinema-Television Laboratories. From 1927 to 1946 he was at the G.E.C. Laboratories.

Prof. G. W. O. HOWE

L. C. JESTY

E. J. EMERY

D. H. FISHER

E. J. Emery, M.Brit.I.R.E., managing director of E.M.I. Sales and Service Limited, has been appointed a director on the main board of Electric and Musical Industries Limited. He joined the sea-going staff of Marconi's in 1916 and on the introduction of broadcasting in 1922 transferred to the Marconiphone Company which is now in the E.M.I. Group. Mr. Emery has been chairman of the City and Guilds advisory committee on radio and television since its formation before the war and is also chairman of the Radio Trades Examination Board.

Donald H. Fisher, a senior television research engineer with Pye since 1948, has joined United Components Limited, the manufacturing company for the Regentone and R.G.D. group, as chief engineer. Prior to joining Pye, where for the past four years he has been responsible for the design and production engineering of television receivers, he was for three years with E.M.I. Engineering Development working on defense projects and television development.

Dr. Harry F. Olson, the well-known American audio engineer who is director of the Acoustical and Electromechanical Research Laboratory of RCA Laboratories, Princeton, New Jersey, has received an award from the Engineer's Club of Philadelphia for his invention 25 years ago of the "velocity" microphone. The award includes a medal and a 1,000-dollar premium.

Among those recently invested by Her Majesty the Queen, with honours conferred in the New Year's list, was **Lt. Col. G. T. Evans**, technical adviser in the signals directorate at the War Office, who was appointed O.B.E. He was seconded to the War Office from the G.P.O.

D. P. B. Neave, B.Sc. (Eng.), M.I.E.E., who has been with Bush Radio for 22 years, has been appointed chief engineer to the company. He will continue to be directly responsible to the technical director, W. H. Harrison, who has been in charge of the Bush Radio laboratories and technical staff since the formation of the company in 1932.

After five years with the English Electric Company as chief television engineer, **D. W. Heightman**, M. Brit. I.R.E., has resigned to join Radio Rentals Limited as chief engineer to the group. Prior to joining English Electric, he was on the board of Denco (Clacton) Limited which he formed in 1938. Mr. Heightman, who has from time to time contributed articles on propagation to *Wireless World*, was in 1951 awarded the Clerk-Maxwell premium by the Brit. I.R.E. for his paper on "The propagation of metric waves beyond the optical range".

Two lecturers in the electrical engineering department of Imperial College, both of whom are radio engineers have been appointed to University readerships in electrical engineering which are tenable at the college. They are John **Lamb**, Ph.D., M.Sc., A.M.I.E.E., and John **H. Westcott**, B.Sc., Ph.D., A.M.I.E.E. Dr. Lamb, who graduated from Manchester University where he undertook extra-mural research for the Ministry of Supply, has been at Imperial College since 1946. He is 34. Dr. Westcott, who is 35, graduated from London University and undertook post-graduate research on servo-mechanisms at Imperial College and the Massachusetts Institute of Technology. Since 1950 he has been lecturing at Imperial College where he started the control systems laboratory in which he will continue to work.

W. H. Page and **S. J. Tyrrell** have been appointed joint managing directors of Rola Celestion Limited, the well-known loudspeaker manufacturers, of Thames Ditton, Surrey. They both joined Celestion in 1929 and have been directors of the company since the fusion with Rola. Mr. Tyrrell will continue to control design and manufacture and Mr. Page the sales organization.

E. H. Cooke-Yarborough, A.M.I.E.E., deputy head of the electronics division at the Atomic Energy Research Establishment, Harwell, which he joined in 1946, has been promoted to deputy chief scientific officer in the Scientific Civil Service. Before going to Harwell he was working on radio countermeasures and guided weapons. He is now concerned with the design of digital computers.

H. Reginald Adams, of the McElroy-Adams Manufacturing Group, has been invested by the President of the Polish Republic with the insignia of the Knight Officers Cross of the Order of Polonia Restituta. The award was made primarily for his radio assistance to Poland during the early part of the war.

OBITUARY

Dr. Eric C. S. Megaw, director of physical research at the Admiralty since 1951, died on January 25th at the age of 48. Prior to joining the Admiralty Signal and Radar Establishment in 1946, where he became superintendent of research, he was for sixteen years in the G.E.C. Research Laboratories, where he specialized in the study of transit-time oscillators. It was for his work on methods of generating ultra short-waves that he received the Duddell Premium of the I.E.E. He received his Doctorate of Science from Queen's University, Belfast, in 1946 and was appointed an M.B.E. in 1943.

H. C. Van de Velde, who relinquished his position as senior executive of the Marconi International Marine Communication Co. last autumn, but was retained as a consultant, died in January whilst on a tour of the company's Mediterranean and African establishments. He was 65. His association with radio began in the first world war, at the end of which he was chief wireless officer to the Canadian Air Force. In 1919 he joined Marconi's, of which he became general manager in 1935. A year later he was also appointed managing director of Marconi Marine. As president of the International Maritime Radio Committee (C.I.R.M.) he was well known in international circles as well as in this country, as was evidenced by the large congregation at the memorial service in Chelmsford cathedral.

The late H. C. Van de Velde

Dr. Greenleaf Pickard, the American electrical engineer and inventor, who can justly be included among the pioneers of wireless for his early work on the crystal detector and the radio compass, died in Massachusetts in January at the age of 79. He had held engineering appointments with a number of manufacturing concerns, including RCA Victor, before forming a consulting organisation.

IN BRIEF

Hire Purchase.— Sound and television receivers and radiogramophones are among the consumer goods for which the hire purchase deposit was increased by the Chancellor of the Exchequer from February 18th. A deposit of 50% instead of $33^1/_3$% is now necessary. This is the second increase in six months and the fifth change in four years. The Chancellor has also introduced a new restriction requiring nine months' rental to be prepaid on all rental agreements for receivers and radiogramophones.

I.T.A. Yorkshire.— The P.M.G. has announced that the I.T.A. Yorkshire transmitter, which is planned to be built on Emley Moor, between Huddersfield and Barnsley, will operate in Channel 10 (vision 199.75 Mc/s, sound 196.25 Mc/s). The P.M.G. had previously stated that plans have been made to clear a further two Channels and added "we are pursuing the problem of releasing the remaining three".

A.P.A.E. Show Cancelled.— The Association of Public Address Engineers announce that, in view of the Audio Fair to be held in London in April, it has been decided to cancel the Association's annual exhibition planned for the end of April. A.P.A.E. caters primarily for the public address industry, but as the Audio Fair is planned to cover both this and the domestic field the Association has decided to support the Fair.

C.C.I.R.— The revised dates of the 8th plenary assembly of the International Radio Consultative Committee, which is to be held in Warsaw, are August 9th to September 13th. In addition to the many technical questions on the agenda, the committee has to elect a new director. The term of office of the present director, Dr. Balth. van der Pol, who has held the position since 1948, was extended to cover the 1956 plenary assembly. The vice-director is L.W. Hayes who was with the B.B.C. prior to joining the C.C.I.R. in 1948.

Acoustics Congress.— The second international congress on acoustics, which is being organized in conjunction with the 51st meeting of the Acoustical Society of America, will be held in Cambridge, Mass., from June 17th to 23rd. The technical sessions will be devoted to bio-acoustics, noise control, architectural and musical acoustics, physical acoustics and sonics. Details of the congress, which is sponsored by the International Commission on Acoustics (International Union of Pure and Applied Physics) are obtainable from John A. Kessler, Massachusetts Institute of Technology, Cambridge, Mass.

A Convention on **digital-computer techniques** is being organized jointly by the Radio and Measurements sections of the I.E.E. It will be held at the Institution from April 9th to 12th and will be followed by visits to digital-computer installations on the 13th and 14th.

The Convention is open to non-members of the Institution on a payment of the registration fee of £1. Details and the registration form are obtainable from the I.E.E., Savoy Place, London W.C.2.

Another Festival of Sound is being arranged by G. A. Briggs, in collaboration with P. J. Walker. A concert of live and recorded music will be given in the Royal Festival Hall, London, on May 12th at 2.30. Tickets, price 8s 6d, 5s 6d and 3s 6d, are obtainable from "Hi-fi" dealers in London or direct from Wharfedale Wireless Works, Ltd., Idle, Bradford. Special recordings in the Festival Hall are being made by E.M.I. for the concert.

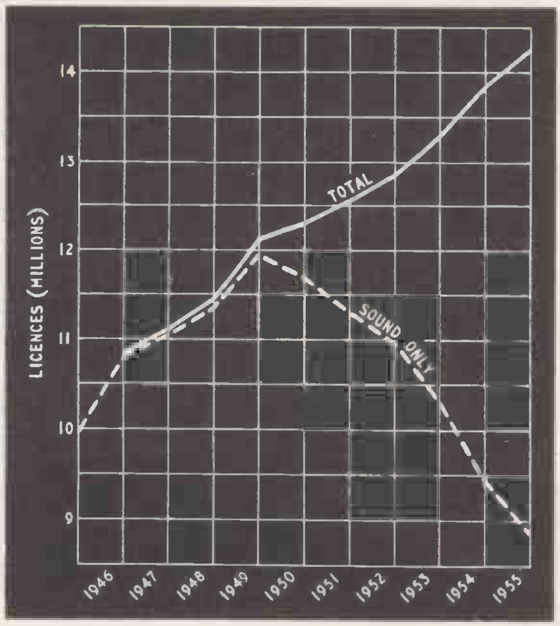
The now well-known test card of G9AED has been radiated by Belling and Lee from the site of the **Lancashire I.T.A.** transmitter since February 13th. The pilot transmitter, using a vision carrier of 194.75 Mc/s and a carrier of 191.25 Mc/s for the 600 c/s tone, radiates from 10 to 1 and 2 to 5.30 on Mondays to Fridays and from 10 to 1 on Saturdays. The 4-bay aerial, mounted 340ft above ground, provides a peak white e.r.p. of 1 kW.

Television Waveforms.— A tolerance of $\pm 3\%$ was shown against the amplitudes of B and B_1 in the tabular matter on the British television waveform given on page 26 of our January issue. To avoid ambiguity, the two amplitudes should have been bracketed with a common tolerance of $\pm 3\%$, for black level (B_1) is always 5% above suppression level (B).

Technical Authorship.— The Technical Publications Association, which was formed just over a year ago to promote the interchange of ideas between technical writers in industry, is collaborating with the City and Guilds of London Institute to etablish national examinations and certificates. Courses are being arranged by some educational authorities and a syllabus for a ten-week part-time course has been received from the College of Arts, Coventry. Particulars of membership of the Association are obtainable from the Secretary, 46, Brook Street, London, W.1.

An international congress on **Microwave Valves** (operating frequencies above 500 Mc/s) is to be held in Paris from May 29th to June 2nd. Organized by the Société des Radioélectriciens and the Société Française des Ingénieurs Techniciens du Vide, it will be held at the Conservatoire National des Arts et Métiers, 292, rue Saint-Martin, Paris-III^e.

C.I.R.M.— The London office of the International Maritime Radio Committee, which was temporarily in Ingersoll House, Kingsway, is now established at Ludgate House, Fleet Street, E.C.4 (Tel.: Fleet Street 7111). This is now the office of the recently appointed general secretary, J. D. Parker.



DECEMBER's INCREASE of 138,384 in the number of television licences brought the total to 5,400,083. The number of sound licences was 8,848,297 (including 289,455 for car radio) which gave an overall total of 14,248,380. The increase in the number of television licences in the United Kingdom during the past ten years is shown by the divergence of the two curves. The full line shows the total number of broadcast receiving licences and the dotted line the number of sound-only licences.

INDUSTRIAL NEWS

An international instrument show is again being organised by B and K Laboratories, Ltd. It will be held at Denison House, Vauxhall Bridge Road, London, S.W.1, from May 7th to 18th. Tickets for the Show, which will include equipment by United Kingdom and overseas manufacturers, are obtainable from B and K Laboratories, Ltd., 59-61, Union Street, London, S.E.1.

German Components.— R. H. Cole (Overseas) Ltd., of 2, Caxton Street, London, S.W.1 (Tel. Abbey 3061) have been appointed agents for this country for a variety of radio components manufactured by Siemens and Halske, of Munich, Germany. The components at present handled include selenium rectifiers and "Styroflex" polystyrene foil capacitors and a range of ferrite parts.

All **Plessey** switch production will eventually be transferred to the Company's new factory recently opened at Leigh Park Estate, Havant, Hants. A new type of rotary switch is already being manufactured at the works, which will eventually employ over 1,000 people.

The new headquarters of **Solartron Research and Development, Ltd.,** is at Goodwyns Place, Dorking, Surrey (Tel.: Dorking 4661). The floor space vacated at the Thames Ditton works will be utilized by the manufacturing side of the Solartron Group.

At an exhibition of instruments staged at the Hotel Russell, London, by the **Solartron Electronic Group** at the end of February the exhibits included not only instruments manufactured by Solartron but also foreign equipment. Among the overseas instrument manufacturers for whom Solartron are sole U.K. selling agents are Schomandl (Germany), Wandel u. Goltermann (Germany), Metrix (France), Metrawatt (Germany) and Denbridge (Denmark). Details of the activities of the five companies forming the Solartron Group are given in a 26-page brochure "Electronics and Solartron".

Nine tankers being built for the Eagle fleet and six Esso tankers are to be fitted with **Marconi** radio communication and navigational equipment. The new 8,400-ton cargo motor vessel **City of Ripon** is also fitted with Marconi gear.

A new 75-ton research vessel has been built for **Kelvin and Hughes**. She will be used mainly for research and development of radar and echo sounding equipment, and will have accommodation for a resarch staff of ten.

Transistor Operating Conditions

Finding the D.C. Working Point

By W. T. COCKING, M.I.E.E.

IT is a peculiarity of the transistor that it can be operated so that its collector voltage is almost zero at the peak of collector current, and it is this fact which accounts for its high power efficiency. It is not always realized that it also makes it possible to devise some very simple design procedures.

The characteristics of a junction transistor in the earthed-emitter connection have the form sketched in Fig. 1, in which is also shown a load line through the operating point V_cI_c. The load line joins the two points E_c and I and represents a resistance of value $R_L = E_c/I$. The difference between the zero-voltage scale and the transistor curves is, in reality, even smaller than in the sketch and, as an approximation, the collector voltage can be swung from V_c to zero on the one hand and to E_c on the other. In doing this, the current swings from I_c to I on the one hand and from I_c to zero on the other.

It is obvious that the proper condition is to have $V_c = E_c/2$ and $I_c = I/2$ since this makes the voltage and current changes a maximum for a symmetrical waveform. It follows at once that the proper load resistance is $R_L = E_c/I = 2V_c/2I_c = V_c/I_c$. The optimum load is thus equal to the d.c. resistance of the transistor at its operating point.

If the load is coupled in through a transformer then, neglecting the resistance of the primary, the input power to the transistor is V_cI_c. For a sine-wave output, the output power to the load is $E_cI/8 = 4V_cI_c/8 = V_cI_c/2$. and so the efficiency is 50%.

A transistor has certain ratings which must not be exceeded if danger of damage to it is to be avoided. It is not always convenient to employ sufficient negative feedback at d.c. to avoid all possibility of trouble, especially in an output stage. It is often desirable, particularly in experimental equipment, to include sufficient resistance in circuit to prevent any possibility of the ratings being exceeded.

If collector current is cut off in the transistor, the collector voltage will rise to the supply voltage E_c. The first safety requirement is thus to limit E_c to the peak voltage rating V_{cp} of the transistor.

The second safety requirement is that the d.c. load line drawn from E_c should cut the zero-voltage axis at a point which does not exceed the peak current rating I_{cp} of the transistor. This means that the resistance included must not be less than E_c/I_{cp}.

This does not necessarily give protection against the power-dissipation rating being exceeded. Just as in the a.c. case already discussed, the power in the resistance is greatest when this equals the d.c. resistance of the transistor, and the power in the two is then the same. Therefore, the d.c. resistance should not be less than the load resistance and should equal it if operation at the maximum rating is required.

The collector dissipation is $V_cI_c = P_c$. Now $V_c = E_c - I_cR$; that is, the collector voltage is the supply voltage minus the voltage drop in the resistance. So $P_c = I_cE_c - I_c^2R$. This must not exceed the peak power rating for any value of I_c and it is easy to show that P_c is a maximum when $I_c = E_c/2R$. We then have $P_{cp} = E_c^2/4R$.

We thus find that to avoid any possibility of the dissipation rating being exceeded, the resistance included in the circuit should not be less than $E_c^2/4P_{cp}$.

We have thus found two possibly different values of resistance set by different transistor ratings. If they are not the same, the higher value is the one to be used.

To avoid loss of power output, the resistance should be bypassed. There is a d.c. power loss in it equal to the dissipation of the transistor, and so its use makes the maximum possible efficiency 25% instead of 50%.

Total Circuit Resistance

As an example, consider an OC72 transistor for which $P_{cp} = 45$ mW, $V_{cp} = 13$ V and $I_{cp} = 110$ mA. For complete safety E_c must be not more than 13 V. To avoid current overload the included resistance must not be under 13/0.11 = 118Ω. To avoid power overload, the included resistance must not be under 169/0.18 = 935 Ω. If operation is to be at 13 V, therefore, the 935-Ω value must be adopted.

In such a case, the mean voltage would be 6.5 V on the collector and the current 45/6.5 = 6.92 mA, and the peak current would be 13.84 mA. The optimum load would be 6.5/6.92 = 0.935 kΩ.

If the battery were reduced to 3 V, the safety resistances would become 3/0.11 = 27.2 Ω to prevent current overload and 9/0.18 = 50 Ω to prevent power overload. The operating voltage is 1.5 V and the current is 30 mA and the required load is 50 Ω.

If the battery is reduced further to 1.5 V, the safety resistance for current overload drops to 13.6 Ω and for power overload to 2.25/0.18 = 12.5 Ω. The higher value must be selected for complete safety and it will not now be possible to obtain 45-mW dissipation under any conditions and the output will be restricted. With the 13.6-Ω resistor, the operating voltage will be 0.75 V and the current 55 mA, so the dissipation will be only 41.2 mW and the output power will be proportionately reduced. The optimum load will be 13.6 Ω.

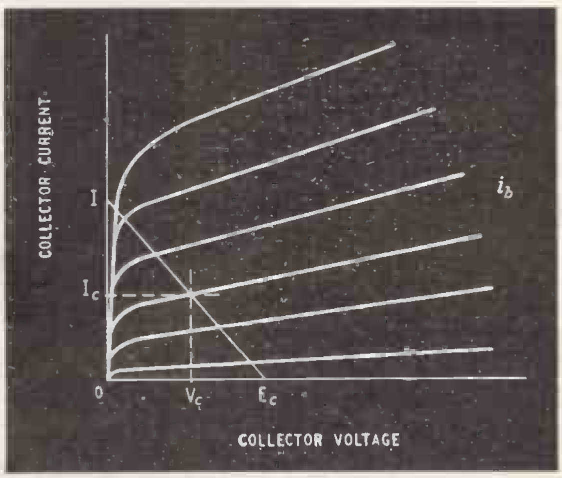
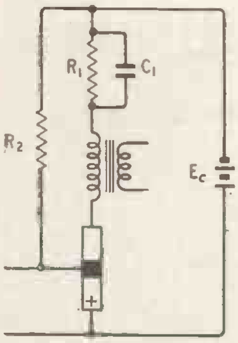
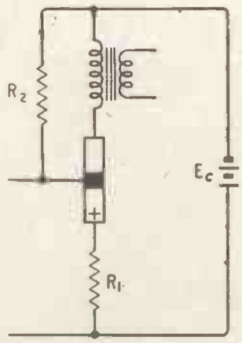


Fig. 1. Typical transistor characteristics.





Left:— Fig. 2. Earthed-base transistor with safety resistance in the collector circuit.

Right:— Fig. 3. Here the safety resistance is in the emitter circuit.

It is interesting to notice how the optimum load varies with the battery voltage. It changes from 13.6 Ω at 1.5 V to 935 Ω at 13 V.

The safety resistance will always be provided in part by the d.c. resistance of the output transformer primary or other output device. This is very rarely negligibly small in transistor circuits. In a particular case, the writer found that the output device accounted for 50 Ω out of a total of 140 Ω required and so it was necessary to add only 90 Ω.

Resistance in the output device cannot, of course, be bypassed and so causes a loss of signal power. Sometimes this can be tolerated. It is then economical to wind the output device to have the required total value of resistance. Not only is a resistor dispensed with but, because of the finer wire which can be used, the output device can be smaller.

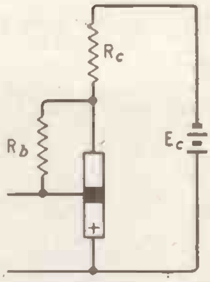
In this way, and without any knowledge of the transistor beyond its limit ratings, one can design the collector-emitter circuit with reasonable accuracy for many applications.

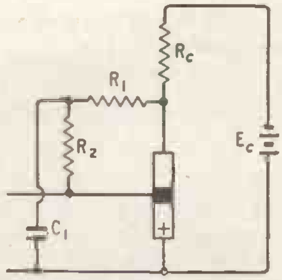
Having got so far, the feed resistor for the base must be chosen to produce the required collector current. This must be done experimentally unless accurate transistor characteristics are available. With the circuit of Fig. 2 a meter can be included in the collector circuit and R_2 can be adjusted for the desired current. It is then measured and a resistor of the proper value is included. Since the base voltage is usually negligibly small, the current is very nearly E_cR_2.

Instead of putting the safety resistance in the collector circuit as in Fig. 2, it can be placed in the emitter circuit, so that some d.c. feedback is obtained from it. This tends to stabilize the operating point and the change affects the value of R_2 because the presence of R_1 drops the voltage effective on R_2. In this form, the circuit becomes like Fig. 3 and R_1 can be bypassed or not according as one wants the feedback at d.c. only or at both d.c. and a.c.

The current through R_1 is actually the sum of the base and collector currents and so the value of the resistor could be reduced slightly. The base current is small compared with the collector current, however, and the error introduced by ignoring it is also small.

The writer has used this circuit successfully with $R_1 = 90\ \Omega$ and $R_2 = 9\ k\Omega$ and a collector load having a d.c. resistance of 50 Ω. With an OC72 transistor and $E_c = 4.4$ V, the collector current was 12 mA. The drop across R_1 would then be slightly more than 1.08 V and so the voltage across R_2 would be 3.32 V, making the base current 3.32/9 = 0.37 mA.





Left:— Fig. 4. Early stage transistor circuit with base-feed resistance connected to the collector.

Right:— Fig. 5. Circuit of Fig. 4 modified to prevent a.c. feedback.

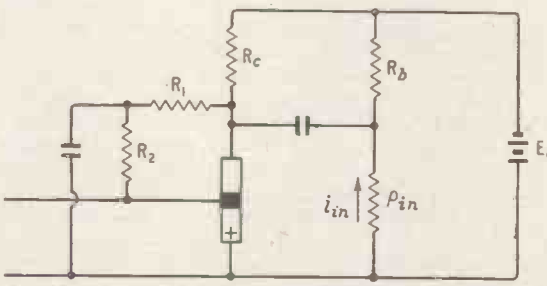


Fig. 6. Circuit of Fig. 5 with input resistance of following stage.

Taking this figure, the emitter current is 12.37 mA and the R_1 drop becomes 1.1133 V and the base current 2.2867/9 = 0.3652 mA. By repeating the process one can reduce the error to negligible proportions, but it can be seen that it is, in reality, negligible in the first instance. With 12 mA at 4.4 V, the input power is 52.8 mW. The loss in the resistance is 0.14×0.012^2 = 20 mW, making the transistor dissipation 32.8 mW.

Early Stages

In the case of an intermediate amplifier stage, the same limiting conditions apply but so much resistance is normally included that operation is rarely anywhere near the limits. The coupling resistance should be large compared with the input resistance of the following stage but it must be small enough for the standing current to be at least equal to the peak current needed to drive the following stage plus any losses in the coupling elements.

Stabilization is more important in an early stage because, although there is no likelihood of the transistor ratings being exceeded, temperature changes are more likely to affect the operating point. The arrangement of Fig. 4 is often suitable. With a transistor like the OC71, the coupling resistance R_c can often be about 10 kΩ. Ignoring the base current in R_c, the peak current cannot exceed E_c/R_c and the mean current should be about half this. Therefore R_b can be adjusted experimentally to make $I_c = E_c/2R_c$.

With $R_c = 10\ k\Omega$ and $E_c = 4.4$ V, we have $I_c = 0.22$ mA. The writer has used this with a lower effective value of E_c due to the presence of decoupling and, with $I_c = 0.2$ mA, R_b turned out to be 350 kΩ.

Feedback occurs through R_b at both d.c. and a.c. It is greater at d.c. than at a.c., however, because the collector load at d.c. is R_c alone whereas, at a.c., it is R_c in shunt with the input resistance of the following stage. When R_b is of the order of 350 kΩ it causes little loss of amplification but, when it is small, it may be necessary to decouple as shown in Fig. 5. Here R_b is divided into two parts with a decoupling capacitor C_1; R_1 and R_2 can usually be roughly equal. For a.c., R_1 shunts the output and R_2 the input.

The writer found this arrangement desirable in a stage with $E_c = 4.4$ V, $R_c = 4.7$ kΩ, for which $I_c = 0.47$ mA. The proper value for R_b turned out to be 47 kΩ and this was split as $R_1 = 22$ kΩ, $R_2 = 25$ kΩ

One further useful relation can be found. Fig. 6 shows a transistor with a circuit like Fig. 5 connected to feed another one having an input resistance ρ_{in} and requiring a peak input current i_{in}. The resistance R_b is the base feed resistance of this stage and corresponds to R_2 of Figs. 2 or 3.

The total a.c. load on the transistor is the value of R_1, R_c, R_b and ρ_{in} all in parallel, say R_L. The peak transistor current is equal to the mean current and is i_c, say. The voltage across the load is i_cR_L and so the input current to the transistor is $i_{in} = i_cR_L/\rho_{in}$. We must have, therefore

$$i_c = i_{in}\,\rho_{in}/R_L$$

Let the combined value of R_1, R_b and ρ_{in} be R' so $R_L = R_cR'/(R_c + R')$, then

$$i_c = i_{in}\,\rho_{in}(R_c + R')/R_cR'$$

We have also $i_c = E_c/2R_c$ and from these two equations we can find R_c. It is

$$R_c = R'\left[\frac{E_c}{2\,i_{in}\,\rho_{in}} - 1\right]$$

This is actually the maximum value which can be used if the transistor is to supply enough current to drive the following stage. For example, suppose $E_c = 4.4$ V, $i_{in} = 0.3$ mA, $\rho_{in} = 3$ kΩ, $R_b = 9$ kΩ and $R_1 = 22$ kΩ, what is the proper value of R_c and what must be the transistor current in Fig. 6?

R' comprises 3, 9 and 22 kΩ in parallel and so is 2.05 kΩ. Then

$$R_c = 2.05\left[\frac{4.4}{2 \times 0.3 \times 3} - 1\right] = 2.94\ \text{k}\Omega$$

Therefore $i_c = 4.4/5.88 = 0.75$ mA.

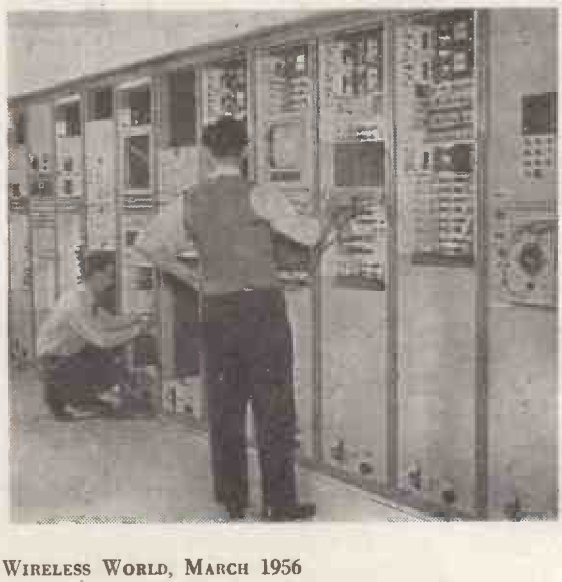
To employ this relation one must, of course, know i_{in} and ρ_{in}. If these cannot be measured, they can be estimated from the transistor characteristics and the usual formulae, allowing for feedback.

I.T.A. Midlands Station

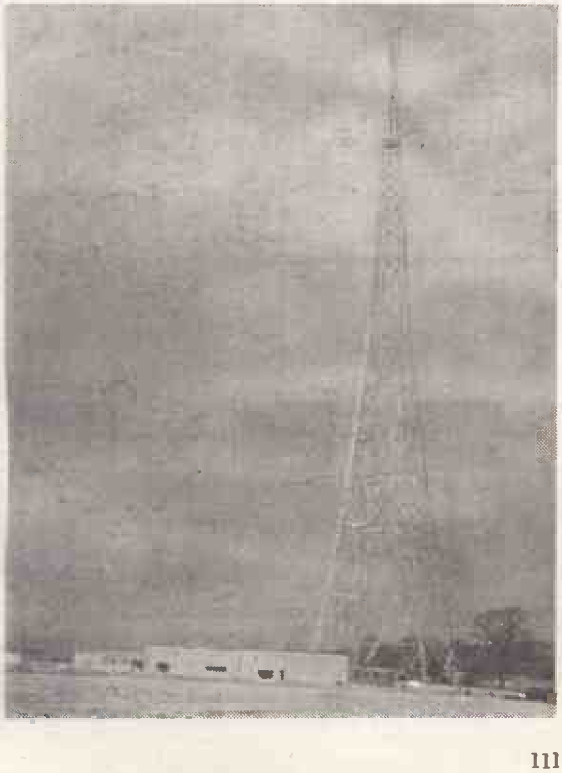
REGULAR programme transmissions began on 17th February from the new I.T.A. station at Hints about 5 miles S.E. of Lichfield. The station has been built in less than seven months and is an outstanding example of effective planning and team work on the part of the I.T.A. engineering department under the guidance of P. A. T. Bevan, the architects E. R. Collister and Associates, the builders James Crosby. Equal credit goes to the main contractors for the mast and aerial (Marconi's Wireless Telegraph Co. Ltd.), the transmitter (Pye Radio, Ltd.) and to the Post Office who were responsible for the microwave link from the Birmingham Television Control and the two-way radio link between Birmingham and London.

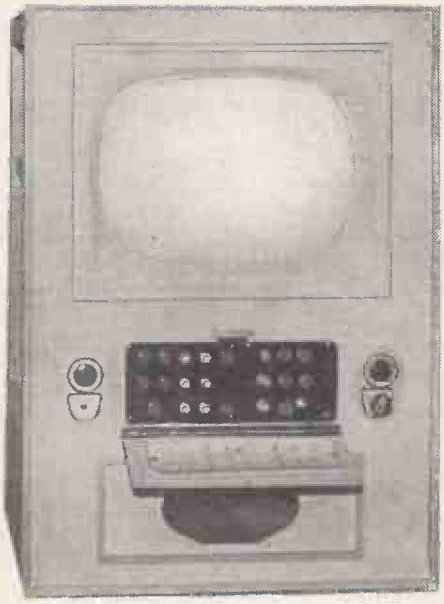
At the moment the Midland station is radiating from the 5 kW modulated driver stages with an effective radiated power of 60 kW from the high-gain aerial. When the 20 kW final amplifier has completed its trial period the power will be increased to 200 kW (e.r.p.) which will make the I.T.A. Midlands station one of the most powerful Band III transmitters in the world.

Crystal drive, pulse and waveform generating units of the Midlands I.T.A. transmitter being set up by Pye engineers.



The low profile of the station buildings contrasts with the 450-ft aerial mast of the I.T.A. station at Hints, Staffs.





Front view of the complete receiver, showing the setting-up controls on the small panel. The cabinet is small enough to go through an average living-room door.

Experimental

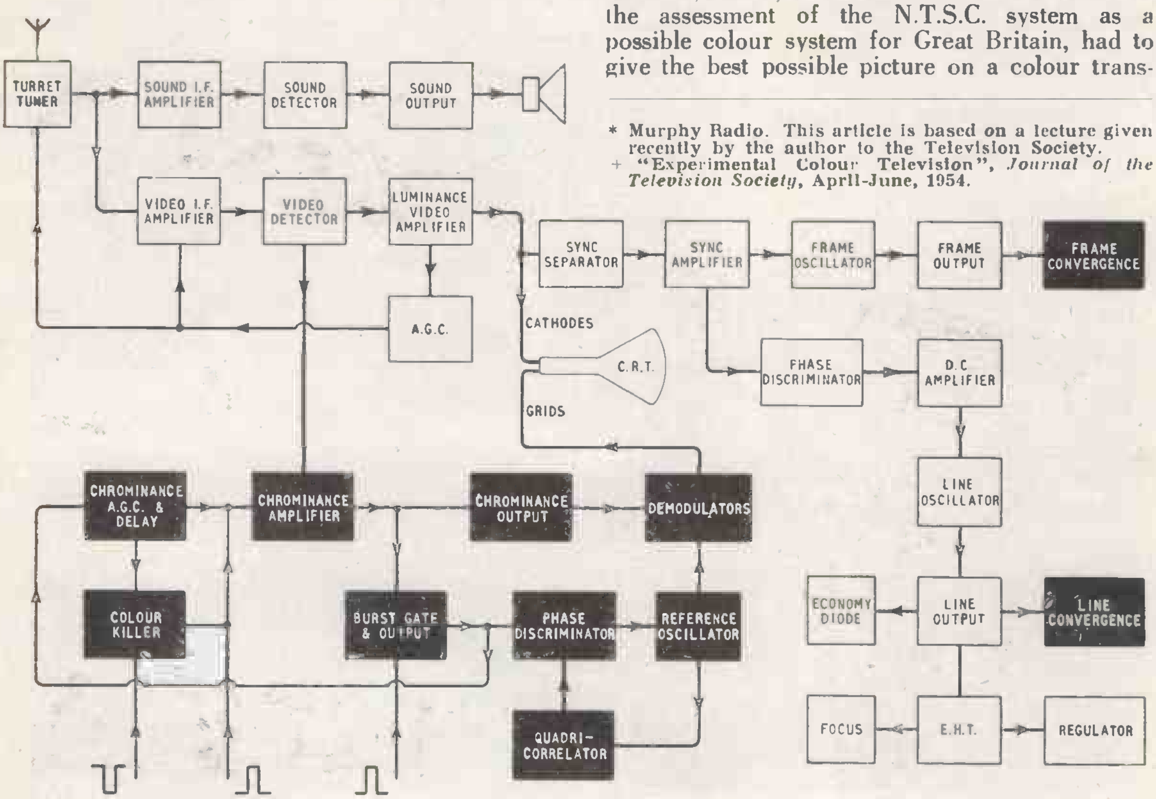
By H. A. FAIRHURST*

WHEN the decision was first made to develop a colour television receiver working on "British N.T.S.C." standards it was anybody's guess just what frequency should be adopted for the colour sub-carrier. However, as this frequency had to fall between certain fairly narrow limits the uncertainty was no bar to the inception of the design. Also, as the Marconi Company had shown in their demonstration that a frequency of 2.6578125 Mc/s+ gave acceptable results, and as there seemed little likelihood of this being changed later on without very good reason, this figure was chosen.

As one of the requirements of the receiver was that it should be suitable for use in the home, it was decided with little argument that it should employ the RCA shadow-mask tri-colour cathode-ray tube as the means of display, not so much because it was thought that this would be the eventual solution when it came to a public service, but because the alternatives were either not available or, in the case of the triniscope and to a lesser degree the three-tube projection method, rather too cumbersome. There was likewise little argument over the basic design of the receiver, which, as it was to be used to assist in the assessment of the N.T.S.C. system as a possible colour system for Great Britain, had to give the best possible picture on a colour trans-

* Murphy Radio. This article is based on a lecture given recently by the author to the Television Society.
\+ "Experimental Colour Television", *Journal of the Television Society*, April-June, 1954.

Fig. 1. Block schematic of the complete receiver, with black blocks indicating the circuits concerned with chrominance information.



Colour Receiver

DESIGNED FOR RECEIVING "BRITISH N.T.S.C." TEST TRANSMISSIONS

mission without faults which could be avoided by the use of the best monochrome technique. Thus the basic design included vision a.g.c., flywheel line synchronisation and sufficient sensitivity to enable the colour signals to be viewed under fringe conditions.

It is beyond the scope of this article to go into any detailed analysis of the N.T.S.C. system, and it will be assumed that the differences between it and the system as modified are also known. The precise characteristics peculiar to the modified system were arrived at by discussion between the B.B.C. and representatives of the radio industry and they relate to the sound and vision frequencies, the colour sub-carrier frequency, and the amplitude and phase response of the video modulation. In most respects they represent the American system scaled down in the ratio of the video pass band.† They will be dealt with more fully in the description of the apposite parts of the receiver.

Referring now to the block schematic of the receiver (Fig. 1), it will be seen that there is a tuner; a sound i.f. amplifier, detector and output; a vision i.f. amplifier, detector and video amplifier, and sync separator and amplifier; with a frame timebase and a flywheel-synchronized line timebase. A.G.C. is provided for both sound and vision, and up to this point one might say that the receiver is very like a *de luxe* model normal television set. Then one comes to sections labelled chrominance amplifier, colour killer, burst gate, frame and line convergence, etc., and it is brought home that there is perhaps more to a colour receiver than at first meets the eye.

Going more deeply into the circuitry of each individual section, we soon find that only the tuner and sound amplifier are normal. The remainder either have characteristics designed to cope with the colour signal without introducing undue distortion of hue and saturation, or, in the case of the timebases, characteristics that enable them to scan the colour tube in a reasonable manner and to provide the large amount of e.h.t. necessary.

However, it will be seen that in the chrominance amplifier a certain amount of chrominance information has been deliberately sacrificed in order to obtain greater stability of operation and freedom from drift of colour values during a programme. It could be argued that in an experimental receiver full advantage should be taken of all the information transmitted, but against this we had to consider that the receiver would not only be used in the laboratory but often by relatively unskilled people, and that the greater stability to be obtained by the sacrifice of a little colour bandwidth could be well worth while.

† "Colour Television Standards", *Wireless World*, August, 1955.

In this interior view of the receiver the delay-line cable in Fig. 2 (next page) can be seen arranged in a coil.

Vision I. F. Amplifier

Dismissing the tuner and sound receiver as being normal and commencing with the vision i.f. amplifier (Fig. 2, following page), it will be seen to consist of three stages with normal couplings between the second and third stages and third stage and detector but with what are known as "bifilar T" traps coupling the first and second stages and the tuner and first stage.

Recalling for a moment the format of the composite signal, it will be remembered that, with the colour sub-carrier at 2.6578125 Mc/s and the top limit of the chrominance sidebands above 3 Mc/s, it is obvious that if full justice is to be done to the colour information the vision pass band up to the point where the colour sub-carrier is extracted must be wide enough to

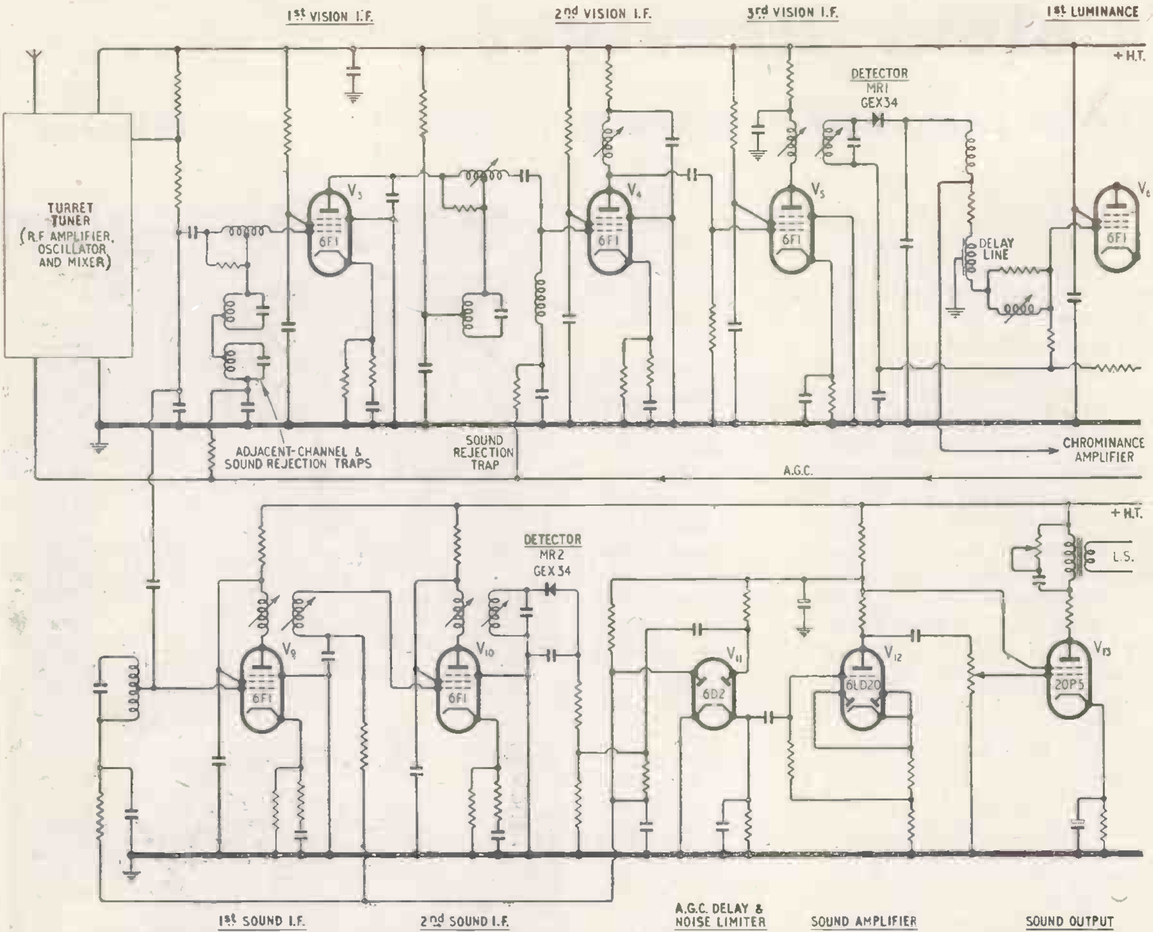


Fig. 2. Vision and sound receiving circuits, showing where the sound and chrominance signals are taken off and also the arrangement of the "bifilar-T" traps in the vision channel.

amplify these frequencies without serious attenuation.

At the same time the sound carrier must be attenuated more than the normal 30-40 dB, for not only must the effect of the sound be imperceptible on the luminance, or brightness, channel, but it must be imperceptible also on the chrominance channel. and as the beat between sound carrier and chrominance sub-carrier is only 0.84 Mc/s, a relatively low frequency, it is much more visible than the normal sound carrier is on the brightness channel. Hence the attenuation required in the vision i.f. chain at the sound frequency is in the region of 60 dB, and this. coupled with the requirement that the pass band must be more or less flat to 3.1 Mc/s, gives the designer a problem at the outset.

Coupled with the requirement that the amplitude response be flat up to at least 3.1 Mc/s through the i.f. amplifier is the requirement that nothing goes wrong with the phase of the signal over the band occupied by the colour sub-carrier and its sidebands. As the colour information is present as phase changes of the sub-carrier, any distortion would be very serious in its effect. The requirement is, then, that the delay of all frequencies through the amplifier should be constant, i.e. the change in phase should have a linear relationship with frequency. Unfortunately the kind of traps commonly used to reject the sound in the vision i.f. amplifier do not fulfil this condition. They are usually of the minimum phase-shift type, and if they are made sufficiently selective to give both the required amplitude response and rejection, serious phase errors result.

Fortunately rejector circuits exist which go a long way towards solving the problem. These traps are of the non-minimum phase-shift type and have phase characteristics that are more suitable for the purpose. At the same time their amplitude response is peculiarly suited to the requirement that the pass band of the amplifier should be flat to as high a frequency as possible. These factors, coupled with the fact that the rejection obtainable is only limited by the "Q" of the trap circuit, make the "bifilar-T" trap a most suitable circuit to use. Fig. 3 shows the kind of response obtainable with these traps.

One other thing that had to be taken into account when designing the i.f. amplifier was the fact that in the U.S.A. it has been found

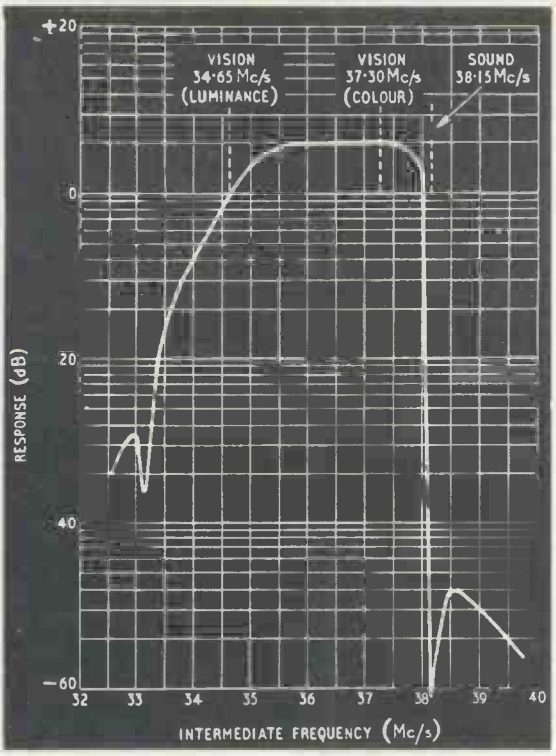


Fig. 3. Response curve of the "bifilar-T" traps in the vision i.fs of Fig. 2.

desirable to distort the phase characteristic of the transmission to compensate for the residual phase errors in the receiver. Calculations and actual measurements carried out by people in this country had shown that a similar correction would be advantageous here. The signal specification for the experimental transmissions broadcast by the B.B.C. incorporated the required amount of phase correction, and so the i.f. amplifier had to incorporate the required number of non-minimum phase shift traps.

Apart from these traps the intermediate frequency amplifier is normal in its design and it is not until the second detector and video stages are reached that there are further departures from common practice.

Luminance Delay

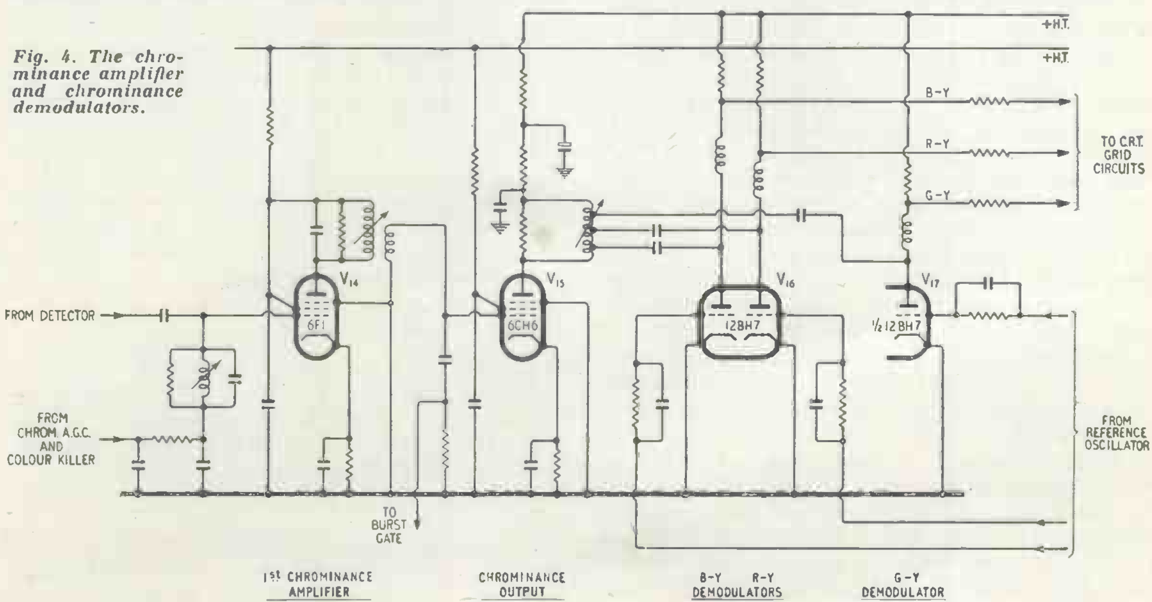
Present in the rectified output is the colour sub-carrier, carrying the colour information, and this, as can be seen from the block schematic, has its own separate amplifier. It is inevitable that this amplifier should retard the signal and, being of restricted bandwidth, it retards it by a considerable amount. The video amplifier does not delay the luminance, or brightness, component of the signal by anything like as much, and as it is of prime importance that the colour information should be in register with the brightness component on the display, some means must be provided for delaying the luminance signal by the required amount.

Suitable delay cables are now available with characteristics that make their inclusion in an amplifying chain relatively simple, and it was found advantageous to insert the requisite amount of cable between the detector and the first video valve, but naturally after the sub-carrier take-off point (see Fig. 2).

It is undesirable that the picture as displayed should have the crawling dot structure that would be inevitable if the colour sub-carrier reached the cathode-ray tube so a trap tuned to the sub-carrier had to be included, not so sharply tuned as to make it ring but not so wide as to remove too much of the higher frequency components of the luminance signal.

A second video valve is merely a cathode-follower to enable the three cathodes of the shadow-mask c.r.t. to be fed without trouble.

Fig. 4. The chrominance amplifier and chrominance demodulators.



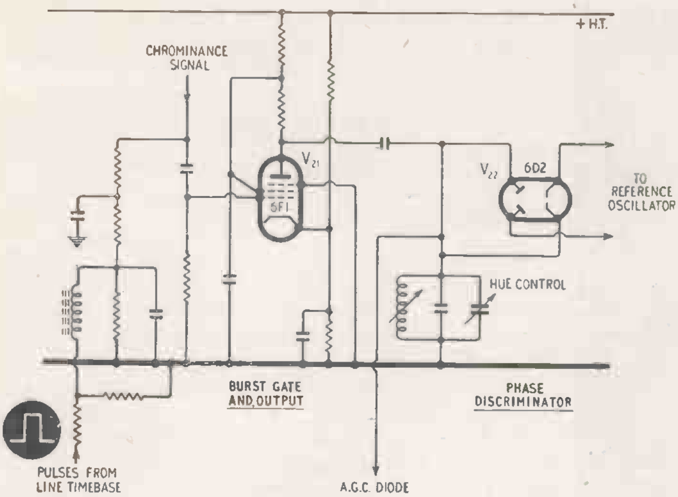


Fig. 5. The burst gate and phase discriminator.

Incorporated in its circuit is the master brightness control, which controls all three guns simultaneously. The other controls for the individual guns and those for setting the tube characteristics will be dealt with later.

Before turning to the chrominance amplifier it will not be out of place to recall briefly the method by which the colour information is transmitted, for this will help to explain how greater receiver stability can be obtained by the deliberate sacrifice of colour bandwidth.

At the transmitter the red, green and blue signals from the camera (R, G and B) are transformed into three separate pieces of information: the Y signal, which is the sum of R, G and B and which is transmitted normally to provide the compatible signal for monochrome receivers; plus R-Y and B-Y which contain the colour information. It will be remembered that G-Y is unnecessary because of the constant luminance principle where R+G+B always equals Y.

R-Y and B-Y are used to modulate two carriers in quadrature with each other, the modulators being such that the carriers themselves are suppressed, but in the modulation process the signal resulting from the addition of the R-Y and B-Y carriers is not defined along the R-Y and B-Y axes but along two others, called " I " and " Q ", shifted in phase by 33° from the originals. This transformation of the signal is the result of the desire to have as high a frequency as possible for the colour sub-carrier, and the phase shift of 33° was chosen because it caused the information transmitted by the two carriers to lie along the orange-cyan and green-magenta lines of the colour triangle instead of the originals.

Because the eye is most sensitive to colour detail along the orange-cyan line and much less sensitive along the green-magenta, the bandwidth required to transmit the latter signal need not be as great as that required for the former. However, if the colour sub-carrier were increased in frequency to the limit allowed by the "Q" signal, the sidebands of the wider "I" signal would stray into the sound region unless they were prevented. The solution to this problem was to make the "I" signal partly asymmetric, cutting off all those sidebands which would have otherwise strayed out of the prescribed limits of the luminance channel.

Without going more deeply into the question, which has been dealt with very thoroughly in the literature,** it can now be seen that because of this 33° rotation of the reference axes the only way to extract the original R-Y signal from the transmitted signal direct is to take some of the "I" signal and some of the "Q" signal and to combine them. Likewise with B-Y. But as the "I" signal is asymmetric, there is the likelihood of crosstalk between the channels if the bandwidth of the demodulator is made more than that of the " Q " signal, so direct demodulation of the signal automatically implies a colour bandwidth not greater than this. The choice in the chrominance amplifier and demodulator was therefore to decide between demodulation along the " I " and " Q " axes with the subsequent transformation of the signal to produce R, G and B, but with the full colour bandwidth, and demodulation along the original axes R-Y and B-Y, necessitating equal bandwidths for both, but with much simplified circuitry.

As has been said previously this latter was the route followed, and it will be seen from the circuit diagram that the demodulation is extremely simple (right-hand side of Fig. 4). In fact, the last stage of the transformation back to the original R, G. and B can be done in the colour tube itself if the demodulation is accomplished at a high enough level. All that is necessary in principle to do this is to apply the Y signal to the cathodes of the three guns and the appropriate R-Y, B-Y and G-Y signals in the appropriate phases to the three grids. At one stroke this system avoids all the chrominance video amplifiers that would otherwise be neccesary, with their possibilities of drift in gain during a programme — drifts which would have to be kept down to a very low level.

Chrominance Amplifier

Returning now to the chrominance amplifier (left-hand side of Fig. 4), it will be seen to consist of two stages, the second being the output valve feeding the demodulator triodes. Because

(*Continued on p.* 117.)

** G.G. Gouriet. "An Introduction to Colour Television", Norman Price Publications. Also "Transmitting Colour Information", *Wireless World*, Aug. 1955.

of the system of demodulation chosen, its bandwidth need be no more than that of the "Q" signal. It is fed in a conventional manner from the detector output of the luminance channel from a point preceding the delay line. Attached to the amplifier are the circuits for its automatic gain control, the gating of the colour burst from the composite signal, and a suppression circuit which reduces its gain to zero in the absence of the colour burst. These features will be dealt with separately.

The demodulators are circuits which take the amplified chrominance signal and compare it with the local oscillator and deliver an output proportional to their relative phases. There was a certain freedom of choice of circuitry here and several circuits were tried, some using only two valves, although interaction between the channels made these last-mentioned rather tricky to design and maintain in operation. As stability of operation was desired and had, indeed, already been paid for by the basic system of demodulation chosen, it was finally decided to provide a separate valve each for R-Y, B-Y and G-Y.

In operation the taps on the output tuned circuit of the chrominance amplifier feed the requisite amounts of signal to the anodes of the R-Y, B-Y and G-Y demodulators, while local oscillation of the correct phase for each is fed on to the respective grids. The valves then act as switches, passing current proportional to the overlap of the waveforms on grid and anode, and this current passes through loads in the anode circuits where the R-Y, B-Y and G-Y signals are developed. These voltages, in addition to suitable brightness voltages, are fed to the grids of the colour c.r. tube.

The demodulators will obviously fail to deliver the correct signal if the phase of the reference oscillator is incorrect or the oscillator is not synchronized, so an essential part of the colour receiver is a reference oscillator synchronising circuit. Here there is a large fund of published work to be drawn upon †† but it is not so easy to decide which route to follow without doing a large amount of work.

It will be remembered that the conditions are rather different from those that the normal a.f.c. loop has to cope with, in that the synchronising signal, i.e. the colour burst consists of only 9 cycles of 2.6578125 Mc/s once every line and none during the frame pulse. Also it must be remembered that if the reference oscillator changes phase by more than a few degrees during a line it will show up by changes of hue across the picture.

These factors have made some workers use crystals in the reference oscillator circuit, crystals ground to almost the correct frequency but whose frequency can be varied by a small amount by a reactance valve. These circuits work well but are costly. On the other hand, a normal a.f.c. loop will give the required performance on a day-to-day basis, but is susceptible to long-term drifts which will eventually cause the oscillator to fail to synchronize. The reason for this is the fact, well known to anyone familiar with a.f.c. circuits, that the stability of phase required between the colour bursts necessarily means a very narrow pull-in range.

Other workers have sought to overcome this defect of the a.f.c. loop by adding to it another circuit which could detect when the oscillator was out of sync and use this power to alter the loop constants. By this means the pull-in range could be extended up to nearly + or — half-line frequency (not more because if the pull-in range were made wider the oscillator would tend to lock on a frequency + or — line frequency, the result of the burst not being there continuously) and the a.f.c. loop could be made a practical proposition. These circuits have generally become known as "quadricorrelators"*** because they use two discriminators fed with reference oscillations having a 90° phase difference between them, but the circuit used in the present receiver is rather different and is one that has been developed in our own laboratories.

In this circuit a diode rectifies the beat produced when the oscillator is out of sync and

*** *Proc. I.R.E.* 2nd Colour Issue, pp. 106-133 and 288-299.

†† *Proc. I.R.E.* Convention Record Part 4, pp. 3-17, Jan., 1954. 2nd. Colour Issue, pp. 106-133.

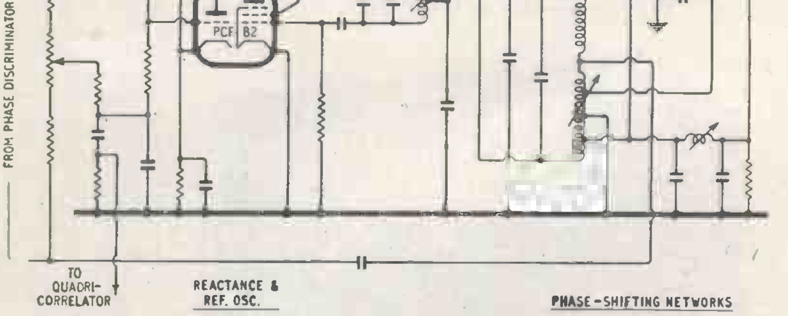


Fig. 6. The reference oscillator is formed by the pentode section of the PCF82 while the controlling reactance valve is the triode part. On the right are circuits giving three outputs with phase displacements suitable for the chrominance demodulators.

uses the resulting voltage to render conducting a valve which applies this beat to the reactance valve, thus widening the pull-in range to the desired extent. Once in sync the valve is cut off and the time-constant of the control circuits reverts to that necessary for proper operation.

The burst gate (Fig. 5), which has so far had only a passing mention, is an essential part of the receiver, without which the reference oscillator would be at the mercy of the chrominance information. Its function is to separate the colour burst from the rest of the signal so that only the burst is applied to the discriminator. Chrominance signal is taken from the grid circuit of the chrominance output valve and fed in parallel with pulses from the line timebase on to the grid of the gate. These gating pulses are delayed and shaped by a suitable LC and RC circuit so that the gating valve is rendered conducting only during the period of the colour burst. While resistors prevent the grid from being driven too far positive, the grid capacitor and leak ensure that between gating pulses the valve is cut off.

The colour burst, which appears at the anode of the gate freed from chrominance information, is fed to the anode and cathode respectively of two diodes in a conventional discriminator, the only refinement being the connection to the correlator circuit previously described and a means for obtaining an accurate balance in its output. However, the tuned circuit which forms the anode load of the gate is tunable and becomes a " hue " control, as by this means the phase of the gated burst pulses in the output can be shifted with respect to those at the input.

The reactance valve and reference oscillator (Fig. 6) are conventional and are controlled via the smoothing circuit from the discriminator. The smoothing circuit must have constants to comply with the requirements that the phase shift of the oscillator during a line must not be more than 5°. The oscillator output is fed to the three demodulator grids in amounts adjusted to suit the chrominance signals on their anodes. The R-Y demodulator is fed directly, while the other two are fed via phase shifting circuits which can be preset to give the required shift.

It can now be seen why the gate anode circuit has been made tunable, for by this means the R-Y demodulator can be made to give the right output, after which the B-Y and G-Y demodulators can be adjusted until they follow suit.

(To be continued.)

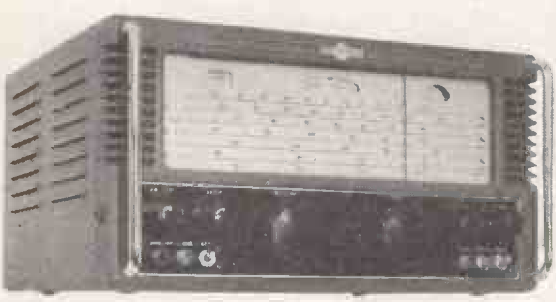
Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

U. H. F. Communications Receiver

THE Eddystone "770U" receiver embodies many unique features, including the unusual frequency coverage of 150 Mc/s to 500 Mc/s. The set is a double superheterodyne having a specially designed "front-end" unit consisting of a small, but very sturdy, 6-range coil turret (with 18 coils), a small three-gang variable capacitor, r.f. and oscillator valves and a germanium crystal mixer giving an i.f. output on 50 Mc/s.

The 50-Mc/s amplifier has one cascode stage and one r.f. pentode and the second frequency change to 5.2 Mc/s is effected in a double triode. The cascode-pentode amplifier and triode mixer are followed by two 5.2-Mc/s i.f. stages and together they provide a high i.f. amplification at a low noise level. This portion of the receiver can be used independently if required and a 50-Mc/s external signal applied to the 50-Mc/s cascode amplifier and the amplified output taken from a cathode follower after the last 5.2-Mc/s i.f. stage.



Eddystone 150-500 Mc/s communications receiver, Model 770U.

Switching provides for either a.m. or f.m. reception, the latter using a Foster-Seeley discriminator and the former a crystal diode. The circuit includes an a.m. noise-limiter, "S" meter, two a.f. amplifiers and a small output pentode (6AM5) with negative feedback. The output transformer is tapped for 2.5-Ω and 600-Ω output loads. The h.t. for all oscillators and the r.f. unit is stabilized.

Other features of interest in the specification are: 15-kc/s overall i.f. bandwidth; 25-dB image attenuation at 400 Mc/s and 40-dB at 200 Mc/s; sensitivity better than 10 μV for 15-dB signal-to-noise ratio at 50 mW output on all six ranges; built-in a.c. power supply and provision for battery operation.

The receiver is housed in one of the distinctive metal cabinets employed for all Eddystone sets, with separately calibrated scales and a subsidiary logging dial. The overall size is 16¾ × 15 × 8¾ in, the weight is 60 lb and the price is between £250 and £300. The makers are Stratton and Co. Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.

Integrated Sound Installation

THOSE who prefer to buy an integrated sound reproducing system rather than to assemble a heterogeneous collection of units of different makes will be interested in the "Novosonic" high-quality installation recently introduced by Philips. It comprises a special record-changer, a 15-watt amplifier and a three-unit loudspeaker system.

A visual tone control indicator in the form of a variable response curve is incorporated in the AG9000 amplifier, which forms part of the Philips "Novosonic" sound equipment.

The record-changer, which can be used also for playing single records, is fitted with interchangeable crystal pickup heads. A diamond stylus is supplied with the microgroove head, and a sapphire with the standard head. Three output characteristics are available from the player unit: (1) uncorrected crystal, (2) "constant velocity", (3) "presence", in which reduced bass and a lift in the region of 4 kc/s is designed to increase the distinction between voices and accompaniment.

Two inputs are available in the main amplifier, one uncorrected and the other connected to an equalizer giving the A.E.S. (Audio Engineering Society) playback characteristic. The two inputs are controlled by a single centre-zero volume control and this is followed by separate bass and treble tone controls for which a novel indicator has been provided. Behind an indirectly-lighted graticu'e a flat spring, anchored at the centre, is mechanically deflected at the ends as the controls are turned, thus giving a picture of the trend of the frequency response at any given setting.

Two 8-in loudspeakers in a closed ("infinite") baffle cover the frequency range 30-300 c/s, while two smaller cabinet loudspeakers with more directional characteristics, covering 300-20,000 c/s, can be disposed at will to make the best use of the acoustic qualities of the listening room.

The comp!ete installation costs £184 16s (inc. tax).

Transistor Receiver

A PORTABLE receiver using transistors throughout has been developed by Pam (Radio and Television) Ltd., 295, Regent Street, London, W.1, and will be known as the Model 710. It is a superhet for medium and long waves with variable tuning (176-568 metres) on medium and fixed tuning (1500 metres) for the long-wave Light Programme.

Pam transistor portable radio receiver (Model 710).

The circuit employs eight transistors and the sequence is as fo'lows: frequency changer, oscillator, two i.f. stages (315 kc/s) with a.g.c. on the first, detector, driver and two power output transistors in Class B push-pull. Total consumption is 35mA at 6V (from four U2 cells). A ferrite rod aerial is used for radio pick-up and the loudspeaker is a 6in × 4in elliptical type.

The price including purchase tax will be £31 10s.

Trawler Band Receiver

AMONG the new sound broadcast sets introduced recently by Pilot is one, the Model T854, which in addition to the usual short, medium- and long-wavebands covers the trawler band, the full covering being 16 to 50 metres, 50 to 180 m, 185 to 550 m and 1,200 to 2,000 m. Provision is made for an extension loudspeaker and a gramophone input. The cabinet is plastic, finished in maroon and gold. and the price is £21.

There is a companion set, the Model T85M, which is identical except that the trawler band is omitted and it embodies a built-in aerial for medium- and long-wave reception where conditions allow. This model costs £19 19s 0d. Both are a.c.-operated, 5-valve (including rectifier) table-model superhets.

The makers are Pilot Radio, Ltd., Park Royal Road, London, N.W.10.

Versatile Pickup Arm

AN improved version of the B.J. pickup arm, to be known as the "Super 90", has been developed by Burne-Jones and Company Limited, Magnum House, Borough High Street, London, S.E.1.

Adjustable counterweights and calibrated pedestal slide in the B.J. "Super 90" pickup arm.

In reviewing the original model (*W.W.* October 1954, p. 495) we pointed out that the low tracking error (less than ±1 degree) could be realized only by careful attention to the position of the tone-arm pedestal, which must be re-set whenever the pickup cartridge is changed for one of different length. This adjustment is made in the "Super 90" by a built-in guide with calibrated scale, and detailed instructions are given for setting up with most of the leading British and American pickup cartridges. Two plug-in plastic shells are provided with each arm, for housing alternative cartridges.

An additional feature of the new design is the counterweight system which uses continuously adjustable slide weights in conjunction with fixed lead discs. contained in a recess below the nameplate. The price of the "Super 90" is £16 9s.

Precision Photographic Timer. — In the circuit diagram, Fig. 4, page 73 of the February issue the diode 6H6(a) should be reversed i.e. cathode joined to the anode of the EF37 integrator valve.

MAGNETIC

Control panel showing level indicator, main switch, pilot lamp, high and low-level inputs and the volume and tone controls.

THIS amplifier was designed as a self-contained unit to feed a high-quality loudspeaker and can, with minor modifications, be used for recording and reproduction in conjunction with any of the leading makes of tape mechanism.

Briefly, the requirements to be satisfied included the following:

(1) Adequate output, comparable with that accepted in other types of high-fidelity equipment.

(2) Wide-range tone controls, operative on all functions.

(3) Availability as a normal gramophone and microphone amplifier, with possibilities for professional public address work.

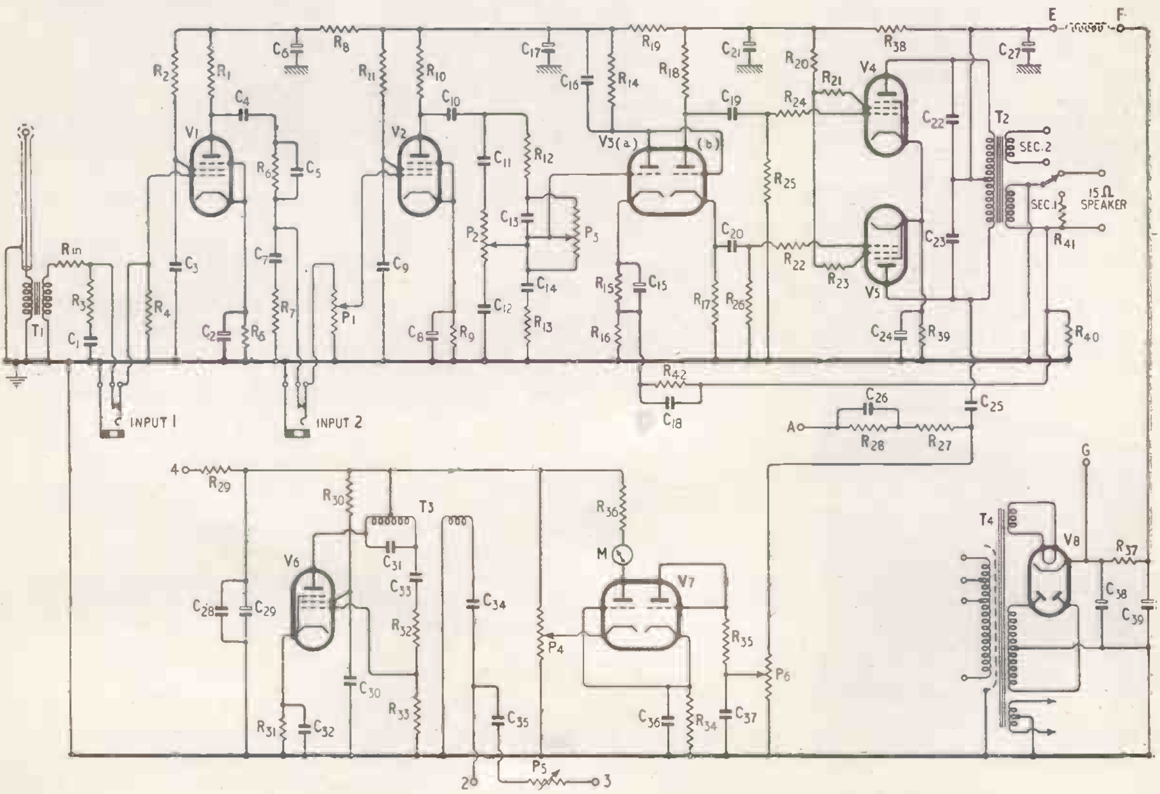
(4) Alternative output to feed cutter head for "dubbing" from tape to disc.

(5) Reasonable simplicity and portability.

Throughout the development work something more than favourable distortion figures and frequency response curves has been aimed at, and the choice between alternative prototypes of similar measured performance has been made on the aural judgment of experienced listeners.

The amplifier, as shown in Fig. 1, is intended

Fig. 1. Complete circuit diagram of amplifier. External connections are marked to correspond with the terminal boards on the Wearite Type 2A "Tapedeck".



TAPE AMPLIFIER

By ARTHUR W. WAYNE*

Versatile Design with an Output of 12 Watts

for use with the "Wearite" Type 2A "Tapedeck". Versions have been made for other decks, notably the "Reflectograph" which is fitted with "Bradmatic" high-impedance heads. The alterations necessary are given in Appendix 2 and Fig. C.

Tranformer T1 is the Wright & Weaire Type 977, and any possibility of reflected resonances is damped by R_{in}, R_3, C_1, which also comprise the first bass-lift circuit, operative only on replay. (This, of course, is the usual gramophone type equalization, but with constants chosen to bring the crossover point considerably higher up the scale.) R_{in} ensures that T1 is properly loaded at all frequencies. The output from T1 is taken to the grid of V1 via input 1, which automatically disconnects T1 when a jack is inserted. V1 is used as both a tape and microphone pre-amplifier, and the output from its anode is connected, via correction circuit C_5, R_6 shunted by C_7, R_7, to input 2 and P1 which in turn feeds the grid of second pre-amplifier and tone control valve V2. It may be objected that C_7, R_7 should not be in use on "Record," but it will be found

* Shirley Laboratories Ltd.

LIST OF COMPONENTS

Resistors

R_1 100 kΩ, high-stability 5%
R_2 1 MΩ, high-stability 5%
R_3 100 kΩ
R_4 470 kΩ
R_5 1 kΩ, high-stability 10%
R_6 47 kΩ
R_7 100 kΩ
R_8 47 kΩ
R_9 2.2 kΩ, high-stability 10%
R_{10} 250 kΩ, high-stability 5%
R_{11} 1.5 MΩ, high-stability 10%
R_{12} 250 kΩ
R_{13} 33 kΩ
R_{14} 1 MΩ
R_{15} 2.2 kΩ
R_{16} 47Ω
R_{17} 100 kΩ - 87kΩ (See text)
R_{18} 100 kΩ (See text)
R_{19} 47 kΩ
R_{20} 150Ω
R_{21} 47 Ω
R_{22} 4.7 kΩ
R_{23} 47 Ω
R_{24} 4.7 kΩ
R_{25} 680 kΩ
R_{26} 680 kΩ
R_{27} 47 kΩ
R_{28} 47 kΩ
R_{29} 1 kΩ, 3 watt
R_{30} 33 kΩ
R_{31} 220 Ω
R_{32} 47 kΩ } or 100 kΩ
R_{33} 47 kΩ } wire-wound pot.
R_{34} 10 MΩ
R_{35} 100 kΩ
R_{36} 100 kΩ
R_{37} 500 Ω, 10 watt
R_{38} 4.7 kΩ, 2 watt
R_{39} 130 Ω, 4 watt
R_{40} 1 kΩ
R_{41} 15 Ω, 10 watt
R_{42} 1 kΩ
R_{in} 47 kΩ
All resistors ¼ watt, 20% except where otherwise stated.

Capacitors

C_1 3000 pF
C_2 50 μF
C_3 0.05 μF
C_4 0.05 μF
C_5 500 pF
C_6 16 μF
C_7 3000 pF
C_8 25 μF
C_9 0.05 μF
C_{10} 0.05 μF
C_{11} 500 pF
C_{12} 3000 pF
C_{13} 1000 pF
C_{14} 0.01 μF
C_{15} 50 μF
C_{16} 500 pF
C_{17} 16 μF
C_{18} 220 pF (see text)
C_{19} 0.05 μF
C_{20} 0.05 μF
C_{21} 16 μF
C_{22} 5000 pF
C_{23} 5000 pF
C_{24} 25 μF
C_{25} 0.25 μF
C_{26} 1000 pF
C_{27} 16 μF
C_{28} 0.25 μF
C_{29} 16 μF
C_{30} 0.05 μF
C_{31} 3000 pF
C_{32} 0.1 μF
C_{33} 5000 pF
C_{34} 0.05 μF
C_{35} 5000 pF
C_{36} 0.05 μF
C_{37} 1000 pF
C_{38} 50 μF
C_{39} 50 μF

Potentiometers

P1 500 kΩ, log.
P2 2 MΩ, log.
P3 2 MΩ, log.
P4 I MΩ, linear
P5 10 kΩ, wire-wound, linear
P6 100 kΩ, log.

Valves

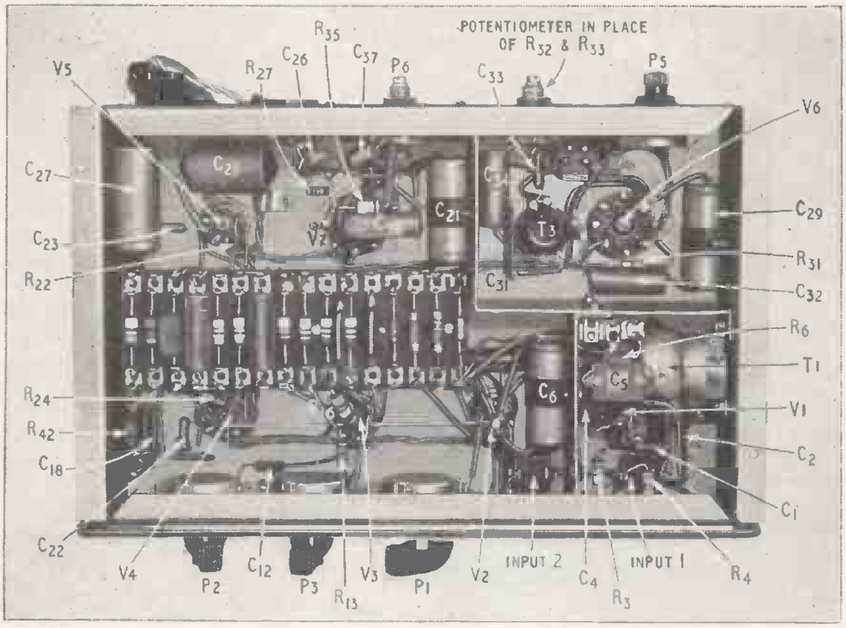
V1 EF86
V2 EF86
V3 ECC83
V4 EL84
V5 EL84
V6 EL90 or EL34
V7 ECC83 or ECC35
V8 EZ81

Transformers and Coils

T1: Wright and Weaire, Type 977.
T2: Output transformer; Pri. 7.600 Ω anode-to-anode; Sec. 1, 15 Ω; Sec. 2 as required. (Wynall Transformers Ltd., Retreat Road, Richmond, Surrey. Type WG1536 or Type WA219.)
T3: Wright and Weaire, Type 579.
T4: Mains transformer. Pri. (as required), screened; Secs. 310 — 0 — 310 V, 120 mA; 6.3 V, 3½A centre-tapped; 0 — 5 — 6.3 V, 2½A.

Meter

0 — 1 mA scaled 0 — 10, with overload mark at 7½. (Sifam, Type M202).



Underside of chassis, showing positions of the principal components. Only the output transformer, and, of course, the valves appear on the top of chassis. From left to right the components on the tag board are : R_{22}, R_{21}, R_{23}, C_{19}, R_{25}, R_{26}, C_{20}, R_{18}, R_{17}, R_{15}, C_{16}, R_{14}, C_{11}, R_{12}, R_{10}, R_{11} and R_8.

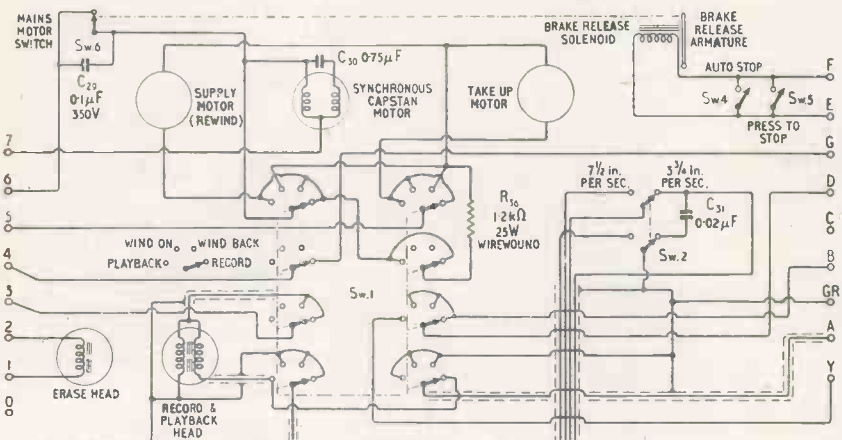


Fig 2. Connections of the Wearite "Tapedeck". When used in conjunction with the circuit of Fig. 1 the speed-change equalizer connections (terminating in a 4-pin plug) are not required.

applied to the cathode of V3(a) via R_{42} and R_{10}, phase correction at high frequencies being provided by C_{18}. With some output transformers, alteration of the value of C_{18} may be necessary to avoid r.f. oscillation on transients.

Alternative values are given for R_{17}. While, theoretically, R_{17} should be equal to R_{18}, measurement with a valve voltmeter will often show a discrepancy in grid drives to V4 and V5 on sine-wave inputs; and a reduction of R_{17} to some fraction of R_{18} will then be necessary to restore balance. $R_{17} = 87$ kΩ is a usual figure.

V4 and V5 constitute a conventional Class AB_1 output stage capable of delivering 12 watts at very low distortion. As a matter of fact, it is possible to drive these valves up to nearly 18 watts before distortion becomes aurally objectionable, but if outputs up to 35 watts or so are required, EL34s should be substituted for the EL84s, a GZ34 for the EZ81, and h.t. for the anodes taken directly from the rectifier cathode, with a 64 µF, 450-V working, condenser as reservoir. A 100-mA, 20-henry choke is used in place of R_{37}, R_{43} is omitted, R_{17} and R_{18} are increased to 150 kΩ, and C_{27} and C_{21} are increased to 32 µF, T2 is wound for an anode-to-anode load of 4000 ohms, while T4 must deliver 250 mA.

The screens of the output valves are fed via the common resistor R_{20}, thus ensuring balance with unmatched valves. Drive to the recording head is taken from V5 anode via isolating capacitor C_{25}, R_{27} to simulate constant-current conditions, and R_{28}, C_{26} main equalizer. C_{16}, C_{32}, C_{33} are to keep bias voltage from the grids of V4 and V5 during "Record," and with careful layout may be omitted, when the response of the

(Continued on page 123.)

easy to compensate almost exactly for their effect by intelligent manipulation of P3. However, the purist has only to make use of the spare bank on the deck switch to cut them out of circuit when desired.

C_{11}, C_{12}, C_{13}, C_{14}, R_{12}, R_{13}, P2, P3, together comprise a tone-control circuit giving up to 18 dB bass lift and cut, together with 14 dB treble lift and 18 dB cut, the variable controls being notably effective throughout their ranges. Flat positions are approximately in the middles of rotation. V3(a) is a voltage amplifier, direct coupled to V3(b) phase-splitter. Negative feedback is amplifier from V2 is sensibly flat from 20c/s to 50,000 or 60,000 c/s, and still significant at 120,000 c/s and beyond. S1 is a change-over switch for loudspeaker muting, although it is possible to work with the output transformer secondary open-circuited, the voltage rise being only of the order of 0.5 dB. R_{10} is to prevent possible instability on open circuit. The third secondary is wound to the required cutter-head impedance, and although a higher output and standard corrections would have been desirable for cutting, in practice it has been possible to produce discs of professional quality, once the tone-control settings have been determined with a standard tape and test disc.

Grid drive to the oscillator valve, V6, may need adjustment for optimum results, particularly if it is an EL34, and some constructors may prefer to substitute a variable potentiometer for R_{32}, R_{33}. This should be wire-wound, and in this connection it may be useful to mention that A.B. Metal Products supply small wire-wound pots up to 100-kΩ, (Clarostat, Type 58). C_{20} provides a gradual decrease of bias volts on breaking the h.t. supply, to avoid magnetizing the heads and C_{28} stops r.f. getting into the power supply, should C_{20} be of high power-factor. P_5 is adjusted *with the heads connected* until the recommended bias voltage appears across the record head. This value will be found indicated under all "Wearite" decks, and is individual for each specimen. It is usually between 11 and 13 V. V7 is used in a simple voltmeter circuit for overload warning and has been fully described in *Wireless World* for April, 1953 (p. 166). The "hang" of the meter needle can be adjusted by alteration of R_{34} or C_{36}, but the values given will serve for most purposes.

The power pack, which must be on a chassis separate from the amplifier, at first sight seems a little unusual for a class AB_1 supply. The large values of C_{38} and C_{39}, however, tend to keep the voltage across C_{39} constant under full drive conditions, and no difficulty has been encountered in use. It will be noted that the h.t. feed to V6 is taken via the switch between G and 4 from the cathode of V8, and to avoid the voltage drop across R_{37}. Another point is that the current through the deck solenoid — between E and F on the deck tags — is rather more than Wright and Weaire's rating; but as it is only about 70mA under quiescent conditions, and does not exceed about 100mA on full drive, no difficulties will be encountered. As a matter of interest, one of these amplifiers has been left running for more than eight consecutive hours, and the temperature rise in the coil has been hardly noticeable.

Sensitivity of the amplifier is about 40-mV at input 2, and 1 to 1¼-mV at input 1. It is difficult to evaluate the residual noise and hum levels to be expected, but in amplifiers that have been built, it is quite impossible to hear them working with V2 grid short-circuited, even with full bass boost and the ear close to the speaker. With P1 at full gain, and grid V1 short-circuited, the noise is still difficult to measure, and with the head connected, under normal playback conditions, it should be about 75-85 dB down. This satisfactory result is almost certainly due to the excellence of the EF86 as a pre-amplifier valve.

For setting up, it would be impossible to improve on the instructions given by J. M. Carter in the May 1953 issue of *Wireless World*; but an additional note or two to constructors may be helpful. R_1, R_2, R_4, R_9, R_{10}, R_{11} are all high-stability resistors. P1 is where it is to accommodate a variety of inputs, and in view of the gain from the grid of V1 to the output (75 dB or so), it should be chosen with care. The author's preference is for the "Clarostat" type 37, which is virtually noiseless. C_{25} must be

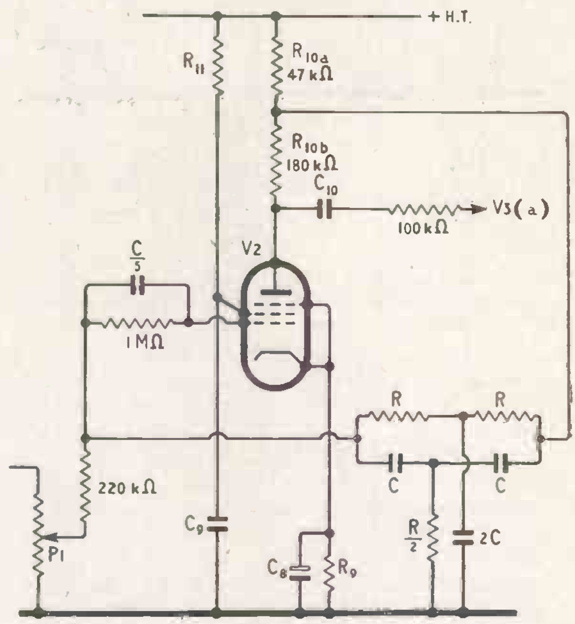


Fig. A. Alternative high-frequency pre-emphasis circuit for recording.

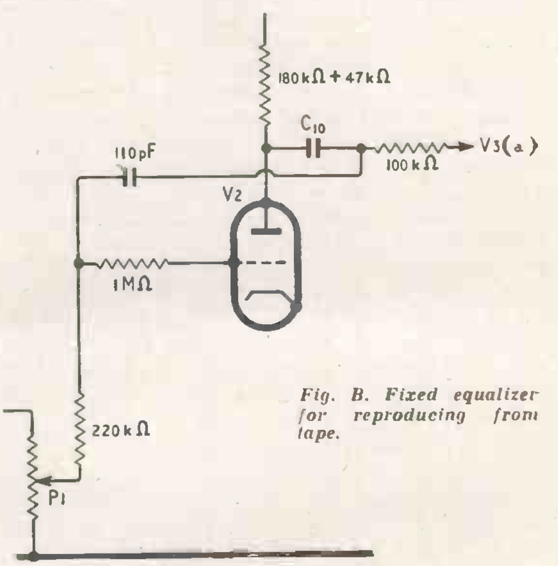


Fig. B. Fixed equalizer for reproducing from tape.

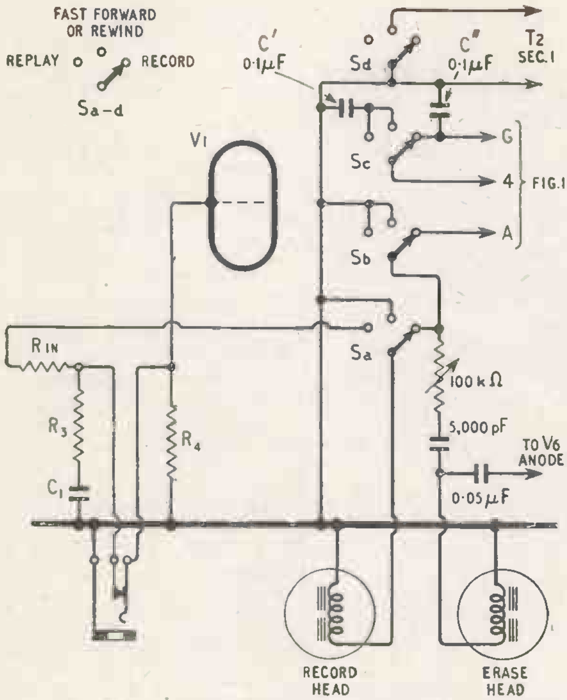


Fig. C. Modifications to the circuit of Fig. 1 for use with tape mechanisms fitted with high-impedance heads.

of very high insulation, as d.c. on the heads will result in noisy recordings. Letters on Fig. 1 refer to the tags on the underside of the "Wearite" deck (Fig. 2), but can without difficulty be translated to decks of other makes. It should be observed that tags B, D and Y are available for speaker muting, but these must be ignored if the amplifier is to be used also for gramophone reproduction. Screened leads and co-axial sockets must be used for the head feed, with screened leads for the bias and erase feeds also. The head lead will almost certainly need to be lengthened on the "Wearite" deck, and it is better here to fit a new piece of the required length, rather than splice. The recommended valves should not be departed from if it is desired to duplicate the performance of the original amplifier, as it is actually designed round them.

Construction must be meticulous, and a suggested layout may be seen on the photograph. Alle returns should be to a bus-bar earthed only at the input socket, and the simplest way to achieve this is to bring the returns to the spigots of the associated valve holders, joining these by a 16 s.w.g. tinned copper wire. The chassis in the photograph is 10½ in × 7 in × 2 in, and internal screens are fitted to isolate the oscillator and pre-amplifier stages, while a metal plate covers the whole bottom, thus making an enclosed box.

APPENDIX (1)

IT will be found that recording, in general, is best done with P3 at the 11 or 12 o'clock position, and P2 at about 2 o'clock. On replay, the settings are P3 at 3 o'clock and P2 at 12: but a few test tapes will soon show the best settings to suit the material being recorded, the acoustics of the room, and the taste of the operator. These settings refer to a tape speed of 7½ in/sec., and for 3¾ in/sec., others will, of course, be required. In theory, the whole equalization curve should be shifted bodily to the left, but in actual practice, apart from scientific and similar applications, manipulation of the tone-controls will permit of very satisfactory results.

For more stringent requirements, the circuit alterations shown in Fig. A and B are suggested. However, it will be found that unless the conditions are exceptional, these refinements are unnecessary as, using a three-head deck with two amplifiers, and recording from a disc or broadcast, it is quite impossible, on switching from input monitor to tape output to determine which is the recorded and which the original signal.

Referring to Fig. A, V2 is used as a feedback equalizer. R_{10a} is approximately one fifth of $R_{10a} + R_{10b}$, and the twin-T network is calculated for a "resonant" frequency $f = \frac{1}{2\pi RC}$, or more conveniently $\frac{159}{R(k\Omega) \times C(\mu F)}$. Taking $f = 10.6$ kc/s and $R_9 = 1$ MΩ, then $R = 200$ kΩ and $C = 75$ pF provides a lift at this frequency of almost 18 dB, which is, in effect, a loss of 18 dB in overall amplifier gain. This is compensated by the removal of the tone-control network, taking C_{10} direct to the grid of V3(a), earthing this with a 330 kΩ leak, and breaking the junctions of C_{10} with C_{11}, R_{12}, and P3 and the grid of V3(a). This increases the gain by the loss in the network, which is approximately 20 dB, thus restoring the status quo. C_{26} is not required.

On replay, the twin-T network is switched out of circuit, and the simple feedback arrangement of Fig. B switched in. This gives a lift of nearly 20 dB at about 50 c/s; but it should not be forgotten (1) that the curve is asymptotic, (2) there are certain very low frequency noises inseparable from the process of magnetic recording: so if the speaker and output transformer are capable of really effective bass reproduction, a twin-T network calculated for $f = 50$ c/s might be more advisable. When calculating treble equalizing networks, f should be (approximately): 3¾ in/sec, 5.25 kc/s; 7½ in/sec, 10.5 kc/s; 15 in/sec, 21 kc/s.

APPENDIX (2)

FOR use with Reflectograph, Truvox and other decks fitted with high-impedance heads, certain modifications to the amplifier circuit will be necessary. Those shown in Fig. C have proved effective.

Referring to Fig. 1, T1, P5, C_{34} and C_{35} will not be required, and bias and erase currents are taken from the anode of V6, that is, the primary of T3, the secondary being left floating. Points E and F are joined. In Fig. C the 4-pole, 3-way switch may be of the ordinary wave-change variety, as it is not essential to use a screened switch with the arrangements given. The " H " type switch made by A.B. Metals Ltd. is very suitable.

The live side of the record head is connected to Sa as indicated, so that in position 1, it is taken directly to the grid of V_1 via R_{in} and input 1. In position 2, it is earthed, and in position 3, it is joined to point A in Fig. 1 via the rotor of Sb. It is also connected to the bias supply which, in this position, is fed with h.t., via Sc, from G in Fig. 1. Sc also switches C′ and C″ to suppress any tendency to arcing on breaking the oscillator h.t., while Sd is merely to provide speaker muting when running the tape fast forward or when rewinding.

The oscillator is tuned for a frequency between 45 kc/s and 60 kc/s, and the voltage at the heads, measured with a valve voltmeter, should be :

"Truvox" deck. Record head, 45V-55V, erase head, 100V-120V.

" Reflectograph " deck. Record head, 120V-135V, erase head, 200V-250V.

At 250V, the " Reflectograph " erase head takes about 5 watts, and this is rather on the high side for an EL90; but it will be found that, providing the recording bias is kept to the minimum compatible with good reproduction, 150 V a.c., driving about 3 watts through the erase windings, will give a very clean wipe. Otherwise, it may be better to use an EL34 for V6, in conjunction with the oscillator coil obtainable from Allen Components Ltd. of 197 Lower Richmond Road, Surrey.

Braking current for the " Truvox " deck is taken, through a 750-ohms, 5-watt resistor, from the junction of R_{37} and C_{38}. Although the drain on V8 is heavy, it is only momentary, so damage to the valve is unlikely.

Setting up for the decks follows, generally, the same procedure as that given for the " Wearite "; but if a little roughness can be detected in the reproduction of a continued sine-wave signal from the older " Truvox " decks — a particularly brutal test, incidentally — improvement can often be effected by judicious adjustment of the pressure arms. This, however, is a skilled job calling for much patience, and should not be undertaken lightly.

PRINTED CIRCUIT PORTABLE

WHAT is believed to be the first commercial receiver to be made in any quantity in this country by the printed circuit technique is now in production at the Newhaven factory of the Champion Electric Corporation. The design was completed some time ago but difficulty in obtaining components suitable for large-scale production with printed circuits held up the actual launching of the set. As it is, considerable ingenuity has had to be applied so that readily available parts could be employed.

The set, which is described as the "Travler" (or Model 844), is a 4-valve portable fitted with 25-mA economy battery valves and a ferrite-rod aerial. It covers the medium and long wavebands, includes a 5-in loudspeaker, measures 12×9×3½in and weighs 4 lb.

Development in Printed Circuitry

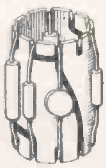
EDGEWISE dip-soldering is among the latest developments in printed circuit technique. In its simplest form it can be applied to a terminal board provided with notched edges and with the desired wiring printed by any of the customary methods on one or both sides and with all soldering points located in the notches. The components are assembled and temporarily held in place by bending their wire ends around the card at the appropriate notches and when complete the edges of the strip are fluxed and dipped into the solder pot. Small metal clips placed in the notches serve to make interconnections between front and back wiring, or the component leads can be utilized for this purpose.

Some examples of this form of construction are shown in the illustrations. One is a plain tagboard, carrying resistors and capacitors; another is bent to form a cylinder with components on the inside and the outside, while a third is a more complex assembly with valves and coils.

Some of the advantages claimed for the notched-edge dip-soldering technique are that both sides of the board can be utilized for mounting components. As only the edges are dipped in the solder, a minimum of flux and solder is employed. The wiring does not pick up solder, while heat from the soldering pot (which can be a narrow trough) is applied only to the edges of the printed circuit element.

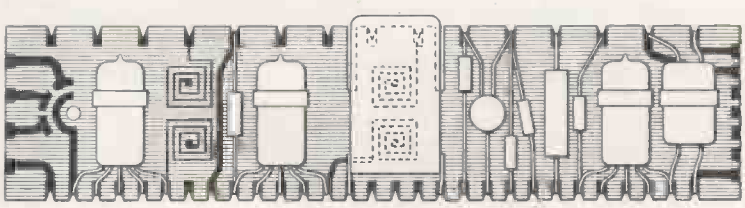
The idea originated in the Du Mont Instrument Division in America and was described in the December 1955 issue of *Tele-Tech and Electronic Industries*, from which the accompanying illustrations are taken.

(a)



(b)

(c)



Three examples of the edge dip-soldering technique for printed circuit plates developed by Du Mont in America; (a) *a simple tag-board,* (b) *cylindrical assembly,* (c) *complex circuit with valves and coils.*

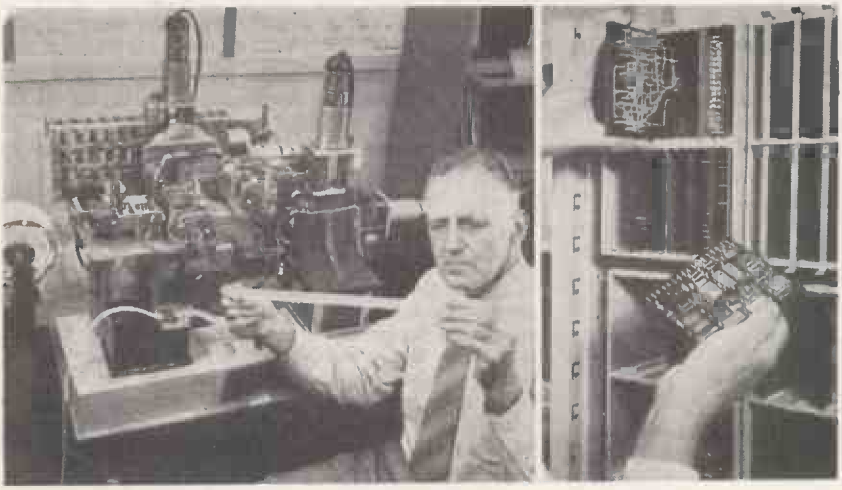
AUTOMATIC WIRING

IN circumstances which dictate the use of conventional circuit wiring rather than "printed" circuitry, it would be convenient to carry out the wiring automatically when the quantities required are sufficiently large.

An experimental machine (Type M4) developed by Bell Telephone Laboratories employs the solderless wrapped jointing principle evolved by R. F. Mallina.* The wire is wrapped mechanically round a rectangular terminal pin and bites into the corners to give a stable low-resistance contact.

The wrapping tool has a power-driven spindle and is moved into a number of predetermined positions along guides, rather like the slide rest of a lathe. At the beginning of each operation the tool picks up the end of the wire from the supply reel (seen at the left of the photograph) and bares the insulation. The start and finish of each wire is determined by the information contained in a punched paper strip which is "read" by electrical contacts in association with a number of relays.

In the left-hand picture it will be seen that the machine has two heads; it is "ambidextrous" and can wire both sides of a panel without removing it from the machine.



The designer, R.F. Mallina, examining the "programming" tape. Typical sub-assemblies are shown on the right.

* *B.S.T.J.* Vol. 32, p. 523 (May 1953).

Phonetic Alphabets

YET another phonetic alphabet for use in radio-telephony was introduced on March 1st. This is the third or fourth official list to be promulgated in just over eight years.

It will be recalled that three or four years ago the International Civil Aviation Organization introduced a word-spelling alphabet which was compiled with a view to the words being readily recognized by those whose mother tongue is not English. It was, however, strongly criticized and many of the member countries of I.C.A.O. refused to adopt it, so that its introduction increased rather than diminished the confusion so far as air radio operators were concerned.

It was given the approval of the North Atlantic Treaty Organization and eventually adopted (in 1952) by the Ministry of Civil Aviation. However, the volume and strength of criticisms were such that I.C.A.O. member countries were asked to submit proposals. A committee was, therefore, set up by the Ministry of Transport and Civil Aviation including representatives of the civil air-line operators, the Armed Forces and phoneticians, and six changes were suggested. These were Charlie (instead of Coca) for C, Fox (Foxtrot) for F, Mike (Metro) for M, Nugget (Nectar) for N, Uniform (Union) for U and X-ray (Extra) for X.

Some of these suggestions have been included in the new phonetic alphabet which is to be used by all N.A.T.O. forces and by civil air-line operators from March 1st. We give below the new alphabet in the first column, followed by the 1951 I.C.A.O. list, the Able-Baker-Charlie list and the somewhat cumbrous words listed in the final acts of the Atlantic City International Radio Conference of 1947. The syllables to be emphasized are shown in heavy type in the new list.

On the marine side we understand that no change is being made. For working between British ships and British coast-stations the Able-Baker-Charlie list will continue to be used and for international working the Atlantic City phonetics. It will be recalled that during the war the Armed Forces adopted Able-Baker in place of the old Ack-Beer.

A	Alfa	Alfa	Able	Amsterdam
B	Bravo	Bravo	Baker	Baltimore
C	Charlie	Coca	Charlie	Casablanca
D	Delta	Delta	Dog	Danemark
E	Echo	Echo	Easy	Edison
F	Foxtrot	Foxtrot	Fox	Florida
G	Golf	Golf	George	Gallipoli
H	Hotel	Hotel	How	Havana
I	India	India	Item	Italia
J	Juliet	Juliet	Jig	Jerusalem
K	Kilo	Kilo	King	Kilogramme
L	Lima	Lima	Love	Liverpool
M	Mike	Metro	Mike	Madagascar
N	November	Nectar	Nan	New York
O	Oscar	Oscar	Oboe	Oslo
P	Papa	Papa	Peter	Paris
Q	Quebec	Quebec	Queen	Quebec
R	Romeo	Romeo	Roger	Roma
S	Sierra	Sierra	Sugar	Santiago
T	Tango	Tango	Tare	Tripoli
U	Uniform	Union	Uncle	Upsala
V	Victor	Victor	Victor	Valencia
W	Whisky	Whisky	William	Washington
X	X-ray	Extra	X-ray	Xantippe
Y	Yankee	Yankee	Yoke	Yokohama
Z	Zulu	Zulu	Zebra	Zurich

TELEVISION SIGNAL RECORDING

Proposal for a New Method Giving Better Quality Pictures

By W. WOODS-HILL*

When a television programme is to be recorded for later re-transmission the usual method is to employ apparatus consisting basically of a cine camera mounted in front of a television receiver to photograph the images which appear on the cathode-ray tube screen. There are certain drawbacks to this arrangement, which results in a loss of definition obvious to anyone who has witnessed a "telerecording."

This loss of definition springs from many sources in the long chain of processes which the picture elements must follow between leaving the camera and eventual display on the receiver cathode-ray tube, but the most degrading are (a) stroboscopic effects, and (b) the finite size of the spot (hence the lines) and the grain of the c.r.t. used for recording. There are others, of course, but most of these are common to the ordinary television transmission of cine films, and can be ignored as they introduce no distortion other than that considered normal to satisfactory picture reproduction.

The proof of this is that a transmission of normally photographed cine film on the B.B.C. television service gives a final picture equal and very often superior to that of live broadcasts. The system to be described proposes to eliminate (a) above and reduce (b) to tolerable limits by recording the picture elements on 35-mm film without ever producing a picture recognizable as such until it is reproduced on a monitor or television receiver.

"Sound-Track" Principle

If a cine film could be made to travel fast enough, say 200 feet per second, then the electrical signals from a television camera could (assuming suitable amplifiers) be injected into the normal sound track of a 35-mm sound film, and the 3-Mc/s picture components would be recorded in variable area and later (after processing) reproduced. This 200 feet per second could, because modern film emulsions have a very fine grain size, be reduced to say 100 feet per second, if special care was devoted to the slot and optical arrangement, to say nothing of the light modulator.

Nevertheless, the suggestion is quite impractical because very long lengths of film would be required for a 15-minute programme, and the mechanical problems attendant on such fast-moving film would be almost insurmountable. If, on the other hand, the film is moved at normal or twice normal speed and the recording slot is made to travel over the film, or, more correctly, made to appear to travel at the required speed over the entire usable surface of the 35-mm film (not just one edge), then the system becomes more practical.

Further, if this apparent rapid movement of the "slot" is produced by electronic means, then there will be no extra mechanical problems to solve. Such a movement could be achieved in the following way. A spot is made to traverse continuously from left to right the face of a cathode-ray tube in much the same way as in an oscilloscope. The movement is produced by a time-base synchronized to the line pulses and applied to the X plates. The Y plates of the tube are energized by a 15-Mc/s radio-frequency voltage giving a vertical deflection of, say, 1 inch. This r.f. is modulated by the picture signal from the camera.

The effect of this is to produce a vertical bar of light which is swept across the face of the tube and whose height at all instants is proportional to the picture modulation. This is now reduced by optical means so that the resultant image is less than 1/200 of the height of a 35-mm film frame and the length of sweep is just sufficient to go from one edge of the usable film to the other. This arrangement is shown in diagrammatical form in Fig. 1(a). If the sensitive film is now moved continuously past the optical system a trace will be recorded on the film similar to that depicted in Fig. 1(b). The similarity to a television raster is obvious but of no great significance.

To replay this recording after processing requires but to pass the film through the apparatus again, with the "slot" now unmodulated but scanning as before, and pick up the light variations produced by the recording on a photo-electric cell.

Before going into details about the modulation and intricacies of ensuring correct registration during playback, the following points should be noted. (1) That this is a proposed system for recording in black and white the equivalent of the electrical waveforms produced continuously by a television camera or transmitter and need therefore take no account of interlacing or frame synchronizing. (2) In a television system of 400 lines and a bandwidth of 3 Mc/s there are some 600 picture elements per line, i.e., a picture with maximum possible transmitted detail would only produce 300 sine waves per line. (3) About 15% of any line

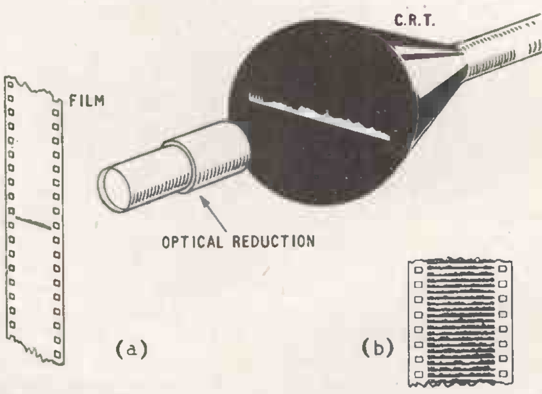


Fig. 1. (a) Essentials of the proposed recording system, with (b) showing how successive traces would appear on the film.

* British Tabulating Machine Company.

time is devoted to the sync pulse and associated "porches".

The modulation of the radio frequency applied to the Y plates differs a bit from conventional practice inasmuch as only the top half of the envelope is allowed to vary. The lower half is clipped by diode action and therefore never displayed. The depth of modulation never exceeds 70%. The effect of these restrictions will produce a display similar to Fig. 2. To understand the need for this we must look in detail at what a portion of a recording would look like and how such a recording is played back.

Just as in conventional sound-on-film recording the length of a slot of light is made to vary in sympathy with the electrical equivalent of sounds, and there are push-pull tracks and single-sided tracks, so this system is recording vision-on-film by making the length of a slot of light vary in sympathy with the electrical modulation components of a picture. The system chosen is a single-sided-track recording because, unlike the sound track, where reference can be provided by the black edge of the film, in this case the reference edge must be provided during recording much as it is done on modern sound-tracks recorded with suppressed-silent-passage techniques. No such refinement is proposed here, but the reference is produced by the clipped lower edge of the modulation. This edge provides the reference required by the next scan, and so on. Notice that there is no need, therefore, for accurate location of the trace on the tube or film during recording. Fig. 2 shows what an enlarged section of recording might look like.

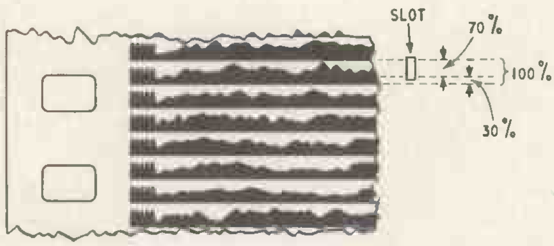


Fig. 2. Magnified section of the film showing the position of the recording slot (right) relative to the traces it produces.

We have glossed rather quickly over the recording techniques because there are certain requirements during the playback operation which influence the recording system and they must be understood before returning.

When a film is run through a camera, even though it be a continuous-motion camera, there is always a certain amount of "wandering." This wander is present even though the same apparatus is used for recording as for playback. This unpredictable movement is small, measured in thousandths of an inch, but is more than can be tolerated in the proposed system because of the minute size of the recording track. Refinement of the film-moving mechanism would be expensive and tedious, so the solution is to nullify the effect of the wander by means of a servo circuit which automatically alters the position of the scanning beam during playback in sympathy with any wander which might occur during recording or playback. This movement is slow in relation to the scan frequency and will be of the order of one scan width in 100 or more.

During the line blanking period a burst of 1-Mc/s modulation is injected. As the flyback is very rapid a portion of the line blanking period appears on the left of the film, complete with 1-Mc/s sine wave. This can be seen in Fig. 2. During playback the image of the "slot" is maintained normally at full amplitude such that its upper extremity travels somewhere in the first 10% of the previous recorded scan and its lower limit is in the first 20% of the present scan. These approximate positions are shown in Fig. 2. As this image sweeps across the recording the amount of light transmitted through the film on to the photocell will be modulated by the configuration of the recording.

When the slot image reaches the end of the scan and flyback occurs, the 15-Mc/s radio-frequency is suppressed so that the slot shrinks to a spot. If the registration during the last scan has been correct, the spot will travel just over the peaks of the sine waves, producing a small amount of 1-Mc/s component in the photo-electric cell and hence the output channel. If the spot is too high no 1-Mc/s output will result and if it is too low then a very large 1-Mc/s output will be produced.

The output channel of the video amplifier is sampled during the line blanking period by means of a gate and these samples are amplified, rectified, and, after RC filtering, applied to the Y plates of the tube.

It is clear that if the correct phase relationship is maintained the beam position will adjust itself so that the amplitude of 1-Mc/s voltage produced will cause a recharging of the RC filter by an amount just sufficient to balance the leakage during the previous scan period. Should the beam be positioned too high, the charge will not be replenished and the beam will drop; if it is too low the charge will be greater and move the beam up. The values in the RC filter must be sufficiently large to give only a small change during any one scan but not so large as to be unable to follow the wander introduced by play in the mechanical components.

Circuit Arrangement

Fig. 3 shows in block form the sort of circuits required. They will consist of two main blocks (inside the dotted squares), one for the recording chain and one for the playback servo circuits.

The recording circuits (on the right) consist of two oscillators. The 15-Mc/s oscillator feeds the modulator, which consists of quite a normal low-power anode-modulated power amplifier stage, containing a means for altering the amount of r.f. drive (negative bias) as a "slot length control" and a diode clipper stage for removing the lower half of the modulation. The 1-Mc/s oscillator feeds the input of the modulator together with the camera signal line. This oscillator will only be energized during line blanking whilst recording.

The playback servo circuits (top left) will consist of a sampling gate, which is open only during line blanking, feeding a tuned r.f. 1-Mc/s amplifier which in turn feeds a diode rectifier and RC filter network. The output of this network is applied as a d.c. shift potential to the Y plates of the c.r.t. and picks up the output of the modulator on its way.

This playback servo chain is, of course, fed from the photocell output via the video amplifier, which also feeds the monitor and transmitter. During the playback the 15-Mc/s oscillator and modulator will still be required because the "slot" is produced by the output of the modulator, but, it will be remembered, this r.f. is partly suppressed during flyback to allow sampling of the 1-Mc/s beam positioning burst. This suppression is achieved by injecting line blanking signals into the modulator during playback. The last block is the time base which is quite conventional. All the circuits which feed the tube deflection plates have been shown as single-ended for simplicity, but would in practice be push-pull for the usual reasons.

The limitations of the highest recordable frequency on such an apparatus are expected to spring from three main causes: (a) finite spot size and halo, (b) afterglow, and (c) tube-screen grain and film-base noise; also the film emulsion.

The effect of (a) will be minimized, apart from using a special c.r.t. fluorescent screen material, by making this tube as large as convenient and running it at high voltages to ensure a sharp focus and, if possible, running it at such a low intensity that the halo is below the "knee" of the film emulsion characteristic.

Regarding (b), afterglow will show up on both the recording and the playback operations as fogging and noise. The "fall away" of glow in oscilloscope tube screen is rapid during the first few micro-seconds, but flattens off with time, so that the above remarks about operating near the "knee" of the response curve will apply here.

Film-Base Noise

On the question of (c), the problem of screen grain will be expanded later. Film-base noise will presumably be of an order equivalent to that produced with standard photographic picture techniques. A possible way of reducing this is by having a white opaque base and picking up the light modulation on the photo cell by reflection from the emulsion side and not by transmission through the film base at all. The capacity of the emulsion to record clearly the small details should be quite adequate. The amazing definition achieved with the so-called "microfilm" is ample proof of this.

There are many other interesting aspects to this proposal, but an extract from the calculations to ascertain the size of the smallest detail to be recorded would not be out of place here.

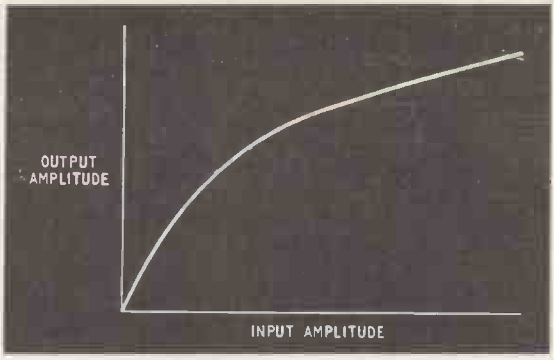
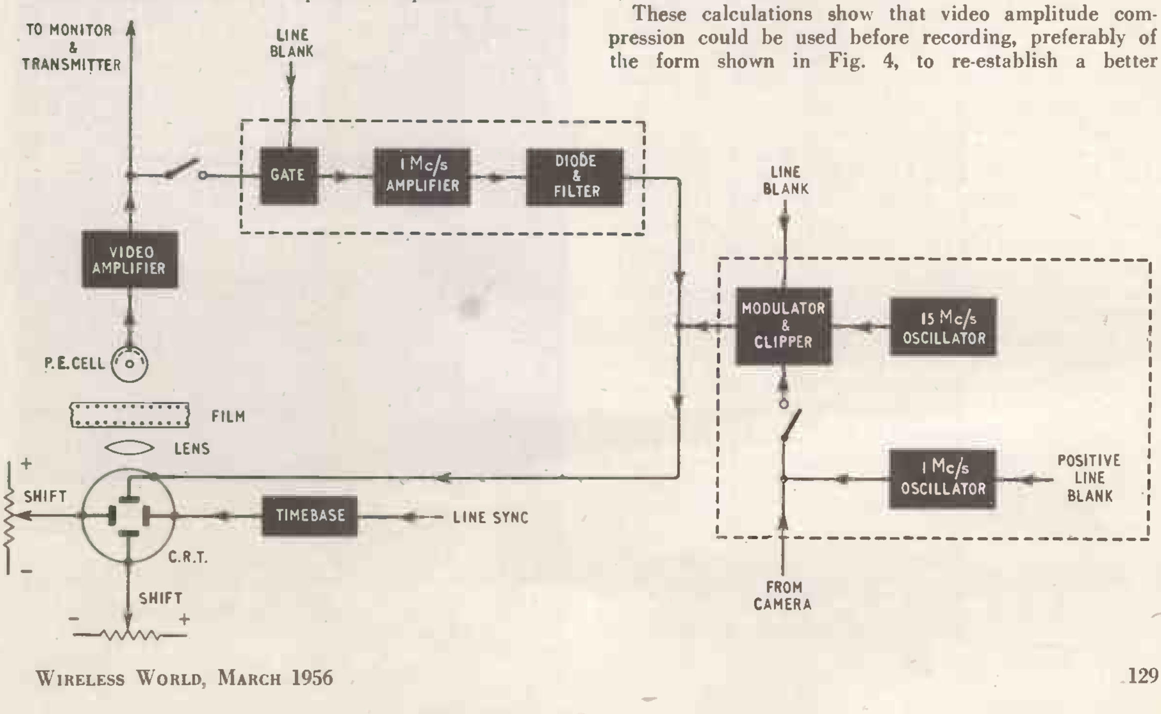


Fig. 4. Recording characteristic with video amplitude compression.

Assuming the film is running at twice normal speed, then 200 scans must be accommodated in a little over 0.75 inch. (There are no partitions between frames, as there are no picture frames, in the film or television sense of the word, and the whole area of emulsion is available to record information.) Then each scan is pitched 0.75/200 of an inch from its neighbour, but only 70 per cent of this is useful information as the modulation is kept at that level. Therefore the brightest to darkest contrast will have a height of $\frac{0.75}{200} \times \frac{70}{100} = \frac{5.2}{2,000}$ or approximately 2.6 thousandths of an inch. Assuming that the smallest gradation of light and black is 1/10 down on this, gives $\frac{0.75}{200} \times \frac{70}{100} \times \frac{1}{10} = \frac{5}{20,000}$ or approximately $\frac{1}{4,000}$ of an inch. As there are 600 picture elements per line and approximately 1 inch is available across the film for this, then the smallest horizontal detail will be 1/600 of an inch.

These calculations show that video amplitude compression could be used before recording, preferably of the form shown in Fig. 4, to re-establish a better

Fig. 3. Block schematic of the system, giving some idea of the kind of circuits required. The recording chain is in the right-hand dotted square while the playback servo circuits are in the top dotted square.



relationship between height and breadth detail on the film. The effect of a recording curve such as Fig. 4 is to curtail drastically the not very often used peak-whites and boost the lower and middle contrasts. The playback amplifier would have a circuit of opposite characteristics to restore to normal. A curve of this form would increase the smallest contrast to 4 times the previous, so the new smallest detail becomes (1/1250) × (1/600) where the frequency component of the signal is still less restricted than the amplitude component. On the other hand, advantage can be taken of this two-to-one asymmetry to reduce the film speed by half and record two consecutive television lines across the width of the film (the time-base repetition frequency must also be halved).

From the previous calculations we can establish the aspect ratio of the "slot", which should be at least half as wide as the smallest horizontal detail, i.e., 1/1200 or less than one thousandth of an inch, and have a height for playback of approximately 3 thousandths of an inch, a ratio of approximately 4:1. If a tube with 10 inches of useful scan is available, then the spot must be 1/1200 of this, which is 1/120 of an inch—quite a tall order, but achievable. (The present "flying spot" film transmission is quite adequate.)

If the height of the slot at maximum was measured on the tube it would be only 1/32 of an inch, which implies that the smallest contrast (vertical) detail might be lost in the screen grain. To circumnavigate this the maximum height of the slot measured on the tube should be increased to one inch and the aspect ratio restored by optical means before reaching the film.

Variable Intensity Systems

During discussions on this subject doubt has been cast on the possibility of providing cheap enough film stock capable of resolving such small gradations in area. The "microfilm" previously mentioned has an adequate definition but may be prohibitive in cost. For this reason it might be best to utilize a variable intensity recording, where the apparatus remains the same as described but the video modulation is applied as an intensity modulation to the c.r.t. beam and not as a slot-length variation. This brings the system very close to those described by Wood* and Hulme† which unfortunately were not brought to the author's attention until after this article was written.

The proposal has been made with television signal recording in mind because it is an obvious application, but the possible advent of high-speed magnetic tape recorders capable of handling similar bandwidths may detract somewhat from its usefulness. Nevertheless, it is worth noting that the magnetic tape will have to be run at high speed, while the film in this system does not. Moreover, the system does not suffer from the stretching and distortion which is a serious drawback in high-speed magnetic tape. Further, it offers a more permanent form of recording which cannot be accidentally erased, and the mechanical handling equipment is in existence and would need little alteration.

And, last but not least, it is a variable-area system and not variable intensity, so that the poor response of film to delicate gradations of light, evident in the low quality of variable-intensity sound track, will not mar the picture.

* Wood, C. B. B. "Some Fundamental Aspects of Telerecording," *J. Television Soc.*, Oct.-Dec., 1953.
† Hulme, V. B. "16-mm Telerecording for Sequential Television Systems," *Electronic Engineering*, Dec. 1955.

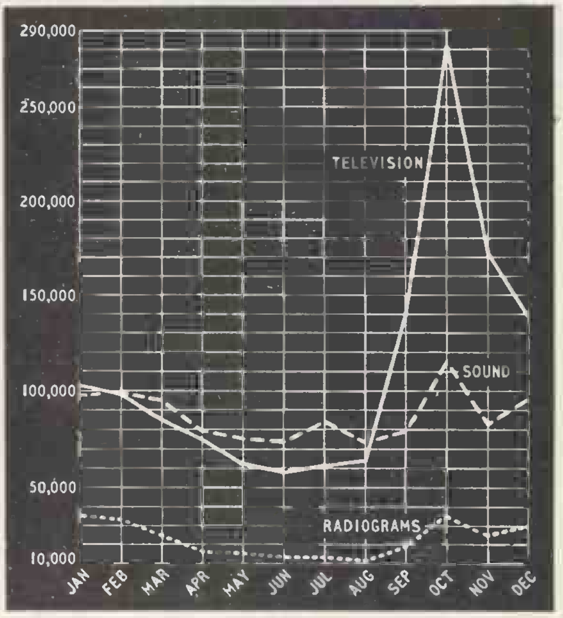
Yachtsman's Echo Sounder

A COMPACT supersonic echo sounder designed to work from a 12-volt battery and costing only £75 is announced by Pye Marine, Ltd., Oulton Works, Lowestoft.

The operating frequency is 200 kc/s and a single transducer, fitted to the bottom of the hull, is used for both transmission of a 1/3 msec pulse and the reception of the echo from the sea bottom. The repetition rate is 9.1 per second.

Pye "Leadsman" echo sounder with transducer and hull gland. The overall dimensions of the unit are approximately 13 3/8 in × 8 1/2 in × 7 3/4 in.

A neon lamp attached to the end of a rotating arm indicates the interval between the transmitted and received pulses against a scale calibrated in both fathoms and feet. The accuracy of calibration depends on constant speed of rotation, and to achieve this in face of possible voltage fluctuations, the arm is driven by a synchronous motor deriving its current from a high-stability vibratory convertor.



RECEIVER SALES. — A summary of the retail sales of domestic receivers during 1955, issued by the British Radio Equipment Manufacturers' Association, reveals that by comparison with 1954 the total sales of television receivers rose by 6% to 1,335,000. The sale of sound receivers fell by 14% to 1,048,000, and radio gramophones by 10% to 269,000. In this graph we give the month-by-month sales of domestic receivers during the year.

MATHEMATICS

"CATHODE RAY" on the Proper Use of a Much Abused Science

SOME while ago* I was charged with writing in a manner likely to increase readers' fear of mathematics. While admitting that such conduct, if proved, would be reprehensible, I held that the intention — and especially on the particular occasion given as an example — was precisely the opposite. And bearing in mind that the road to hell is said to be paved with good intentions, I produced evidence that this intention had not been left at that; the reader, so far from having been given cause for alarm, had been led gently by the hand right up to a typical mathematical weapon — the cosh — and shown there was really nothing to be afraid of.

However, if I repeat my defence too much you will suspect a guilty conscience — " Qui s'excuse s'accuse ". The fact is that a shortage (I hope temporary) of requests has thrown me back on my own choice of subjects, and the little argument just recalled triggered off a meditation on the use and abuse of mathematics in technical literature.

It would be easy if, in the " 1066 and All That " manner, we could pronounce maths to be either a Good Thing or a Bad Thing. But it can be both, according to where and how it is used; and opinions differ However, we can perhaps at least clear up some misunderstandings.

Real Purpose of Maths

First, what is mathematics for? Some may suspect that it is used with an ulterior motive — to keep out the uninitiated and establish a privileged class, to make things more difficult, or to show off. How many, on the other hand, believe that the real purpose is to make things *easier*; to *save* time and effort? Yet that really is the idea.

To most people — even technical people — it seems obvious that a mathematical paper is more difficult to follow than a non-mathematical one, other things being equal. Those who don't find it so — the mathematicians — are classed as abnormal.

There are several reasons for this. No doubt the early civilizations that " wrote " in little pictures took a similar view of non-pictorial writing when they were first confronted with it. No doubt we ourselves in our early youth looked on printed books in that light. Even such a well brought-up little girl as Alice took a dim view of the book her big sister found so absorbing, because it had no illustrations. Yet in a few years we too could read without effort (more or less!) and now " plain English " is our standard of what is simple and straightforward. Even quite unintelligent people can read more than 15 symbols per second. This is really rather remarkable, especially considering that in English there is no consistent relationship between the symbols used and the sounds they represent. But however incomprehensible and distasteful these symbols once appeared to us, we were kept at them until they became meaningful and easy. (I am aware, of course, that there are millions of people who never get beyond the comic-strip stage, but they would hardly be reading this.) And while all agree that pictures and diagrams have their uses and can often advantageously be substituted for words, it would be inconvenient — even tedious — if words were banned altogether.

I feel sure that the trouble with a lot of the anti-mathematicians is that either they were not kept at maths long enough for the symbols to become meaningful in the way written words did, or they were kept at it in the wrong way, so that they never really grasped what it was all for. While, at this distance, I am prepared to admit that my teachers did a pretty good job on the whole, I do think they could have made maths a lot easier and more acceptable if they had told me at the start what (for example) was the point of the apparently futile occupation of carrying out arithmetical operations with letters instead of numbers. From what little I have seen of present-day school teaching I have no reason to believe that the same educational mistake is not continuing to be made.

The need for a clear explanation of the purpose of mathematical symbols is all the greater because several distinct purposes are often mixed up together. Symbols are sometimes used as mere abbreviations; for example " V " to mean " volt " or " valve ". Then they are used, often in the same context, in their more strictly mathematical role of standing for quantities whose values are unknown or unspecified. In this sense " V " might mean the potential difference between two specified points. Lastly, some symbols mean mathematical operations; " + ", " ÷ ", " √ ", etc., are unmistakable. but " d/dx " looks like an ordinary algebraical expression that could be simplified to "$1/x$" unless one happens to know that it is an instruction to "differentiate with respect to "x" whatever it is written against. This, of course, is confusing to the uninitiated, but is easier to learn than (for example) how to read " bough, cough, dough, lough, rough, through ", etc. "d/dx" does at least always mean the same thing. It is even the same thing in other languages, which is more than can be said of the words it stands for. This applies to most mathematical symbols. So work written mathematically hardly needs to be translated. That is an advantage worth remembering even if it doesn't seem likely to affect us directly or by itself amount to enough to justify mathematical writing.

Shortage of Symbols

It must be admitted that there is another side to this. There are not nearly enough symbols, even bringing in Greek and all the available varieties of type, to allow one for every possible thing. So each may have to bear a number of different meanings. The people who arrange these matters try to see that these different meanings are distributed in widely different fields of study, so that there is unlikely to be any doubt which applies. In *Wireless World* " L " can pretty confidently be taken to mean inductance, and it doesn't matter if biologists or astronomers — or motorists! — use it to mean something else. " μ " is more difficult, because even in *Wireless World* it could have at least three different meanings, but there is seldom any confusion. After all, in " plain " English many words, such as " box, " have several alternative meanings, but we can usually tell from the context which applies.

* *Wireless World*, Jan. 1955, p. 22. Reply : Feb. 1955, p. 72.

A more serious difficulty with mathematical symbols, I think, is that the standard list doesn't get one very far. When we have learnt that list we know that "I" stands for current, "E" for electromotive force, "R" for resistance, and so on; but it is wrong to write even such a thing as

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

without further explanation. The current that flows through a resistance of 500 ohms when an e.m.f. of 5 volts is applied is 10 milliamps. Yet when we substitute these numbers for the letter symbols we get

$$10 = \frac{5}{500}$$

which is not exactly true! When one first presents the concise statement "$I = E/R$" it is absolutely necessary to mention that if E represents the e.m.f. in volts and R the resistance in ohms, I is the current in *amperes*. It is also necessary to say something about the circumstances in which this relationship holds. Seeing, then, that the whole thing has to be written out fully in words anyway, why bother to bring in mathematical symbols at all? Well, there are two reasons: one is that "$I = E/R$" is a handy reminder of the general law that has been fully stated in words; and secondly, in a whole article or book it may be necessary to refer to certain quantities very many times, but as they need only be defined in words once the saving can be considerable.

But this does point to a very common misuse of mathematics — expressing things in abbreviated symbolic form without making clear beyond all misunderstanding (1) what the symbols mean, and (2) in what circumstances the statements made with them are true.

And it does also explain why even those of us who are reasonably accustomed to maths nevertheless find mathematical writing something of a strain to follow. For most if it, the standard symbols by themselves are too general; there may be half-a-dozen or more voltages in a circuit under discussion, and it is necessary to define symbols V_1, V_2, etc. Some of the burden of remembering these can be avoided by adopting a regular system such as "V_{ab}" to mean the difference in potential between points *a* and *b* on the circuit diagram. But quite often there are quantities completely unprovided for on the standard list — such things as the ratio of the resonant frequency of a tuned circuit to the frequency at which the voltage across the circuit is $1/\sqrt{2}$ times that at resonance. In such cases the writer has to choose a symbol for his particular purpose, preferably one that cannot easily be confused with anything else, and which is in accord with certain general principles that have been recommended †.

Problem of Special Symbols

Unless the reader is gifted with an exceptional memory, the effort of keeping in mind the meanings of these special symbols during a prolonged mathematical treatment adds considerably to the labour of reading it. And if one forgets, and the definitions are scattered through the article or book, there may be further labour in locating them — hence the benevolent practice (not always adopted) of providing a "Table of Symbols" in which they are all collected together. In any given case, the amount of strain imposed on the reader depends very much on how much care the writer has taken to use no more special symbols than are needed to make his meaning clear, and to choose and define them appropriately.

It depends, too, on how much has been written mathematically and how much in words. Whatever the writer does will be wrong — for some people. If he uses any mathematical symbols at all, some readers will be frightened away. As Eddington said,** "If in a public lecture I use the common abbreviation *No.* for a number, nobody protests; but if I abbreviate it as *N*, it will be reported that 'at this point the lecturer deviated into higher mathematics'." On the other hand, to make any concession to the mathematically weaker brethren is to invite the criticism — not to say contempt — of the enlightened, who point out how much more concisely or precisely or elegantly it could have been expressed mathematically. Rightly or wrongly, my own aim is to put into English some of the things that are usually said mathematically, or into simple maths the things that are usually given in more advanced terms. Quite a number or readers appreciate this; but there are others. Sometimes these others may be right. It is a mistake (so I have gathered) to keep a baby too long on milk. It retards his proper development. And not long ago a correspondent pointed out (quite kindly) that in the attempt to provide a non-mathematical demonstration of the fact that

$$\int_0^{2\pi} \sin m\theta \sin n\theta \, d\theta = 0 \qquad (m \neq n)$$

I had twice slipped up ††, and that this would never have happened if readers had been asked to accept a simple trigonometrical formula (presumably the one I have just quoted).

While I entirely admit this, and regretfully apologise for the inaccuracies, I still think it right to make the attempt to present technical information non-mathematically. This, I hold, would be so, even if every reader were mathematically developed enough to "accept the simple trigonometrical formula". It is dangerously possible to have one's head full of mathematical formulæ, simple and otherwise, and not be able to make good use of them, through lack of a clear idea of how they are connected with practical affairs.

It may be that I ought to say to readers "Look here; it's going to be good for you that I should be tough and do things the mathematical way, so that if you can't understand it you will jolly well have to learn the necessary maths". But perhaps those who advise that line of talk imagine that people learn things at one go. If some people do, I haven't come across them. The normal way is for things to sink in gradually. So although in theory it may be correct to confront the learner from the start with the most refined presentation, in practice it is likely to be a sheer waste of time.

Suppose an average youth who had decided to go in for radio asked about wireless waves, and his teacher told him that all he needed was

$$\text{curl } \varepsilon = -\frac{\partial B}{\partial t}$$

$$\text{curl } H = i - \frac{\partial D}{\partial t}$$

$$\text{div } D = q_v$$

$$\text{div } B = 0$$

the shortage of future radio engineers would thereupon probably increase by one. If people had to wait until

† For example, in British Standard 1991: Part 1: 1954.

** "The Philosophy of Physical Science", p. 137.

†† "More About Fourier", *Wireless World*, Oct. 1995, pp. 508 and 509.

they could accept information in its most concise form, very few would even start. So there is a use for presentation of the same principle at different levels. After the learner has gained some idea of a thing in descriptive terms, then is the time for somebody to come along and show how it can be expressed more concisely and perhaps more precisely.

That doesn't necessarily mean that ultimately every page would be a mass of maths. It would hardly be an appropriate medium for describing the carrying out of an experiment, say. But the quantities involved in the experiment would presumably be expressed in symbols, for convenience in graphs and tables and for frequent reference. They would also enable the results of the experiment to be expressed concisely and clearly.

This is merely shorthand, however; not mathematics. But mathematics can often be used to develop experimental results or other known information into new conclusions. This is the stage at which words become unbearably clumsy and mathematical expression is fully justified. Often it forms the main "meat" of students' textbooks, in which a few assumed or previously established facts are used as the starting points for a gradually expanding field of knowledge. Provided that the development is clear, and the significance of the results is stated every so often in words, one cannot argue against mathematical treatment here.

Elsewhere, as in technical articles and reference books, the practice of showing mathematically how statements made were derived and in what conditions they hold good, rather than leaving them bare and unsupported, is commendable. But the trouble is that certain writers — the showing-off and over-zealous types — display their mathematical proofs everywhere as they go along, interrupting their own discourses with what the hasty reader may not want at all. The proper place, of course, is in an appendix or footnote, so that sceptical or thorough readers can have them, but those who are prepared to take the author's word do not have to work laboriously through a lot of maths only to find that it was quite optional or even totally unnecessary.

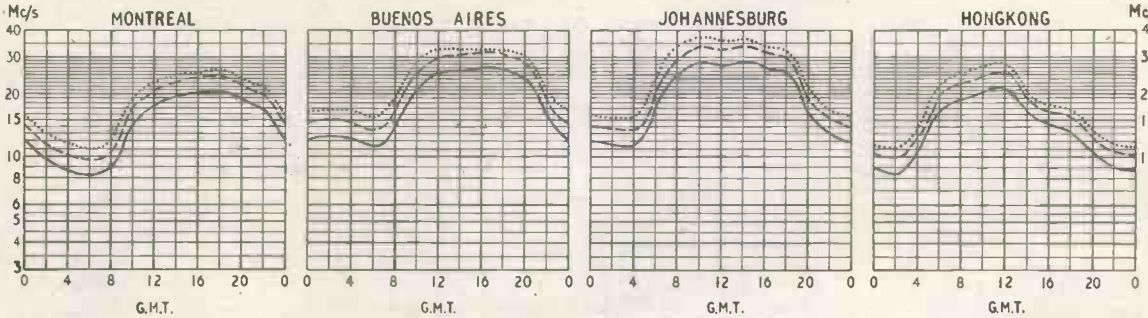
At the word "laboriously" my critics will perhaps say "There he goes again, making out that it is so difficult and frightening people away". If so, I would point out that to work through the same information expressed in words would probably be even more laborious, even though the meanings of the words would not, like the symbols, have to be learnt specially for the occasion. It is sometimes overlooked that because of its much more concise form mathematical writing is almost bound to demand more time and effort from the reader *per square inch of paper*, but the proper basis of comparison is the amount of information conveyed.

Mathematics not only saves time by its abbreviated forms of expression, but saves thought as well by enabling previous results to be used without going through the derivations in full every time. When we calculate mentally that if we buy half a dozen sevenpenny articles they will cost us three and six, we are making use of a number of previously ascertained results. Otherwise we would have to put down six lots of seven counters, sort them into groups of twelve and then count the groups and the left-overs. Similarly, as in the example quoted at the beginning, making use of a table of coshes saves a lot of algebra. The differential and integral calculus is a good example of how calculations that would be very difficult and laborious can be made quick and easy — almost automatic — by following simple rules that someone has been kind enough to find out the hard way. To use them intelligently we all ought to do them the hard way — once. After that we can with a clear conscience take the short cut every time. If each time we did this we had to explain the rules in full for the benefit of others, the advantages would be considerably reduced

To sum up then, let me suggest to those who grumble whenever they come across some maths that if they really want to get anywhere with this thing it would save trouble in the long run if they got down to it and learnt the rules; and that my attempts to put things as non-mathematically as possible are not intended to dissuade anyone from going on to more mature study. And of the mathematical critics I would ask: Is all your mathematics really necessary? And can you honestly say that your motive throughout is to help your reader (less brilliant, perhaps, than yourself) and not to demonstrate how clever you are?

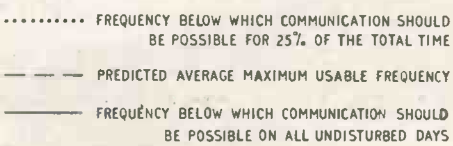
SHORT-WAVE CONDITIONS

Predictions for March



THE full-line 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 March.

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



Simplified Band III Convertor

DESIGN FOR USE IN AREAS OF HIGH SIGNAL STRENGTH

By O. E. DZIERZYNSKI

The complete Band-III convertor. The box-like projection on the front of the unit contains a dial mechanism showing the actual television channel to which the convertor is tuned. This is a refinement not dealt with in the text.

THE majority of Band III convertors employ an r.f. amplifier followed by a combined mixer/oscillator frequency changer arranged as shown in the schematic block diagram Fig. 1. Its input circuit is matched to an 80-ohm feeder while the output is matched to the input impedance of an orthodox television receiver; this also is of the order of 80 ohms.

An r.f. amplifier can be justified when the Band-III signal is considerably weaker than the Band-I signal, or where a single aerial, with optimum tuning in Band-I, is used for both purposes. The simplified convertor described in this article is intended for use where the Band-III signal is quite as strong as the Band-I signal and no amplification, except that provided by a frequency changer, is needed before feeding it into the television set.

Circuit Requirements.— Details of the circuit employed for the convertor are given in Fig. 2. From this it will be seen that an r.f. amplifier is omitted and the Band-III signal, as received by the aerial, is applied *via* a high-pass filter and input transformer (T_o) to the grid of the mixer section of a PCF80 frequency-changer valve. A 9-in length of coaxial cable, with a plug and socket connection at the filter end, joins the two units and the outer screening braid of this cable must be the only "earth" connection between the two units. The cable connection must be retained if the filter is embodied in the convertor

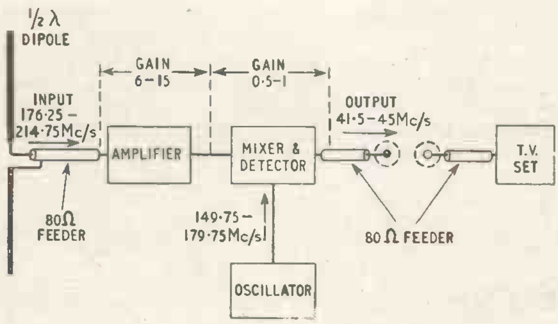


Fig. 1. Block schematic diagram of a conventional Band-III convertor.

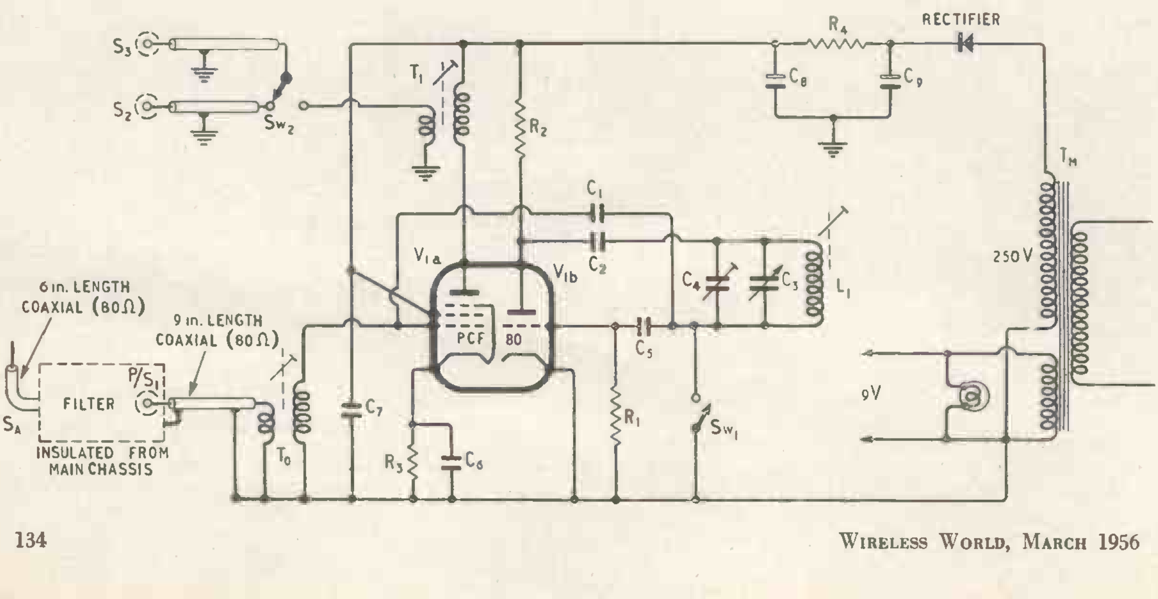


Fig. 2. Theoretical circuit diagram of the simple convertor described in the text.

LIST OF COMPONENTS

CAPACITORS

C_1	2.5 pF miniature, 250 V wkg.
C_2, C_6, C_7	1,000 pF miniature, 250 V wkg.
C_3	2-10 pF air-spaced variable on ceramic base.
C_4	3-30 pF air-spaced concentric trimmer (Mullard).
C_5	15 pF miniature, 250 V wkg.
C_8, C_9	32 μF electrolytic, 350 V wkg.
C_{10}, C_{11}, C_{12}	3-30 pF air-spaced concentric trimmer (Mullard).
C_{13}, C_{14}, C_{17}	2-15 pF air-spaced trimmer.
C_{15}	2.5 pF miniature ceramic.
C_{16}	500 pF mica trimmer.

RESISTORS

R_1	1,200 Ω	¼W
R_2	20 kΩ	¼W
R_3	1,500 Ω	¼W
R_4	2,700 Ω	1W

MISCELLANEOUS

1	Mains transformer. Pry; 200/250 V, 50 c/s. Sec; 250 V r.m.s., 20 mA; 9 V 0.3 A.
5	Coaxial sockets.
	Coil formers, cores and screening cases; see text.
V_1	PCF80 valve.
Pb	12 V pilot lamp.
1	Epicyclic reduction drive.
1	Contact - cooled rectifier, Type 16RC1-1-16-1 (Westinghouse).

unit and there is a space for it, as shown in one of the illustrations, on the top of the convertor chassis. It was more convenient, however, to have the filter separate during the development stage.

Another feature of interest is that the oscillator circuit (the triode section of the PCF80) tunes continuously and without switching over the whole of Band III.

With a conventional Band-III convertor; that is, one embodying an r.f. amplifier, the overall gain lies between 6 and 15, most of which is provided by the r.f. stage. With the circuit employed in the present case only the mixer section of the PCF80 valve can be relied on to provide any amplification. It is therefore vitally important that this stage is operated under the most favourable conditions.

The grid input transformer, T_0, should provide, theoretically, a voltage step up of about 2, but inevitably imperfections in the impedance matching between aerial and feeder, and feeder and input to the filter, will reduce the probable gain between aerial and mixer to unity, or less, over the working range of frequencies.

The most important factors contributing to the gain of the mixer stage are the operating grid bias, the injected oscillator voltage and the efficiency of the output circuit. The values given in Fig. 2 for R_3, the bias resistor and C_1, the oscillator coupling capacitor, together with the design of T_1, the output transformer, will ensure the highest gain from this stage. Measurements made with the unit at different parts of Band III yielded the following amplification figures:—

Channel 6 ...... amplification = 2
Channel 9 ...... amplification = 1.6
Channel 13 ...... amplification = 1.4

It must be pointed out that these figures represent the overall gain of the convertor, being the ratio of the Band-I signal (after conversion) applied to the television set and the actual Band-III signal injected into the primary winding of T_0. The actual amplification of the mixer stage alone is considerably greater and, expressed as the ratio of the Band-I signal at the primary of T_1 and the Band-III signal applied to the mixer grid, varies between 4 and 8.

Particular care is needed also in the layout and wiring of the oscillator circuit in order to achieve the desired coverage and ensure a reasonably constant output and good frequency stability. A maximum variation of ± 50 kc/s over a period of time is a good target at which to aim. With the output transformer T_1 tuned to Channel I (Band I) the coverage required of the oscillator is 132 to 175 Mc/s. This will be subject to modification for other Band-I channels.

In order to keep the frequency drift of the oscillator as small as possible a low-inductance coil is used for L_1 with as much fixed capacitance in the trimmer C_4 (Fig. 2) as the circuit will tolerate. Nevertheless it will be found that the tuning capacitor, C_3, contributes the major

COIL TABLE

Pos.	Function	Details
L_1	Oscillator	1½ turns No. 18 s.w.g. En wire on ¼in dia (approx.) polystyrene former with turns spaced $^1/_{16}$in. Core, dust iron.
T_0	Band-III input trans.	1½ turns No. 18 s.w.g. En wire ¼in dia polystyrene former with turns spaced $^1/_{16}$in. Core; dust iron.
T_1	Band-I output trans.	Channel I; primary, 20 turns No.24 s.w.g. En wire close wound or 0.3-in dia (approx.) polystyrene former; secondary 3 turns overwound at "earthy" end. Core; 0BA threaded brass slug ½in long. Channel 5; primary 4½ turns No. 20 s.w.g. En wire close wound or 0.3in dia (approx.) polystyrene former; secondary 2 turns overwound "earthy" end. Core; dust iron. Screening can for T_1 ¾ in × ¾ in × 1⅜in high.
L_2-L_5	Filter coils 0.113 μH	3½ turns No. 20 s.w.g. spaced to fill $^3/_{16}$in on polystyrene former 0.3in dia (approx.). Core; dust iron.
L_3	Filter coil 0.07 μH	2½ turns No. 20 s.w.g. spaced to fill $^1/_8$in on polystyrene former 0.3in dia (approx.). Core; dust iron.
L_4	Filter coil 0.035 μH	1½ turns No. 20 s.w.g. spaced to fill ⅛in on polystyrene former 0.3in dia (approx.). Core; dust iron.

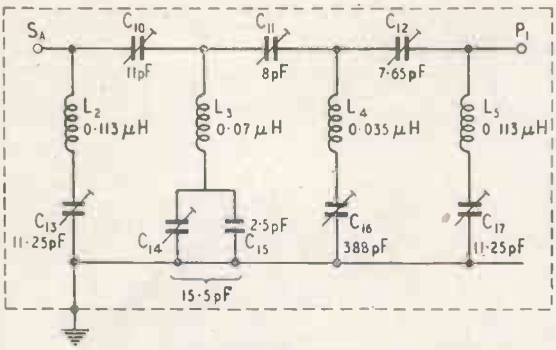


Fig. 3. Circuit diagram of the filter unit.

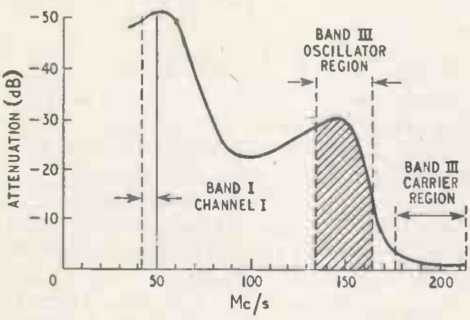


Fig. 4. Attenuation curve of filter unit.

part of the total capacitance. While C_3 is shown as a single earthed-rotor type variable capacitor, it is thought that a split-stator, or butterfly pattern, might improve the performance of the convertor by maintaining a more constant oscillator output. If one of this pattern is employed it should be borne in mind that to achieve the same tuning range as with the original C_3, each section of the double capacitor must have twice the capacitance of C_3. Ceramic insulation is preferred.

The required frequency coverage (132 to 175 Mc/s) is obtained by fixing the highest frequency by adjustment of C_4 and the lowest by adjustment of the dust iron core in L_1. Changes at one end reflect on the other so several attempts will be required to achieve the desired oscillator range.

In regions other than London the oscillator coverage is given by the following simple formulæ:—

$F_{min} = 174 -$ Band-I channel (Mc/s)

$F_{max} = 216 -$ Band-I channel (Mc/s)

For example take the Birmingham district where Channel 4 in Band I is employed; the oscillator coverage will be 115 to 158 Mc/s (approx). The Band-III input circuit can be tuned to favour Channel 8, or T_0 tuned to the mid-point of the band.

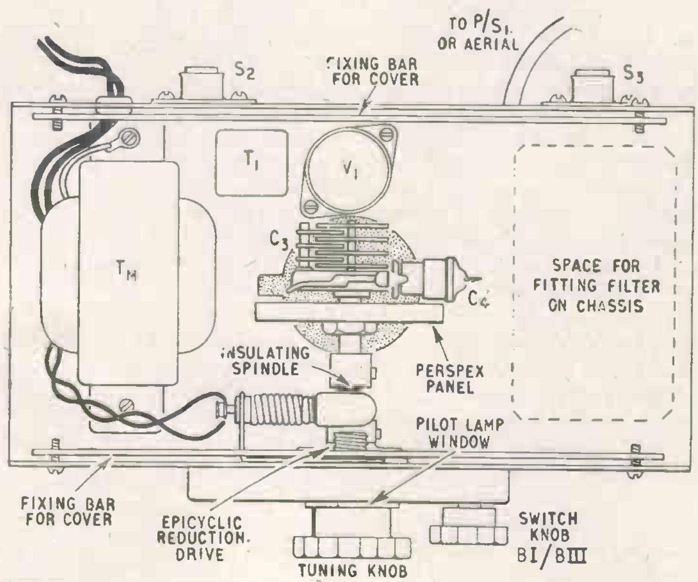
The output transformer T_1 has to be tuned to the local Band-I channel; for London 42 Mc/s is suggested and for Birmingham 59 Mc/s. These are close to the sound frequencies of the particular stations and are chosen in preference to the vision frequencies as the receiver's input circuits will most likely have a bias towards the vision frequencies and choosing the sound for the convertor's output stage simulates a band-pass coupling and gives a flatter response over the particular Band-I Channel in use.

The convertor's output transformer T_1 is tuned mainly by the valve capacitance, the self capacitance of the coil and circuit stray capacitance. However, some control is provided by the use of a brass slug (threaded 0BA).

Filter.— The r.f. stage in a conventional convertor provides not only pre-conversion amplification but serves also as a buffer to re-radiation of the local oscillator, the Band-I converted Band-III signal and to break through of Band-I signals. Spurious frequencies arising in the mixer stage are likewise kept out of the aerial. As no such protection is provided by the circuits of the convertor described here a special filter has been designed which passes all Band-III frequencies and heavily attenuates the oscillator and Band-I frequencies. As the lowest Band-III frequency is 176.25 Mc/s (Channel 6 sound) and the highest oscillator frequency 169.75 Mc/s (for Channel 13) the cut-off frequency chosen for the filter is around 173 Mc/s. The circuit arrangement of the filter is shown in Fig. 3 and its measured response characteristic in Fig. 4. The input and output impedances are 80 ohms.

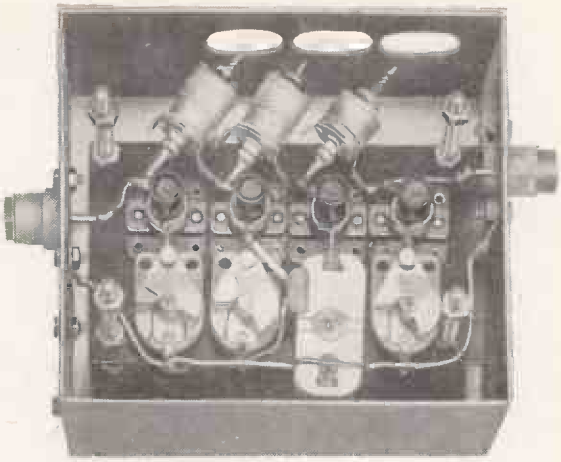
It must be emphasised that the response curve of Fig. 4 was taken with the input matched to 80 ohms, corresponding to a half-wave dipole aerial and an 80-ohm feeder. If a short rod aerial (say 14-in) is used, and one of this kind should be satisfactory in areas of high field strength, the impedance of the aerial could be

Fig. 5. Layout of parts on the top side of the chassis.



almost any value and the behaviour of the filter will be unpredictable and not quite as shown in Fig. 4. In order to compensate for impedance mismatch of this kind with a short aerial a piece of 80-ohm coaxial catch is interposed between the aerial and the filter. With a 14-in rod a 6-in length of cable proved satisfactory. The most vulnerable points in the circuit where unwanted signal pick-up (or radiation) can occur are the output transformer T_1, aerial switch SW_2 and the leads to sockets S_2 and S_3.

Construction.— The illustrations show the appearance of the convertor and filter. The filter is assembled on a panel of Bakelized material measuring $3\frac{5}{8}$ in $\times$ 2in and is housed in a screening box measuring 4in $\times$ $3\frac{1}{2}$ in $\times$ $1\frac{3}{4}$ in. Alternatively there is space for it inside the convertor's cabinet and on the top side of the chassis (see Fig. 5) but some reduction in its size will have to be made to accommodate it.



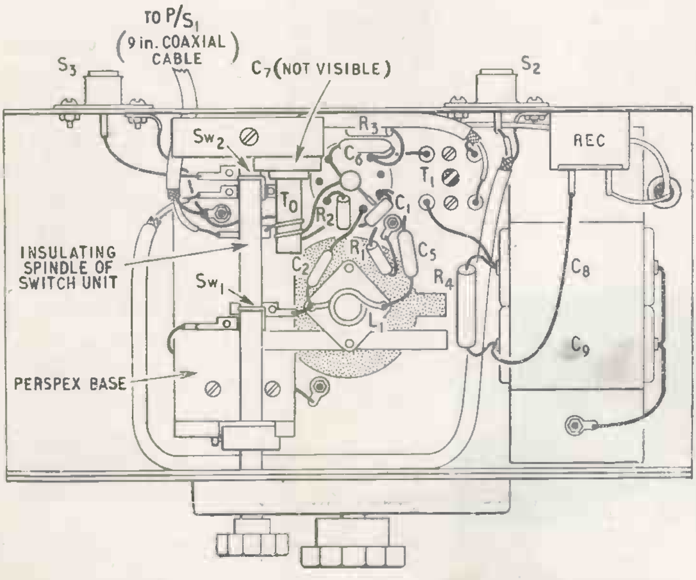
View showing the layout of parts comprising the filter unit.

Layout of the components is vitally important in a convertor of this kind and accordingly two detailed plans, Figs. 5 and 6, showing the top and bottom of the chassis respectively are included here. Fig. 7 is a sketch of the chassis and part of the case, for which aluminium can be used. The top and sides shown open in Fig. 7 are closed by a cover of extruded metal of the kind used for loudspeaker fronts. It is not essential, of course, to adhere strictly to the design of the cabinet illustrated but the layout of the parts must be followed faithfully. The extruded-metal top and sides provide ventilation and this is a vital factor for good frequency stability. Any alternative form of screened cabinet should, therefore, be equally well ventilated, but the method of achieving it is not of great importance.

Figs. 5 and 6 are largely self-explanatory but possibly a few points may need clarifying. The shaded area below C_3 and C_4 in Fig. 5, and below L_1 in Fig. 6, is a cut-out in the chassis to reduce stray capacitance in the oscillator circuit. It is shaped in the manner shown, with two slots each side of a circle, in order to provide a means of fixing the small vertical Perspex bracket supporting C_3 and C_4 on the top side of the chassis and L_1 below the chassis. Although Perspex is mentioned any good v.h.f. insulating material, such as polystyrene, can be substituted. Pliable materials would of course be most unsuitable however good their v.h.f. qualities.

The space where the filter could be accommodated is shown on the right-hand side of Fig. 5. Although not fully visible there is an epicyclic reduction drive between C_3 and the tuning knob. Incidentally C_3 is joined to drive by an insulated spindle and a small metal coupling collar. From Fig. 6 it will be seen that the input transformer, T_0, of the convertor is mounted horizontally, this is done in order to keep the leads to it short. It has a dust core and access to it for adjustment is *via* a hole in the back panel of the unit.

Fig. 6. Layout of parts on the under side of the chassis.



Certain precautions in the wiring are needed and while the correct placing of the components will in most cases automatically ensure the wiring being as planned, since most of the wiring is actually the component wires, care in wiring S_3, S_2, SW_1 and SW_2 is essential. The long all-round-the-chassis lead from S_2 to SW_2 is not as bad as it seems as coaxial cable is used. The connections to S_3 need more care and the two leads (centre and outer connections) should be sleeved wires and run close together and parallel as shown in Fig. 6. This is essential despite the fact that the outer sleeve of the coaxial socket is actually bolted to the chassis.

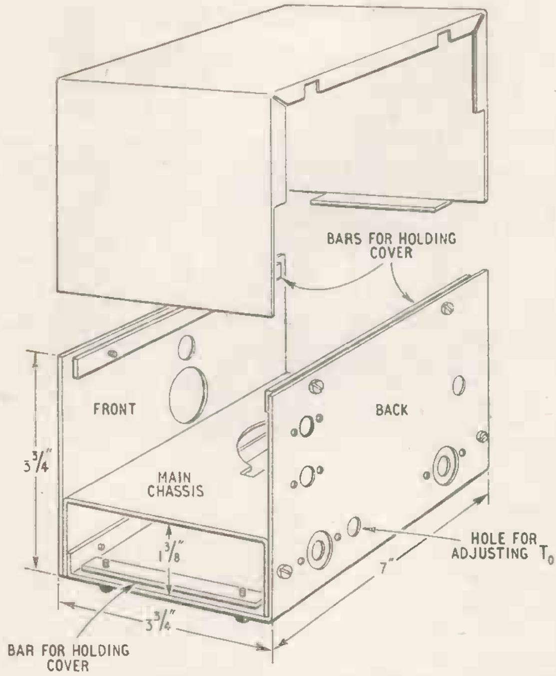


Fig. 7. Sketch of the case and chassis; (below) the sheet metal part, (above) the extruded metal cover.

This brings us to the band switch SW_1/SW_2. Actually the unit would be easier to build if band-switching were omitted and the feeders connected externally to their appropriate sockets as the need arises. But switching is admittedly more convenient and those who have facilities for making the special switch required might well include this facility. If the aerial switching is omitted then S_2 becomes redundant as an aerial connection and S_2 in Fig. 6 becomes S_3 (the output of the convertor) and the long coaxial lead from S_2 to the switch disappears.

Fig. 8 is a sketch of one of the switches SW_1, SW_2. In some respects it resembles an earlier kind of waveband switch and consists of an insulated rod with a metal ring around its circumference permanently contacting the spring C. The lug projecting lengthwise from this ring contacts in turn springs A or B. It is simple, effective and of low capacitance. Two similar switches are required. The rod has to be supported in bearings, front and back, but these might well be left to the ingenuity of the constructor. However, if ¼in diameter rod is used it can be supported in ¼in (hole diameter) panel bushes and ¼in collars (with fixing screws) used to prevent

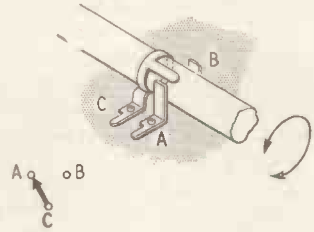


Fig. 8. Details of aerial change-over switch SW_2; SW_1 is built on to the same rod.

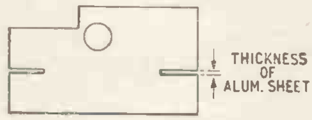


Fig. 9. Details of the Perspex panel supporting the oscillator tuning capacitor C_3 and padder C_4.

end-play. The SW_1 section of this switch need have only one contact (A or B) as it is an on/off, not a change-over switch.

It was mentioned earlier in this article that C_3 and C_4 are mounted on a Perspex bracket fixed vertically on the chassis. Fig. 9 is a sketch of this bracket; it is $^3/_{16}$ in thick and the large hole, which takes the fixing bush of C_3, is positioned so that the epicyclic drive just clears the top face of the chassis. The two slots each side are just wide enough to be a tight sliding fit on the aluminium chassis. The procedure for mounting it is to drop it through the slots on each side of the circular cut-out, so that the thin slots in the Perspex are in line with the chassis, and then slide it into the position shown in Fig. 5. The part which projects below the chassis can be used to support the coil L_1, which can be fixed by a small bracket, or cemented to the Perspex with polystyrene cement, or other suitable adhesive. Incidentally the Perspex panel should be fixed in position with a blob or two of this adhesive.

When the final adjustments have been made to the coils their cores, where used, should be secured in position and the simplest way, perhaps, of doing this is to pour in a little melted wax.

Filter Alignment.— The best way of aligning the filter is first to adjust all the pre-set capacitors (C_{10} to C_{16} inclusive) on a bridge to the values

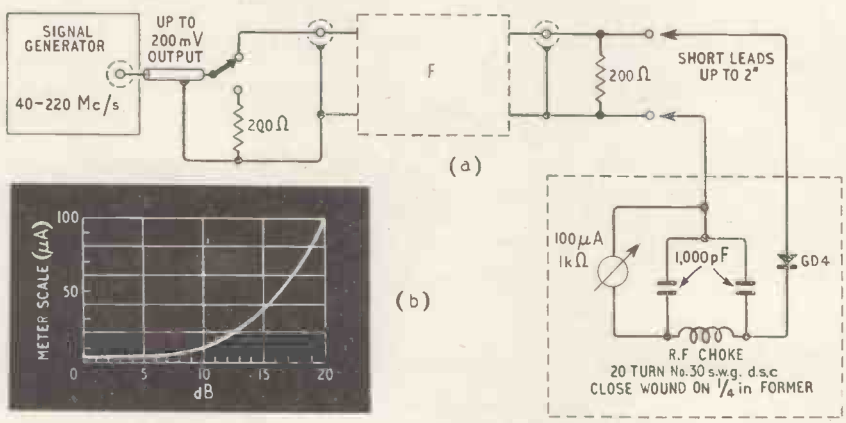


Fig. 10. (a) Schematic diagram of test set-up for aligning the filter; (b) calibration curve (in dB) of output meter.

marked in Fig. 3. Having wound the coils to the specification their cores are adjusted, with the aid of a signal source and output meter, to give the required attenuation curve (Fig. 4).

The schematic diagram Fig. 10(a) shows the arrangement of a simplified form of measuring apparatus, and Fig. 10(b) a typical calibration curve of a home-made sensitive output meter using a 0-100 microammeter. Procedure is as follows:— A signal in the working range 40 to 220 Mc/s, is injected at B into a dummy load consisting of a 200-ohm resistor, and the output attenuator set to give full-scale deflection on the output meter. It is essential the output remains constant over the required range of frequencies, but if it should not do so then a check for full-scale deflection of the output meter must be made before every adjustment of each filter inductance.

Having made a preliminary check of output the signal source is changed over to A, the input of the filter, and the 200-ohm dummy load and output meter transferred to the output end of the filter. Using the calibration curve of the output meter (Fig. 10b) the cores in the inductances should be adjusted to give as near as possible a response as shown in Fig. 4. If the signal source has a reliable attenuator it would possibly be a better guide than the calibrated output meter, the meter then being used merely as an indicator for constant output.

It is probably realised that only a rough alignment of the filter will be possible with the simple equipment depicted in Fig. 10, but final touching up can always be done by trial and error once the general outline of the response is determined. Work is in hand on a filter using fixed inductance coils and fixed capacitors and it is hoped to give details of it in an early issue.

LETTERS TO THE EDITOR

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

F.M. Receiver Design

Mr. RUSSELL's letter (your February issue) contains two criticisms: (i) on the choice of 10.7 Mc/s as an intermediate frequency for f.m. receivers and (ii) on the "cloak and dagger" attitude of manufacturers' organisations.

Taking the former, there is no secret about the choice of 10.7 Mc/s. Our Association adopted it as a standard intermediate frequency (with the G.P.O.'s knowledge and approval) because, first, investigation showed it to be the most satisfactory taking into account all technical and economic factors known to industry at the time the f.m. sound broadcasting service began; second, the early adoption of a standard was an essential feature of planning the broadcasting services (even if such a standard does not eliminate interference, at least it helps to minimise it). Mr. Russell unfortunately only selects one element of the interference aspect; i.e., that of possible interference between f.m. receiver oscillators and Band III reception and avoids making any constructive proposals on even this single issue. That we have chosen 10.7 Mc/s does not mean this will stay "for ever and a day". Work on the subject of intermediate frequencies and standards of many kinds affecting the radio industry is a continuous process which we undertake in co-operation with many other organisations.

The derogatory remarks about manufacturing organisations scarcely call for comment as they bear no relationship to the principal point in Mr. Russell's letter. We must, however, point out that his particular statement about the proportion of "confidential" documents is incorrect, at least in application to B.R.E.M.A. We reserve "confidential" as a classification mainly for information confided to this Association by outside organisations and the number of documents bearing it is relatively small. We would add that, although B.R.E.M.A.'s prime function is to serve the radio manufacturers who created it, in practice the Association goes a great deal further; the results of much of its work are made known to non-member manufacturers and to many other interested national and international organisations. In addition, a great deal of our work forms the basis of British standards which are, of course, public. We also endeavour, whenever possible, to keep the technical press informed of work in progress.

Secretary, S. E. ALLCHURCH,
British Radio Manufacturers' Association.

Electrostatic Loudspeakers

IN the article on "Distortion in Electrostatic Loudspeakers" (February issue) it is claimed that distortion-free operation is obtained only if the two sides of the diaphragm are insulated from each other and fed through independent resistances. This state of affairs is shown in Fig. (4) of the article with the statement that the charges on each side of the diaphragm will remain constant and that the voltages V_1 and V_2 will adjust themselves to satisfy this condition.

Now any potential difference between V_1 and V_2 will give rise to charges on the insides of the conducting surfaces. Since the two inside charges are opposite in sign, there will be a redistribution of charges resulting in unequal charges on the outside surfaces. It can be shown that if the capacitance through the diaphragm is large compared to the capacitance of C_1 and C_2 then the conditions will approach those of a single conducting diaphragm fed through a high resistance, Fig. (3).

The force on the diaphragm *due to the signal* is completely independent of the position of the diaphragm both for the case of constant total charge and for a theoretical case of constant independent charges.

The author points out that if, with constant total charge, the diaphragm is moved mechanically then a force appears on the diaphragm. He states this force is linear with displacement, but is not due to the signal and is therefore a distortion. The force is indeed linear with displacement and acts away from the central position. This is a negative stiffness. It causes no distortion, but it does of course require the introduction of positive stiffness in order to avoid diaphragm collapse to one or other of the fixed plates.

In spite of the above, a diaphragm conducting along its surface will introduce distortion, but for a different reason. Since the diaphragm requires supporting, there will effectively be forces acting at these supports in the opposite direction to the electrical forces. The diaphragm will not be a truly flat piston and the charge per unit area will not remain constant. The time constant of each small unit area (small compared to support spacing) must be made large for distortionless operation.

P. J. WALKER,
The Acoustical Manufacturing Company,
Huntingdon.

May I draw attention to what I believe to be an incorrect conclusion in the article on "Distortion in Electrostatic Loudspeakers" (February issue)? I refer to Fig. 4 (page 55) where two conducting faces of the diaphragm carry each a constant charge Q. In the formulæ given the field between the layers due to the inequality of their potentials V_1 and V_2 is neglected. This is not warranted.

When the distances between the faces and the fixed electrodes are again $d-x$ and $d+x$ the correct potentials are given by:

$$V_1 = \frac{Q}{\varkappa A}(d-x)\frac{d+x+\frac{1}{2}\delta}{d+\frac{1}{2}\delta}$$

$$V = \frac{Q}{\varkappa A}(d+x)\frac{d-x+\frac{1}{2}\delta}{d+\frac{1}{2}\delta}$$

where δ is the thickness of the diaphragm.

One concludes that when δ approaches zero the potentials reduce to the value for a single layer with total charge 2Q. This can be easily understood by noting that the infinite capacity between the layers makes V_1 and V_2 equal.

Calculation of the net force on the diaphragm yields:

$$F = \left(\frac{V_1}{d-x} - \frac{V_2}{(d+x)}\right) Q = \frac{Q^2}{\varkappa A}\frac{2x}{d+\frac{1}{2}\delta}$$

This formula shows that separation of the charge on the diaphragm into two equal parts still results in a force when the diaphragm is moved away from its equilibrium position. The situation is thus similar to that pictured in Fig. 3 of the article. The separation of the charge according to Fig. 4 has no advantage over the situation shown in Fig. 3.

For constant-charge operation the force is linear in x. In order to maintain stability the diaphragm needs to be stretched. When the suspension is linear the loudspeaker will operate without distortion. This is so because the signal force is exactly proportional to the signal voltage (even when the latter is fed asymmetrically to the fixed electrodes).

Amsterdam. E. DE BOER.

Negative Feedback

IN HIS excellent article "The Nyquist Diagram at Work" in the January issue is not "Cathode Ray" guilty of a small error on page 46 when he explains 20 dB of feedback as being the amount for which, at medium frequencies, $|AB| = 10$.

If this definition is adopted, i.e. feedback (dB) $= 20 \log_{10} |AB|$; then for the case where the feedback is quoted as 0 dB, $|AB| = 1$ and the gain is $A/1 - AB$, i.e. half the open loop gain; whereas the only way to specify an amount of feedback which is small enough to have no effect on gain is to call it $-\infty$ dB. ($20 \log_{10} 0$).

The correct definition, surely, is feedback (dB) $= 20 \log_{10} (1 - AB)$, i.e. the factor by which the gain is reduced. This means that 20 dB represents a feedback fraction $|AB|$ of 9, and 0 dB also means that $AB = 0$. (No feedback). It also allows the feedback, when expressed in decibels, to be directly subtracted from the open loop gain to give the gain with feedback at medium frequencies.

Computer Dept., A. H. ELLSON,
Ferranti Ltd., Manchester.

"Cathode Ray" writes:

I am obliged to Mr. Ellson for pointing out what he is kind enough to call a small error, but which I consider serious because it is likely to confuse those who most need clarity. What I did on the page mentioned, and also I am afraid, on p. 47 and on p. 93 in the February issue, was to express the ratio of the feedback voltage to the net input voltage in dB, overlooking the inevitability of confusion between this and the ratio in which that amount of feedback reduces the amplifier gain. Thus, the amounts of feedback that I ill-advisedly specified alternatively as 20, 18 and 12 dB, in the three places referred to, would reduce the gain by 20.8, 19.1 and 14 dB respectively.

It is natural to think of the ratio between the signal feedback and the original input, but clearly one must resist the temptation to express it in dB!

Channels for Trawlers

I WOULD like to refer to the letter by R. Collins in your February issue, without wishing in any way to enter into the controversy which is the real subject of the letter.

My comment concerns only the accuracy of the figures given as the number of ships in the two categories, fishing vessels and "others", which use the channels in question. I am given to understand that the approximate numbers at the end of 1955 were: fishing vessels 1935, others 2160. It will be appreciated that, in addition to compulsorily fitted coasters, the "others" category includes deep-sea vessels and those below 500 tons which are fitted voluntarily with 2-Mc/s radiotelephone.

Equality in allocation of channels would not seem to be unfair to fishing vessels at the present time.

F. J. WYLIE,
Director, Radio Advisory Service,
London, E.C.3.

Print-Through

I HAVE observed on a number of long playing discs — which, I presume, are recorded from tapes — that one can hear the opening bars of the next "number" in the interval between the individual items.

With standard records the position is more difficult owing to the short interval between the locating of the needle — which requires a certain amount of care — and the actual start of the recording; but, if one listens carefully, a faint trace of sound can often be heard.

Ambleside. ROBERT C. BELL.

Art or Science

YOUR correspondent H. S. King (January issue) who disputes the description of electronics as an art has evidently forgotten the old definition. ART: a science having more than seven variables.

Knutsford. E. J. YOUNSON.

Miniature Transmitter-Receiver

By C.H.L. EDWARDS*, A.M.I.E.E.

A Small Compact, Self-Contained Set for Portable, Mobile or Fixed-Station Use

MOBILE radio operation is a fascinating hobby, particularly when the apparatus can be put to immediate use in the event of an emergency. Most mobile equipment depends on the car for its power supplies and cannot conveniently be used in the home or on holiday without a separate power unit having to be constructed. Also the use of normal valves and components, in order to get reasonable output, tends to make the set rather bulky.

The writer, having constructed many different portable units with inputs from one half to seven watts, decided to build yet another which could be used for the Radio Amateur Emergency Network with internal batteries always unused and ready for such emergency, with switching for using external batteries when portable, or car supplies when mobile, and with an internally built-in a.c. power pack, so that the set could be used from the mains and by the fireside, or on holiday in an hotel. Having found from experience that 5 watts input, when mobile, gave very little increase in signal strength compared with one watt input, it was decided to use miniature valves and equipment in order to keep weight and size down to a minimum.

The earlier little 5-valve superhet receivers which the writer had constructed† had been most reliable, were extremely quiet and selective in operation, and were very economical of battery power. These had been designed for radio-telephone reception with the exception of one which had regeneration on the second i.f. coil for the reception of c.w. signals. After some thought, it was felt that a separate b.f.o. would be preferable and would give better results. Previous transmitters had been two-stage sets (v.f.o. and p.a.) and had worked out very well, but tended to have some frequency modulation and pulling of the oscillator when working mobile. In an endeavour to eradicate these effects, it was felt that a buffer stage might be worth inserting, even if it meant extracting a few more milliamps from the battery. The oscillator is a conventional Hartley modified to overcome the limitations of directly-heated valves. Its stability and output have proved adequate in the earlier transmitters.

Previous models had been designed to be operated by a carbon microphone. Criticism of the quality made the writer turn to crystal microphones, which, however, had insufficient output to drive the last two stages of the receiver when they were used as a modulator for the transmitter. It was thought that if the microphone was introduced into an earlier stage, sufficient gain would be available, and this proved to be the case in practice. It was also decided to introduce a netting switch and finally to include the 80-metre band, which might be useful should the set be used for the Radio Amateur Emergency Network. Thus having analysed the designs and results obtained after 15 years' experience of portable equipment a start was made on the new set, the circuit of which is shown in Fig. 1 on the following page.

Construction.— The set is built on a chassis measuring 11in × 7in × ½in with a front panel 11in × 12in. Three other similar chassis are used to complete the box-form of construction shown in the illustrations. One forms the top, another the bottom and a third is a partition dividing the equipment section from the battery compartment. Two sides and a back are screwed into position to complete the case. The v.f.o. is mounted in its own small can measuring 2½in × 2in × 2½in which houses the two coils for the 160- and 80-metre bands and the tuning capacitors and padders for each frequency. It was felt that it would be quite an easy matter to build this as a separate unit so that it could be replaced by another type of oscillator in the future, if desired. The 3V4 valve, its holder and components are accordingly mounted externally on a tiny chassis bolted to the can, so that the whole sub-unit may be removed by the withdrawal of two screws only. The buffer and p.a. stages are mounted to the rear of the v.f.o. and all controls brought out to the left-hand side of the panel. The centre of the chassis carries the 5-valve receiver and b.f.o. and plenty of room is left on the right-hand side for the a.c. power supply and Goodmans 2½-in loudspeaker. All wiring is carried out with sleeved No. 18 s.w.g. hard-drawn copper wire for neatness and rigidity.

The a.c. power supply uses a Westinghouse metal rectifier and is built into its own metal box measuring 5in wide by 6in deep by 3⅛in long, which is secured to the main chassis by two screws and flexibly wired to the selector switch on the front panel.

In order to have easy access to the transmitter and receiver aerial tapped coils, two small doors are cut in the side and top of the box adjacent to them (see Fig. 2) to allow for tapping adjustments when different aerials are used. On the lower part of the panel enclosing the battery compartment is mounted a small voltmeter (M1) with a selector switch (S3) to measure the h.t. and l.t. voltages applied to the set. This voltage checking facility is applicable to both battery and mains operation, as all voltages are at all times d.c.

The general procedure in building this set is first to complete the v.f.o. as a separate unit, test out and set up within the operating bands, mount on the chassis and then complete the transmitter section. The output stage is a pentode valve strapped as a triode and is the author's personal preference to which no objection is raised by the valve manufacturer. The method of neutralizing is to disconnect the h.t. supply from V_7 and connect a milliammeter between the bottom of R_{18} and the chassis. Then adjust C_{22} to resonance, which will be indicated by a change of grid current through R_{18}. Adjust capacitor C_{24} (the neutralizing capacitor) until

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* Amateur Radio Station G8TL.

† "A Top Band Low Power Transmitter-Receiver," *R.S.G.B. Bulletin*, April 1953, p. 425.

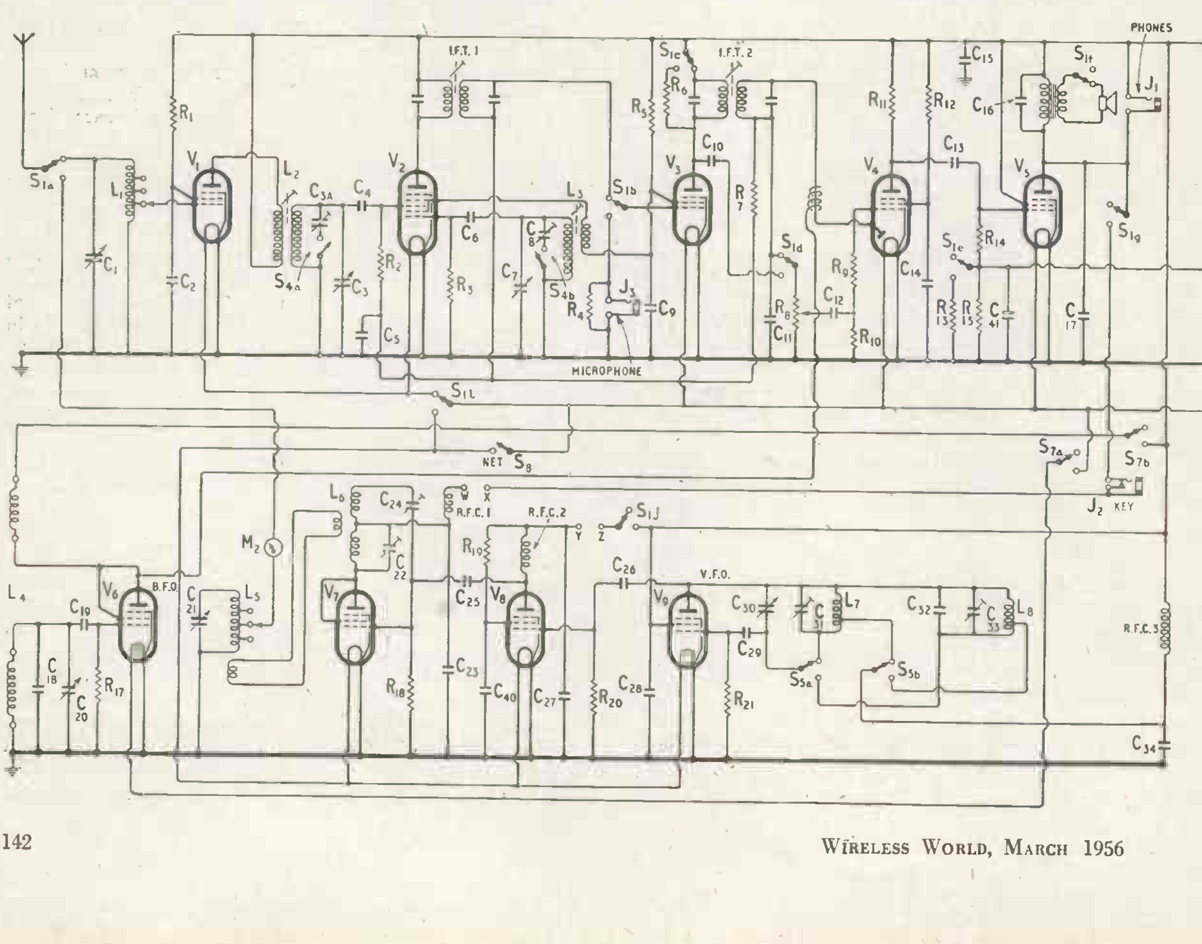
swinging C_{22} through resonance produces no change in the current through R_{18}. Once set, this adjustment will hold indefinitely. When satisfactory, build the receiver section, line up the i.f. transformers and Denco "Maxi-Q" coils, adjust the twin-gang capacitor (C_3, C_7) to cover the 160-metre band, i.e., pull out vanes as necessary and roughly check over when switched to 80 metres. As can be seen from the circuit diagram, the switch S_{4a}, S_{4b} when opened, removes the padder capacitors from across the coils and thus allows tuning over the 80-metre band. As there are no "trick" circuits in either the transmitter or the receiver, conventional methods of alignment should be used. Next, move switch S_1 to the transmit position, having first withdrawn the transmitter valves and coupled the output of the receiver to an external loudspeaker. With the switch in this position, V_3, V_4 and V_5 of the receiver are used as speech amplifiers and modulator for the transmitter. The method of achieving this is as follows: the grid of V_3, via S_{1b}, is connected to the microphone input marked J_3. S_{1c} provides a resistive load (R_6) for the anode of V_3 which is coupled to the grid of V_4 via C_{10}, S_{1d}, R_8 (the volume control), C_{12}, and R_9.

The switching changes the operation of V_3 from an i.f. to an a.f. amplifier. The diode in V_4 is still in circuit but has no effect on the operation. The pentode section of V_4 is unaltered and remains an a.f. amplifier under both transmit and receive conditions. It is necessary to increase the output of V_5 when used as a modulator. To this end R_{13} and R_{15} are joined in parallel by the switch S_{1e}. S_{1f} open circuits the secondary of the speaker transformer, the anode of V_5 is then connected by S_{1g} to the anode of V_7, the primary of this transformer functioning as a modulating choke. Check crystal or other microphone for quality and output. If satisfactory, insert transmitter valves, load up by feeding the transmitter into a dummy aerial and carry out usual modulation tests.

Finally, construct the separate mains power supply unit. This presented quite a problem as there were no standard 1.5-V l.t./120-V h.t. mains transformers available. Having obtained details of the rectifiers from the manufacturers, a suitable transformer and chokes of minimum size were designed specially for this set to give the required outputs of 1.5V, 0.5A l.t., and 120V, 60mA h.t. when coupled to the rectifiers and smoothing circuits. In order to completely remove the a.c. ripple on the l.t. side, it is essential to use 2,500-μF 3-V working capacitors each side of the choke. Smaller values are useless. To safeguard the delicate filaments of the 1.5-V valves a 5-Ω variable resistor (R_{24}) is mounted on the front panel in series with the supply to the selector switch so that, on switching over to the mains supply, a voltage check can be made with the panel voltmeter and adjustments made to R_{24} if necessary.

The h.t. current limiter resistors (R_{16}, R_{22}) are included because when in the receive position, the set is drawing approximately 10mA only whereas in the transmit position, it may draw as much as 50mA. In order to keep the voltage as stable as possible, as the change over this wide range of current must be considerable, the two resistors are arranged in the receive position to give 120 V at 10 mA. When changed to the transmit position R_{16} is shorted out by S_{1k} allowing the 50 mA to pass at 120 V. These resistors are adjusted by trial and error. Because initial adjustment only is required

Fig. 1. Theoretical circuit diagram of the small self-contained transmitter-receiver described in the text.



LIST OF COMPONENTS

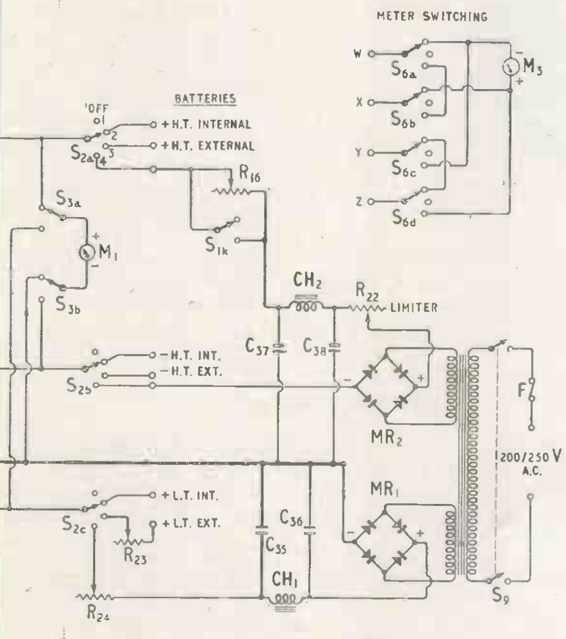
RESISTORS

R_1, R_{17}, R_{20}, R_{21}	47 kΩ
R_2, R_{14}	1 MΩ
R_3	100 kΩ
R_4, R_7, R_{12}	2.2 MΩ
R_5, R_6	27 kΩ
R_8	1 MΩ, potentiometer (Dubilier)
R_9	22 kΩ
R_{10}	6.8 MΩ
R_{11}	470 kΩ
R_{13}	330 Ω, 1 W
R_{15}	1 kΩ, 1 W
R_{16}	3.7 kΩ, 2 W wirewound
R_{18}	68 kΩ
R_{19}	10 kΩ
R_{22}	200 Ω, 2 W wirewound
R_{23}, R_{24}	5 Ω wirewound potentiometer (Colvern Type CLR/1100/15)

Fixed resistors ¼ watt except where defined.

CAPACITORS

C_1, C_{21}, C_{22}	140 pF variable (Eddystone 586)
C_2, C_6, C_{10}, C_{13}, C_{14}	0.01 µF 200 V wkg.
C_3, C_7	75 pF twin-gang variable (Jackson Bros. Type U102)
C_8, C_{3A}	250 pF ceramic padder (Cyldon)
C_4, C_9, C_{11}, C_{19}, C_{23}	100 pF 200 V wkg.
C_5	0.1 µF 200 V wkg.



C_{12}, C_{16}, C_{17}	0.005 µF 200 V wkg.
C_{15}	2 µF 200 V wkg.
C_{18}	140 pF silver mica
C_{20}	15 pF air-spaced variable (Eddystone 580)
C_{24}	3/30 pF trimmer (Phillips)
C_{25}, C_{26}	0.001 µF silver mica
C_{27}, C_{28}, C_{34}, C_{40}	0.001 µF 200 V wkg.
C_{29}	300 pF silver mica
C_{41}	25 µF 25 V wkg.
C_{30}	50 pF air-spaced variable (Eddystone 553)
C_{31}, C_{33}	40 pF ceramic trimmer
C_{32}	40 pF silver mica
C_{35}, C_{36}	2,500 µF 3 V wkg.
C_{37}, C_{38}	16 µF 200 V wkg.

MISCELLANEOUS

3	R.F. Chokes (Eddystone 1010)
2	465 kc/s i.f. transformers (Denco Type IFT11), (IFT1, IFT2)
1	450/470 kc/s b.f.o. coil (Denco miniature) (L4)
1	Range 3 miniature Maxi-Q coil, yellow (Denco) (L2)
1	Range 3 miniature Maxi-Q coil, red (Denco) (L3)
1	4 section 4-pole 2-way switch (S1) (Webbs Radio, N.S.F. Type)
2	Couplers (Eddystone 550)
2	Slow motion dials (Eddystone 872)
1	2½in loudspeaker (Goodmans R4/201/3)
1	Transformer (Goodmans T18/157)
2	Jacks Type J2 (Bulgin) (J_1, J_3)
1	Jacks Type J6, c/s (Bulgin) (J_2)
2	4-pole 3-way miniature switch (S3, S6)
1	2-pole 2-way miniature switch (S5)
3	Switches S277 (Bulgin) (S4, S11, S7)
1	Switch S259 (Bulgin) (S8)
1	Selector switch S437 (Bulgin) (S2)
1	Plug and socket Type 73 (Bulgin)
1	Mains Transformer; primary 200/250 V; secondaries 1.5 V, 0.6 A; 120 V, 60 mA (G.B. Electrical Services Ltd., 1 Goodmays Road, Ilford (T1).
1	L.T. choke, G.B. Ltd. 0.6 A (Ch1)
1	H.T. choke G.B. Ltd., 60 mA (Ch2)
1	Full-wave bridge selenium rectifier (Westinghouse type 3D133) (MR1)
1	Full-wave bridge selenium rectifier (Westinghouse type 14D52) (MR2)
1	0/20 mA miniature moving coil meter (Pullin, Type C15/20M) (M3)
1	0/150 mA miniature r.f. meter (Pullin Type C15) (M2)
1	0/2/200 V miniature moving coil meter (Pullin Type C15/200 V) (M1)
L_1	80 turns No. 28 s.w.g. En close wound; former ⅝in dia. tapped every 5 turns
L_5	Close wound for 2in with No. 28 s.w.g. En on 1¼in dia. former, tapped every 5 turns
L_6	Close wound for ½in with No. 28 s.w.g. En, on ⅞in dia. former, centre tapped
L_7	100 turns No. 34 s.w.g. En close wound; former ⅝in dia. tapped ⅓ from grid end.
L_8	54 turns No. 30 s.w.g. En close wound; former ⅝in dia. tapped ⅓ from grid end.
V_1, V_3, V_6	Brimar 1T4
V_2	Brimar 1R5
V_4	Brimar 1S5
V_5	Brimar 3A4, or Mullard DL93
V_7, V_8, V_9	Brimar 3V4
4	Chassis 11in × 7in × ½in aluminium No. 18 s.w.g.
2	Panels 11in × 12in aluminium No. 18 s.w.g.
2	Side panels 12in × 7in aluminium No. 20 s.w.g.
1	L.T. battery 1.5 V (Ever Ready Type ADI)
1	H.T. battery 120 V (Ever Ready "Winner")

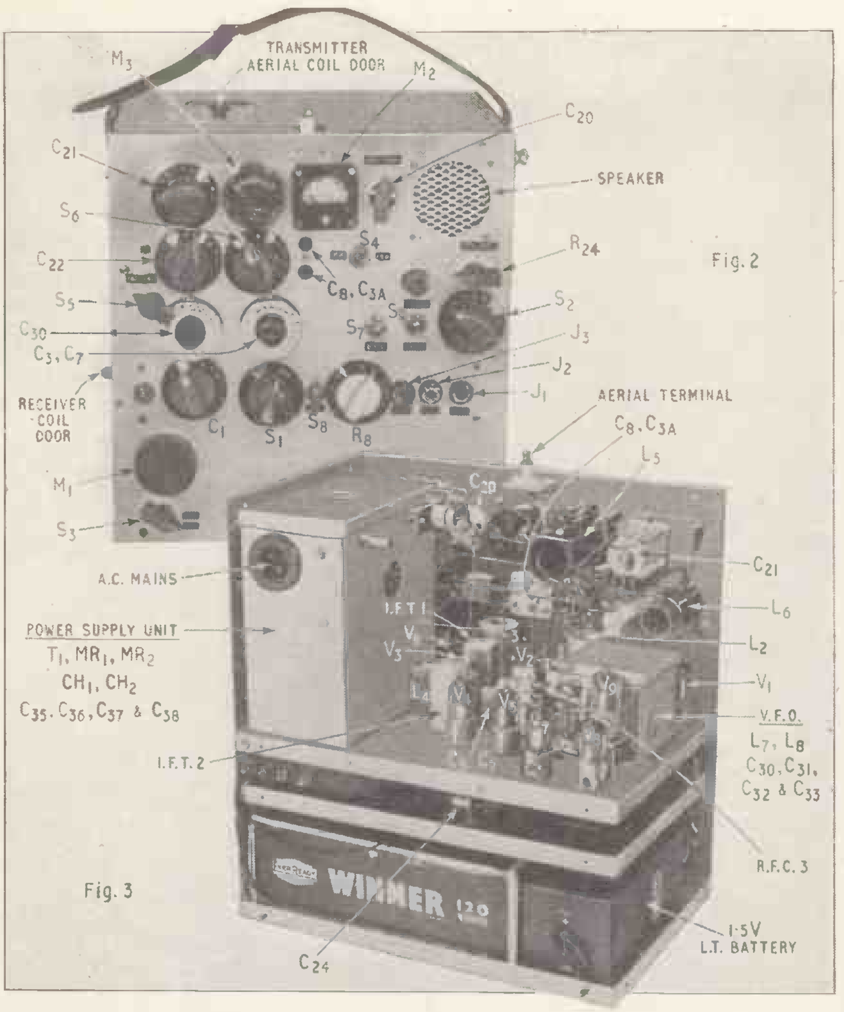


Fig. 2. Front panel of the unit showing the position of the various controls.

Fig. 3. The majority of the components are mounted on a shallow chassis and some are annotated for indentification (see Fig. 1).

here they are not included among the controls on the front panel.

Operation.— As stated earlier, this set is designed for portable and mobile operation and for use in Radio Amateur Emergency Network. The dry batteries housed in the bottom of the case are left unused so that they are always available for immediate use in the event of emergency. From past experience, very little deterioration is noticed when the batteries lie dormant for long periods, but a check can easily be made on the voltmeter, located in the left-hand bottom corner of the panel, from time to time (switch S$_2$ position 2).

For ordinary mobile operation, the writer uses external batteries or a 6/12-V input vibrator unit operated from the car battery (S$_2$ position 3). It was found that the 120-V "Winner" battery tended to drop off to around 100 V after what might be considered a short period of time when delivering 40/50 mA in the transmit position If two 9-V grid-bias batteries are then joined in series with it, the battery gives a constant output of near enough to 120V for a considerable time with little further deterioration. With average use, these should last about six months. For operation at a fixed location, the a.c. supply is always connected (S$_2$ position 4). No hum is noticeable; in fact, if switched back to the batteries, the signal remains constant, there being no discernible difference. As can be seen from the diagram, the netting switch S$_8$ closes the transmitter filament circuit, but as the h.t. is cut on both p.a. and buffer valves (V$_7$ and V$_8$) only the oscillator (V$_9$) becomes operative. To net on the incoming signal rotate the v.f.o. dial (C$_{30}$) until a beat note is heard in the receiver.

The set will operate on any length of wire as an aerial or on a 4-ft centre-loaded whip-aerial atached to a car. On the latter, in the 160-metre band, a Q5 signal can be radiated in a circle of approximately 10 miles irrespective of terrain, except in a dense built-up area, such as the City of London, where buildings are constructed chiefly of steel. When conditions are good a path of 20 miles can be easily covered. The receiver is very sensitive and quiet in operation and will give results on the whip-aerial equivalent to an average communications receiver. When the top-band is "open" the Scottish stations come in at good strength on the loudspeaker in the south of England.

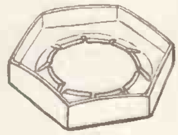
SPRING NUT

THE assembly of "one-hole-fixing" components such as volume controls and switches in electronic equipment is facilitated by the "Palnut" spring washer-nut which can be used instead of the conventional brass nut and serrated lock washer.

The "Palnut" is pressed from high-carbon steel, heat-treated and then cadmium plated. It is formed to fit one complete thread of the bush or bolt and on tightening grips the bottom of the thread. It can be removed without damage either to the nut or to the bolt thread.

A wide range of sizes up to 2in diameter is available, including 0, 2, 4, 5 and 6 B.A. The depth of the nut is in most cases less than that of the equivalent "half-nut".

The makers are the Palnut Company Ltd., 28 Elder Road, Brighton and the distributors are Thos. P. Headland Ltd., 164-8 Westminster Bridge Road, London, S.E.1.



"Palnut" lock nut.

Ionosphere Review 1955

Rapidly Increasing Solar Activity

By T.W. BENNINGTON *

THE activity of the sun, which since 1947 had been, in general, declining, reached a minimum in June 1954. At the end of the latter year, when the last of these reviews was written, it was not possible to say precisely in which month this event had occurred, though it was evident that in the second half of the year the activity had been slowly increasing. Nor, of course, was it at all certain what would happen during 1955, though there was a strong probability that activity would continue to increase. As we shall see, this increase did occur, and was, in fact, relatively rapid; so much so, that by the end of 1955 the usable frequencies for short-wave communication had already increased very considerably, and bands which had not been usable for some years past were again coming into service.

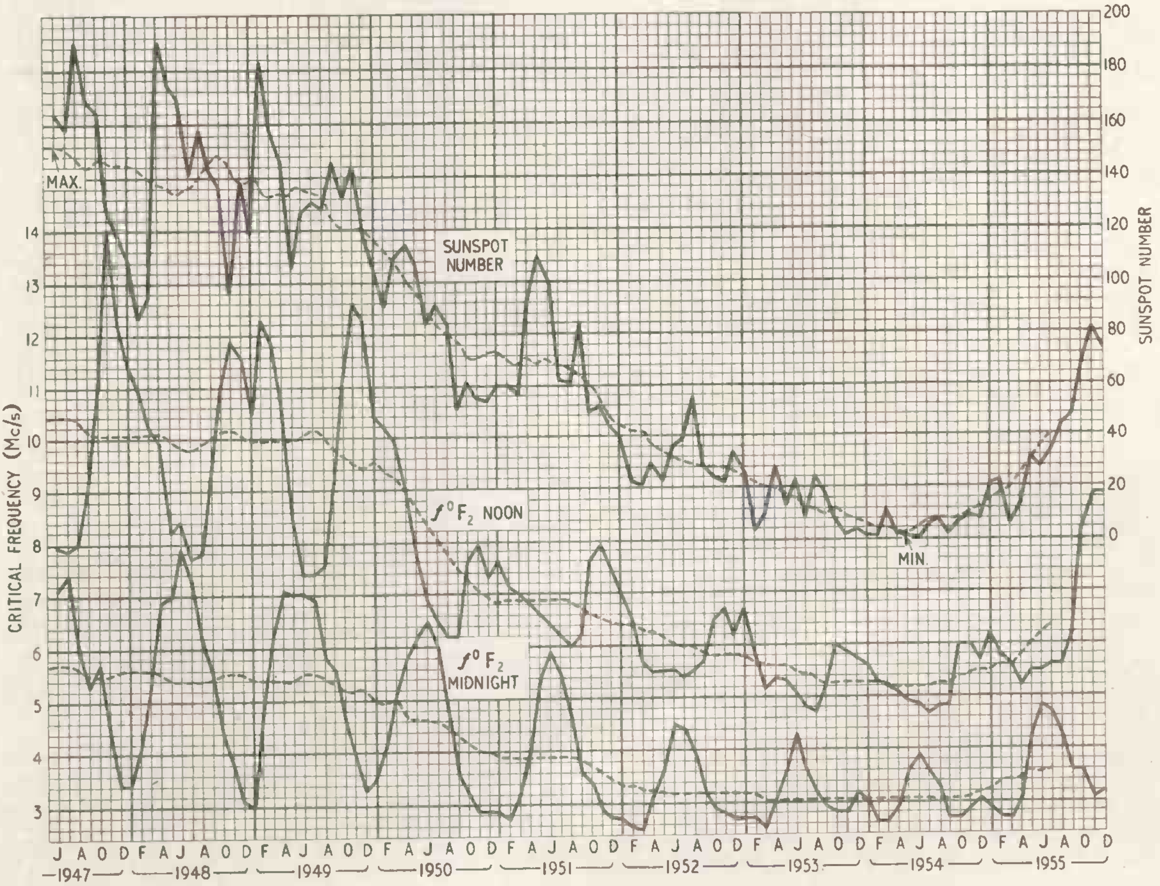
The old cycle.— The course of the solar cycle, from sunspot maximum in 1947 to sunspot minimum in 1954, may be seen from the top curve of the Figure, where the full line gives the monthly values of the sunspot number, the last twelve of which are provisional numbers. It is more informative, however, to smooth out the month by month variations by taking the twelve-month running average of these values, so as to expose the long-period variation more clearly. This is shown in the top dashed curve of the Figure.

Although the lowest value of sunspot number is considered to have occurred in June 1954 the actual epoch of minimum activity is determined from the smoothed curve, and is seen to have been in the period April/May 1954.

The two lower full line curves give the mean monthly values of F_2 layer critical frequency as measured at the D.S.I.R. ionospheric station at Slough, for noon and midnight respectively. The two dashed curves given in these cases are obtained by taking the twelve-month running average of the critical frequencies, and so smoothing out the seasonal variations. These two curves indicate the average ionospheric variations, and well

* British Broadcasting Corporation.

Course of the sunspot cycle, with corresponding variations in ionospheric conditions over the period.



illustrate the dependence of conditions in the ionosphere upon the activity of the sun, which produces it. The maximum usable frequencies for short-wave communication are directly related to the F_2 layer critital frequency, and may thus be assumed to vary in a like manner to the variations shown.

It appears that the mean monthly critical frequency variations from sunspot maximum to minimum of the last cycle were of the order of 2 to 1 at winter noon, of 1.7 to 1 at summer noon and midnight and of 1.2 to 1 at winter midnight. The m.u.f. variations were of an approximately similar character, which means that the m.u.f. ranged from about 43 to 22 Mc/s at winter noon, and had a smaller range at other seasons and times of day. This variation is for the ionosphere over southern England, and would, of course, be somewhat different elsewhere, but it gives an idea of the range in the usable frequencies which might be expected during the course of a cycle with a high maximum, such as the last cycle had.

The new cycle.— To turn, now, to the new cycle and to examine those parts of the curves plotted from values obtained subsequent to the minimum epoch April/May 1954 we see that, though for several months the solar activity increased, on the average, only slowly there has, during the second half of 1955 been a large accentuation in the rate of increase. In fact, compared to many past cycles, what might be called true sunspot minimum conditions prevailed for a relatively short period, and the new cycle soon became well established in its increasing phase. So rapid did the increase become that, to judge from the monthly values towards the end of the year the activity was of an order similar to that which prevailed about the middle of 1950.

As is seen from the Figure the ionosphere has responded in no uncertain fashion, the measured noon critical frequencies towards the end of the year also rising to early 1950 values. Apart from the ionospheric measurements there is plenty of practical evidence to show that the highest frequencies on which the F_2 layer will sustain long-distance communication have risen, and are rising, rapidly. Frequencies of the order of 20 Mc/s, which for the past few years have been but poorly and irregularly received over North Atlantic paths are now well receivable on all undisturbed days. The 26-Mc/s broadcasting band, which for some years has been unusable, is now being successfully employed at the appropriate times of day for transmissions to the Far East and to Africa. The 28-Mc/s amateur band has, of late, very frequently been " alive " with long-distance amateur signals, whilst, occasionally, signals on even higher frequencies have been received in this country from the U.S.A.

Forecast.— The questions are: to what extent will this increase in the usable frequencies continue, and for how long will it be maintained? It is, of course, impossible to answer these questions with anything like complete confidence, because solar cycles vary very considerably in amplitude, duration and in general form, and so they cannot be accurately forecast, especially in such an early stage as has yet been reached. But it does begin already to appear that the present cycle may — like the last — be one with a high maximum, and such cycles have usually been of an asymmetric shape, having a short " increasing " phase, followed by a long " decreasing " one. The " increasing " phase of the last cycle lasted only about 3 years. Cycles with low maxima are quite different in character.

If the cycle is to be one with a high maximum it is probable that the activity will go on increasing at a rapid rate, and that the maximum may occur about 3 years from the minimum; i.e., about the middle of 1957. The expectations therefore are that during 1956 solar activity will continue rapidly to increase, and that ionospheric critical frequencies and m.u.fs will undergo further large increases.

Practical implications.— The practical implications of this are important. It is to be noted, first of all, that this opening up of the higher frequencies should effectively make available a large number of new channels for long-distance communication, and so tend to lessen interference troubles due to the congestion in already used bands. It does not follow, however, that such results will necessarily accrue, firstly because if the move to higher frequencies is universal the tendency will be to create the same congestion on the higher frequency bands as has hitherto existed on the lower ones. And, secondly, because there may be considerations other than those of technical usability which militate against the use of some of the higher frequencies. As an example, there are many broadcast receivers in use which unfortunately do not include the 21- and 26-Mc/s broadcasting bands in their frequency ranges, though there is no doubt that, when technically usable, those are the bands upon which best long-distance reception is likely to be obtained. Similarly some of the channels in the range from about 30 to 40 Mc/s, whilst they might become usable for long-distance services, would not in fact be available to them, because of their occupation by other services.

On the whole, however, it does seem that the higher short-wave frequencies, up to about 30 Mc/s, will, as they become usable, offer the best hope of interference-free long-distance communication. And if the expected increase during 1956 in fact occurs it seems that by November of that year the mean monthly daytime m.u.f. for east-west transmissions may become as high as 34 Mc/s, and for transmission over southerly paths be around 38 Mc/s. Daytime m.u.fs in the summer will, of course, be much lower than this.

Technical Writers' Awards

A RECORD number of articles was submitted for consideration by the Radio Industry Council for the award of the technical writing prizes for 1955. The panel of judges — Vice-Admiral J. W. S. Dorling, Professor H. E. M. Barlow, P. D. Canning. C. E. Strong and W. M. York — considered in all 62 articles published in the public technical press during last year and have awarded six 25-guinea prizes.

One premium was awarded for each of the following: "Memory Systems in Electronic Computers" by A. W. M. Coombs (*British Communications and Electronics*, March); "An Infra-Red Radiation Pyrometer" by R. A. Bracewell (*Electronic Engineering*, June); "Progress in High Power Ultrasonics" by Alan E. Crawford (*British Communications and Electronics*, August and September); and "A Novel Gas-Gap Speech Switching Valve" by A. H. Beck, T. M. Jackson and J. Lytollis (*Electronic Engineering*, January).

Two premiums were awarded jointly for the following three articles which appeared in the *Post Office Electrical Engineers' Journal:* "A Frequency Modulator for Broad-Band Radio Relay Systems" by I. A. Ravenscroft and R. W. White (July); "Equipment for Measurement of Inter-Channel Crosstalk and Noise on Broad-Band Multi-Channel Telephone Systems" by R. W. White and J. S. Whyte (October); and "An Instrument for the Measurement and Display of V.H.F. Network Characteristics" by J. S. Whyte (July).

MARCH MEETINGS

LONDON

1st. I.E.E.—Discussion on "Recruitment to the engineering profession" at Savoy Place, W.C.2.

7th. I.E.E.—"Frequency-modulation radar for use in the mercantile marine" by D. N. Keep.

9th. Television Society.—"Properties and problems of Bands IV and V" by Dr. R.L. Smith-Rose.

14th. I.E.E.—Visit to the Science Museum, South Kensington. The programme included a talk on the Museum's electrical collections by G. R. M. Garratt.

14th. Radar Association.—"New developments in colour television" by B.J. Edwards (of Pye) at the Northern Polytechnic, Holloway Road, N. 17.

16th. B.S.R.A.—"Introduction to design and use of audio-frequency transformers" by W.B.H. Wess at the Royal Society of Arts, John Adam Street, W.C.2.

19th. I.E.E.—Informal evening on electronics and automation including "Some industrial applications" by Dr. H. A. Thomas at 5.30 at Savoy Place, W.C.2.

22nd. Physical Society.—Symposium on "Loudspeakers" (speakers include F. H. Brittain, P. J. Walker, Dr. D. M. Tombs, S. Kelly and G. A. Briggs) at 3.0 at the Royal Institute of British Architects, 66 Portland Place, W.1.

22nd. Institution of Production Engineers.—"Electronic computers and the production engineer" by P. V. Ellis at 7.0 at the Royal Empire Society, Northumberland Avenue, W.C.2.

23rd. R.S.G.B.—"Colour television" by P. Carnt (G.E.C. Research Laboratories) at 6.30 at the I.E.E., Savoy Place, Victoria Embankment, W.C.2.

26th. I.E.E. (Students).—"Fundamentals of cathodic protection" by J. H. Morgan at 6.30 at Savoy Place, W.C.2.

27th. I.E.E.—"Radiation monitors using transistors" by Dr. E. Franklin and J. B. James at 5.30 at Savoy Place, W.C.2.

28th. Brit.I.R.E.—"Some problems of secondary surveillance radar" by K. E. Harris at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

BRISTOL

12th. I.E.E.—"The design of semiconductor wattmeters for power-frequency and audio-frequency applications" by Professor H. E. M. Barlow in the Lecture Hall, University Engineering Laboratories.

13th. Television Society.—"Radar astronomy" by M. Collins at the Hawthorns Hotel, Woodland Road.

26th. I.E.E.—"The electrical activity of the brain" by Dr. W. Grey Walter at 6.0 at the Electricity House, Colston Avenue.

CAMBRIDGE

13th. I.E.E.—"Television methods in astronomy" by Dr. P. G. Fellgett at the Cavendish Laboratory.

CARDIFF

21st. Brit.I.R.E.—"Electronic servomechanisms" by J. L. Russell at 6.30 at Cardiff Technical College.

CARLISLE

2nd. I.E.E.—"Colour television" by Dr. G.N. Patchett at the Carlisle Technical College.

CHATHAM

6th. I.E.E.—"Radio aids to marine navigation" by Capt. F. J. Wylie, R.N. (Retd.).

EDINBURGH

24th. Brit.I.R.E.—Symposium of papers on "Industrial electronics in Scotland" at 7.0 at the Department of Natural Philosophy, The University.

GLASGOW

12th. Brit.I.R.E.—"Principles of the transistor and some important applications" by M.H.N. Potok.

15th. Institution of Production Engineers.—"Computer-controlled machine tools" by D. T. N. Williamson at 39 Elmbank Crescent.

21st. I.E.E.—"Equipment of instrumental accuracy for recording and reproduction of electrical signals using cinematographic film" by H. McGregor Ross.

22nd and 23rd. Brit.I.R.E.—Symposium of papers on "Industrial electronics in Scotland".

HATFIELD

20th. I.E.E.—"Information theory" by Dr. E.C. Cherry at 7.0 at the Hatfield Technical College.

LEEDS

20th. I.E.E.—Discussion on "New courses for electrical technicians" opened by R. A.H. Sutcliffe.

LEICESTER

8th. Institution of Production Engineers.—"Computer control of machine tools" by D. T. N. Williamson.

LIVERPOOL

14th. Brit. I. R. E.—"Underwater Television" by D.R. Coleman and D. Allanson at the Chamber of Commerce, 1 Old Hall Street.

MALVERN

19th. I.E.E.—"Radio astronomy" by M. Ryle at the Winter Gardens.

MANCHESTER

1st. Brit. I.R.E.—"The design and application of quartz crystals" by R. A. Spears.

14th. Television Society.—"Interference with television reception: its causes and cures" by R. A. Dillworth (Post Office Radio Branch) at the College of Technology.

20th. I.E.E.—"The indirectly-heated thermistor as a precise a.c./d.c. transfer device" by F. C. Widdis at 6.15 at the Engineers' Club, Albert Square.

NEWCASTLE-UPON-TYNE

14th. Brit.I.R.E.—"Band III television aerial design" by A. P. Hale at Neville Hall, Westgate Road.

19th. I.E.E.—"Equipment of instrumental accuracy for recording and reproduction of electrical signals using cinematographic film" by H. McGregor Ross.

OXFORD

14th. I.E.E.—"New tools in industry — ultrasonics" by W. Owen Roberts at the Southern Electricity Board, 37 George Street.

WEYMOUTH

9th. I.E.E.—"Transistor power amplifiers" by D.D. Jones at the South Dorset Technical College.

WOLVERHAMPTON

14th. Brit.I.R.E.—"The application of transistors to radio rectification" by E. Wolfendale at Wolverhampton and Staffordshire Technical College, Wulfruna Street.

RANDOM RADIATIONS

By "DIALLIST"

Long-distance F.M....

WRITING from Dereham, in Norfolk, an Air Force reader tells me that he has entirely given up listening to the B.B.C.'s medium- and long-wave stations and now relies on Wrotham for broadcast news and entertainment. Wrotham is about 120 miles from Dereham; but he writes that he has a useful signal for 90 per cent of his listening time and a first-rate signal for 85 per cent of it. One might think that rather good going even if he had a two- or three-element aerial array on a high mast; but, in fact, his aerial is a picture-rail dipole in a ground floor room! Yet with that he has received all the B.B.C. v.h.f. transmitters now at work, as well as some of the Germans. He doesn't say how many r.f. amplifying stages his set contains; but I expect he'll have to cut some of them out when Tacolneston starts up almost on his doorstep with an e.r.p. of 120 kilowatts!

....And TV, Too

And it's not only f.m. that is spanning unexpectedly long distances. I was talking the other day to a friend who also lives in Norfolk. He told me that, having installed a new 13-channel television receiver he thought he'd try for the Croydon I.T.A. station just for fun. He knocked together a rather Heath Robinson Channel 9 aerial, erected it on a calm day and connected it to the set. To his utter astonishment, he found the sound quite good and the picture passable, though apt to come unlocked at times. Since then he has had a six-element Yagi put up and is now able to get an acceptable picture more often than not. It was reported some time ago that Croydon was being received in north Cheshire and I remember reading somewhere of occasional reception in Dorset. Some of these long-distance feats are undoubtedly due to freak conditions; but the others can't be since they are such regular occurrences.

Heater Kilowatts

HAVE you ever thought of the amount of power that's needed to provide listeners and viewers in this country with an evening's entertainment? Leaving studios and transmitters out of account, the figures for sound and television receivers alone are surprising when you work them out. Suppose that on the average 7,000,000 mains sound sets and 3,000,000 television receivers are in use for three hours. Taking the consumption of the sound receivers as 30 watts apiece, their needs amount to 630,000 kWh, while at 150 watts each the TV sets call for 1,350,000 kWh. Total: 1,980,000 kWh. As our figures have all been, I feel, on the conservative side we can make the total the nice round sum of 2,000,000 kWh. Would you have guessed that it would come to so much?

I.Fs and Interference

THE LETTER on f.m. receiver design from G. H. Russell which appeared in last month's issue of *Wireless World* raised a very important point. The whole question of intermediate frequencies in television and sound receivers (both a.m. and f.m.) is one that should be tackled energetically and without delay. I know, for example, a case in which a brand new television set and an equally new a.m./f.m. receiver in adjacent flats cause mutual interference. Whenever it is working the a.m./f.m. set spoils the television picture; the TV set gets its own back by causing the sound receiver to howl if an attempt is made to use it on certain short-wave bands. I imagine that most radio servicemen could cite similar cases of mutual interference and I should think that this sort of thing must be giving the P.O. engineers concerned with the detection and prevention of interference a rather hectic time.

A Plea for Front Controls

IT MAKES, I suppose, for a neat and tidy looking job if all the control knobs of a TV set, except volume (with switch), contrast and brightness, are at the back of the set. But, unless you've the arms of a gorilla and the neck of a giraffe, it also makes it a rather exasperating business to adjust a set. You can, of course, use a mirror propped up on a table; in fact that's what I'm compelled willy nilly to do when putting my own set through its paces on Test-card C. But it's not nearly so satisfactory as being able to look the screen straight in the face as you twiddle the knobs. A few makers realise this and are kind enough to put line-hold, frame-hold, linearity controls, interference limiter and so on under a neat and inconspicuous little hinged cover at the front. Some others put them quite accessibly at one side of the cabinet.

Designers Please Note

One set that I had was a perfect brute to adust. To begin with, the brightness control and the interference limiter were both at the back. That made it twice as hard as it should have been to get proper distinction of shades on the colour wedges and to limit interference effects as far as possible, without spoiling the whites. Then there was the frame-hold. That had to be exactly right for the interlace to be satisfactory and the setting was nearly as critical as that of the tuning knobs of a " straight " short-wave receiver in the old days. Some readers will doubtless recall the delicate touch and the minute movements that tuning such a set to a weak and distant signal involved in the years that now seem so long ago! In the television receiver I'm all for knobs in front. After all, it's the natural and proper place for them and I'm sure that if designers will give high priority to this very important point, they'll find ways of putting them where they should be without spoiling the look of their sets. Those who do so will, I'm sure, earn the gratitude of all who use their sets — to say nothing of the men who have to service them.

SMOKE SIGNALS ARE NOW OBSOLETE

Then the little Hiawatha
  Took a correspondence course.
Studied often, in his wigwam,
  Kirchhoff's laws and lines of force.
Wouldn't stop for Minnie-Ha-Ha,
  Tempting him with breathless sighs,
Had to learn to solve quadratics;
  Had to learn to factorize.

Integrating was quite simple—
  Couldn't differentiate—
See the wild electron war-dance!
  When you want a stable state.
Often he would tear his hair out,
  Often he would rage and squawk,
Couldn't cut a crystal axis
  With a broken tomahawk.

When at last his studies ended,
  Now called Big Chief Injun-Ear,
Not for him the bow and arrow,
  Guided missiles, now, I fear.
So you see how electronics
  Change the life of Indian Braves.
Scalping now is out of fashion—
  Push a switch for closer shaves.

E. E. Rowe.
(Long after Longfellow)

UNBIASED

By FREE GRID

New Entente Cordiale?

I NOTICED recently in the Press that the B.B.C. had signed the contract for work to start on the new television headquarters which are to be built on the site of the Court of Honour of the old White City.

It is in a way singularly appropriate that the TV centre should be built on this site for it so happens that the White City was opened in the very year (1908) that the late Campbell Swinton published in a letter to *Nature* the basic idea behind our modern television system, namely c.r. tube scanning. It will be recalled that the White City was opened to house the Franco-British Exhibition which was intended to further the interests of the *entente cordiale*.

This common date is perhaps rather a tenuous link between the White City and television but now that the new headquarters are being built on its site it is worth mentioning even if only to give a talking point to the V.I.P. who will preside at the opening ceremony a few years hence. It would be highly appropriate if the inauguration ceremony were performed by the successor of King Edward VII, the founder of the *entente cordiale*. Maybe this new "White City" will symbolise the beginning of a still wider *entente cordiale* in accordance with the B.B.C.'s famous motto.

Feet or Megamiles?

ALL readers of *Wireless World* know that the speed of electricity in our house wiring is of the order of feet *per hour* and has nothing to do with the speed of light or wireless waves. If there are any who don't know it, then "Cathode Ray" has laboured in vain. However, such knowledge has not yet penetrated the portals of a prominent daily newspaper which alleged in a general knowledge quiz that 186,282 miles per second was the correct figure.

I have taken "counsel's opinion" on this matter and have been assured that not only is this figure wrong but it could not possibly be right as it would mean that each electron would have an infinitely high mass. The "eminent counsel" (*scientiæ*) whom I consulted also points out to me that it requires a Berkely synchrotron to impart 9/10ths of the speed of light to an electron or proton.

However, we cannot reasonably expect a daily newspaper to go into the matter as deeply as all this. But we do expect it not to stick its neck out in the way it does in a reply sent to a reader of *Wireless World* who questioned the accuracy of the published figure. The newspaper's letter has been forwarded to me and from it I learn that if such a low speed as "feet per hour" were correct we should all have to use candles while we waited for the electrons to crawl along from the switch to the lamp.

It is clear that the newspaper man who puts forward this view has forgotten all about the electrons "in the pipe". I cannot help shedding a tear as I think of him shivering in his pyjamas as he waits with his kettle under the tap for water to make its long and weary way from the local waterworks before he can make his early morning cup of tea.

Watching and waiting.

Supergraphic Morse

ONE of the few things not mentioned in the *Wireless World* report on the R.S.G.B. Show, at which I spent a thoroughly enjoyable time, was the try-your-speed morse exhibit by the R.A.F.

Phones were provided for reading morse at 12, 18, 25 and 35 words per minute. I tried my hand at the first three and, although "I says it as shouldn't," I didn't do too badly. But I didn't risk having a go at the 35 w.p.m. stuff. Although I hung about the stand for some time I didn't see anybody trying to take down a message at this speed; indeed I don't think that the R.A.F. expected anybody to do so as although morse was being churned out continuously at the lower speeds, the 35 w.p.m. phones were marked "on request only".

Quite frankly I don't think that it is possible to do it by "copying" letter by letter in the ordinary way. I find that the maximum speed at which I can write intelligibly is about 30 w.p.m. If any of you think you can do better try scribbling out as fast as you can write some well-known words such as those of the National Anthem.

With a typewriter it is possible to copy morse at 35 w.p.m. and many years ago it was reported in *W.W.* that the world's champion wireless operator attained a copying speed of 73 w.p.m. in this way. But to copy at 35 w.p.m. using pencil and paper would need memorising each sentence and then jotting it down in shorthand. Even so it would obviously mean "copying late" and I don't think it could be kept up for long. If there is some secret method of taking down morse at supergraphic speeds without a typewriter I should like to hear of it.

Iconoclastic Nomenclature

I'M glad that "Diallist" reminded us in a recent issue that the correct pronunciation of Tacolneston is Tackleston; a lot of these East Anglian names such as Wymondham, Hunstanton and Stiffkey form pitfalls for the unwary.

However, if the name of Tacolneston is to be used much by B.B.C. announcers the pronunciation "Tackleston" will soon be forgotten, even by the local yokels. Who now ever talks of Danetree since the B.B.C. started calling it Daventry thirty years ago? Danetree is as dead as Sissister for Cirencester although the B.B.C. wasn't responsible for that. But the all-powerful Corporation has even varied the pronunciation of Newmarket by stressing the first syllable instead of the second, a thing which in Edwardian days was only done by ignorant "Lunnon folk"; nowadays even the oldest inhabitant knows no better.

Probably the best way of preserving the time-honoured pronunciation of place names from the ravages caused by the sacrilegious tongues of B.B.C. announcers would be to amend the spelling before it is too late. This was done long ago in the case of Brighton with the result that it is still pronounced as it was in the days when it was spelt Brighthelmstone.

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MAXIMUM SENSITIVITY:
Full Scale Deflection for 1 Volt input

TIME SCALE:
Variable from .05 microsecs to 5 microsecs

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CALIBRATION:
Provision is made for accurate measurement of time and voltage scales of a waveform

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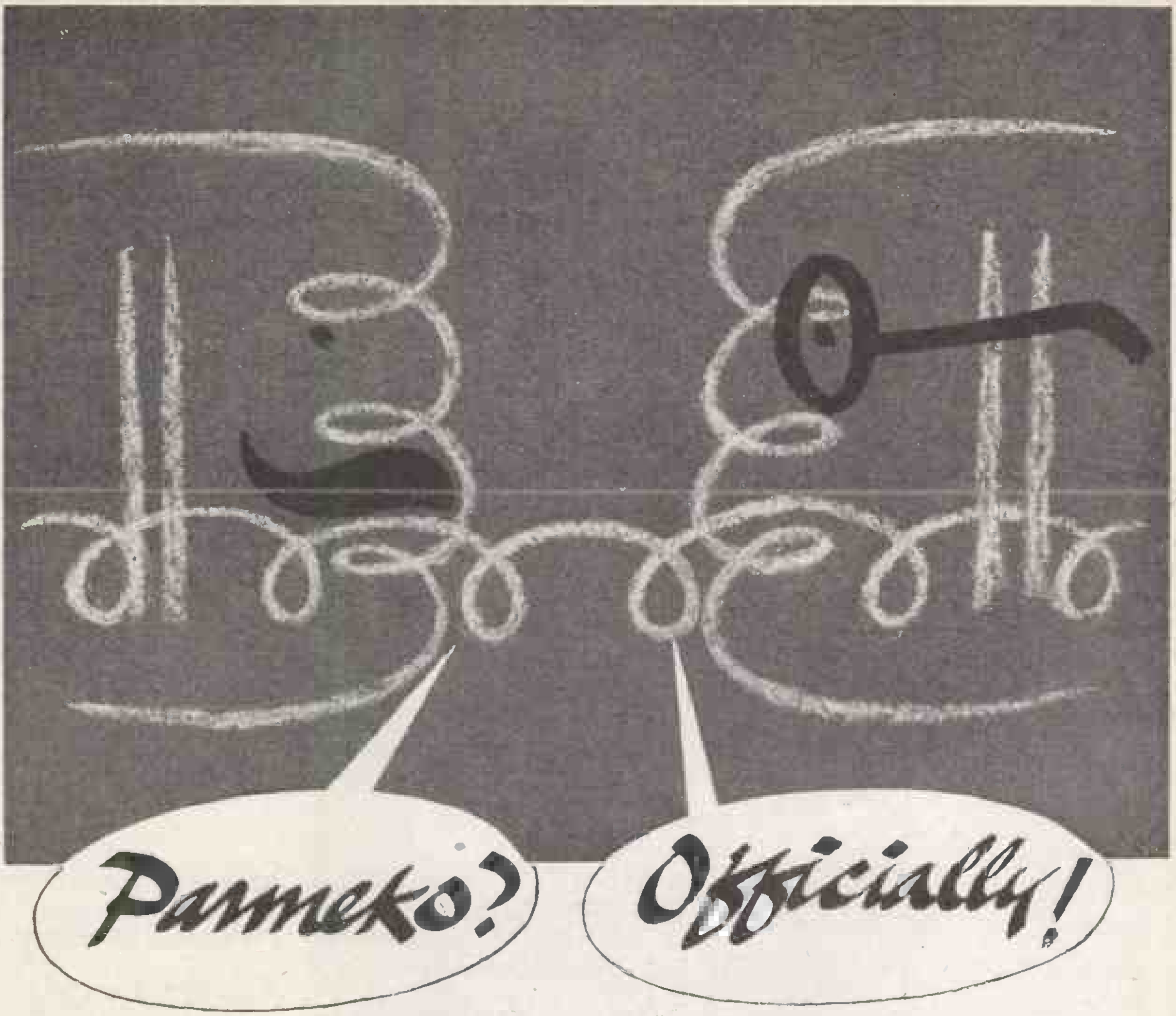

I say, George.

Sir!

By jove! You do sound official.

I am—there have been so many requests for the official description of a transductor.

And you're going to give it.

Exactly. A transductor is a device consisting of one or more ferro-magnetic cores with windings, by means of which an A.C. voltage or current can be varied by an independent voltage or current, utilizing saturation phenomena in the magnetic circuit.

By jove! That sounds impressive, George.

Almost as impressive as the performance of Parmeko transductors—the popularity of which is displayed in other types of 'Saturation phenomena'—bulging order books.

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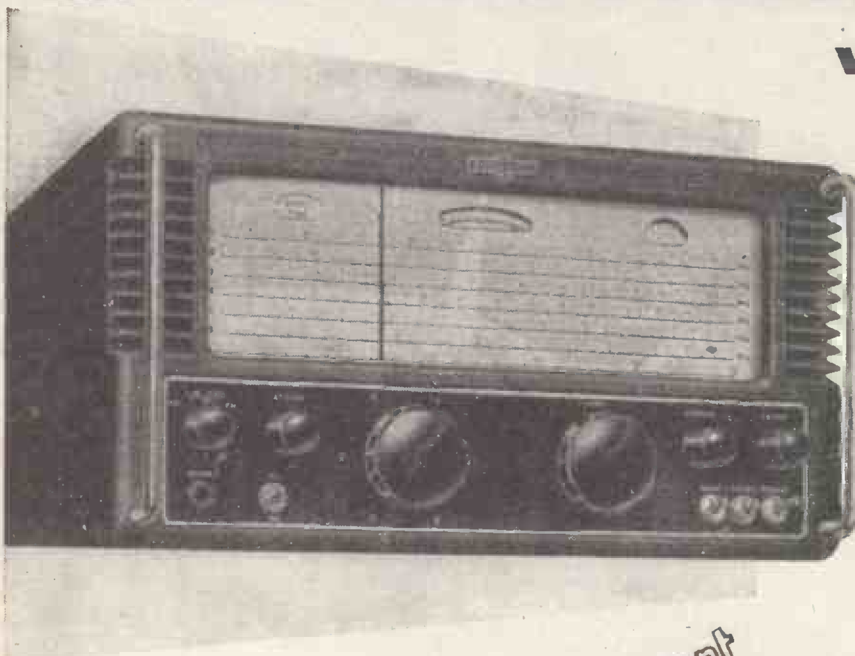

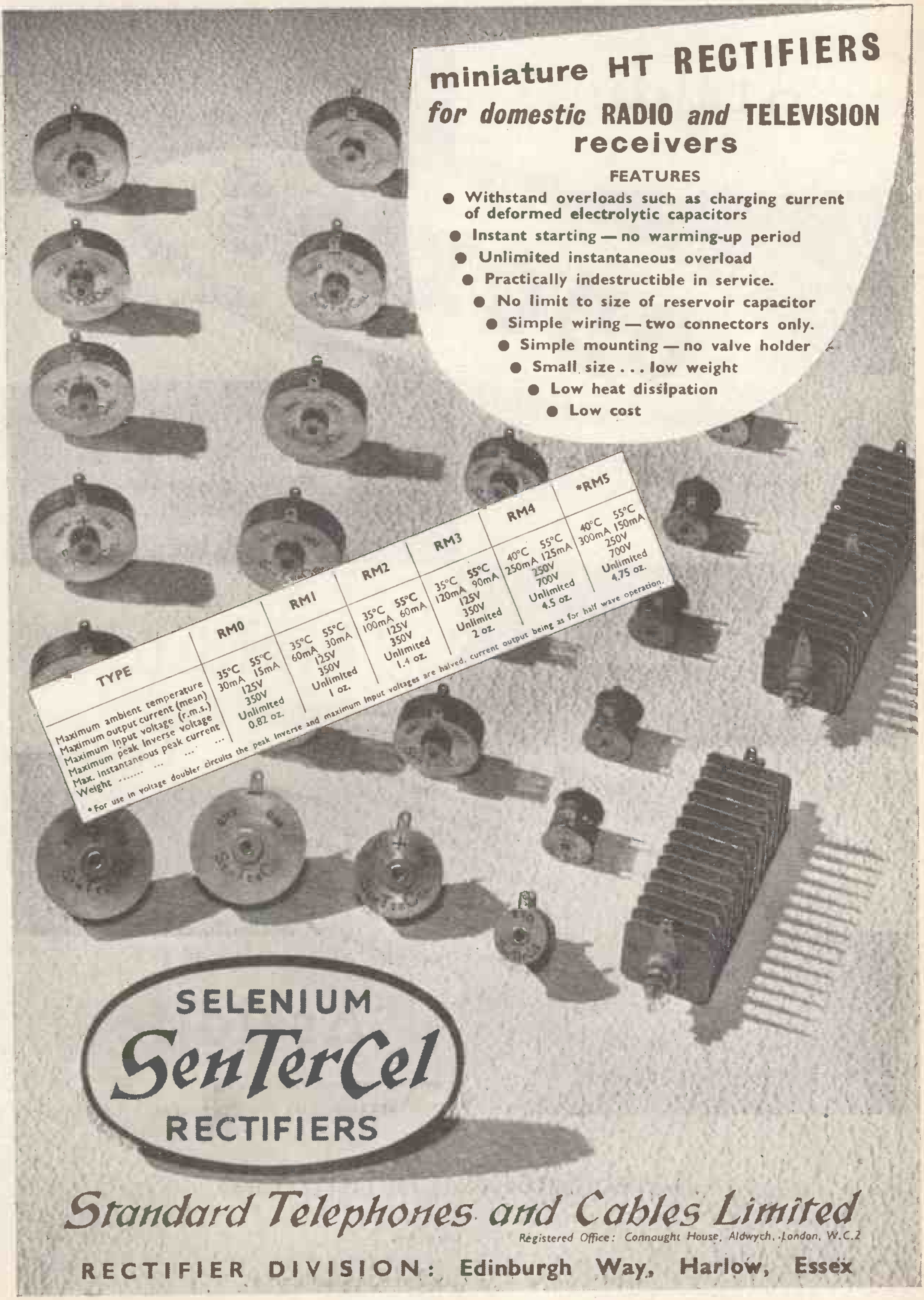
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Maximum output current (mean) | 30mA 15mA | 60mA 30mA | 100mA 60mA | 120mA 90mA | 250mA 125mA | 300mA 150mA
Maximum input voltage (r.m.s.) | 125V | 125V | 125V | 125V | 250V | 250V
Maximum peak inverse voltage | 350V | 350V | 350V | 350V | 700V | 700V
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Weight | 0.82 oz. | 1 oz. | 1.4 oz. | 2 oz. | 4.5 oz. | 4.75 oz.
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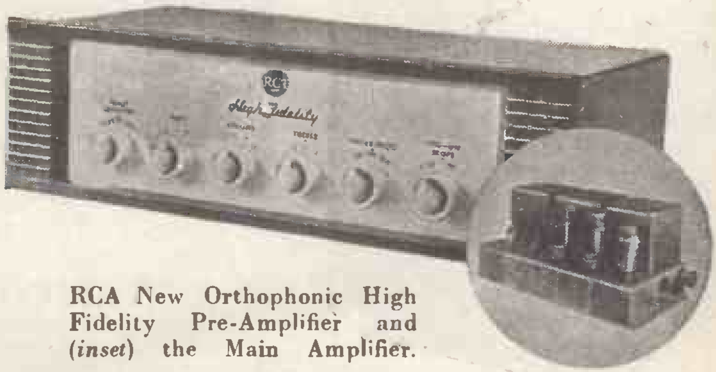

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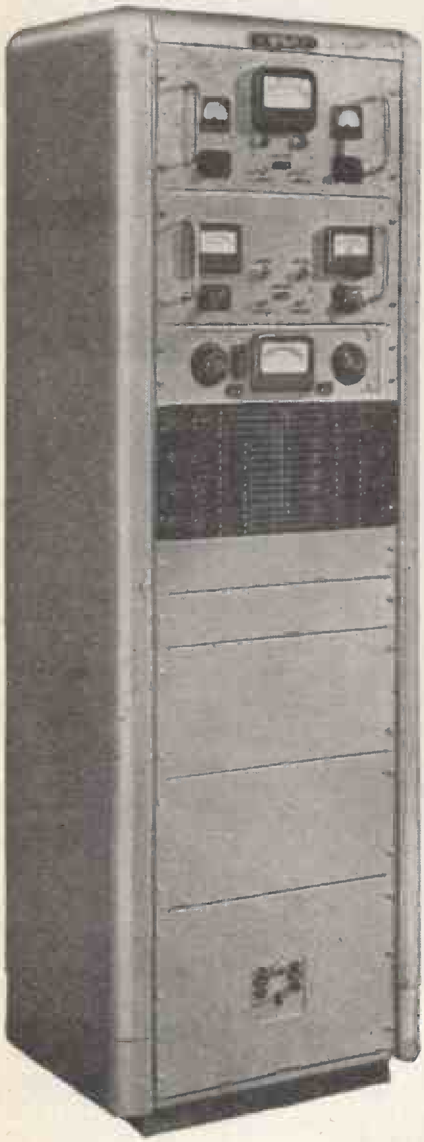

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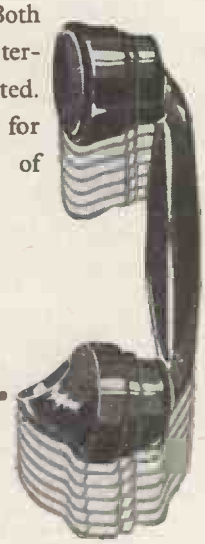

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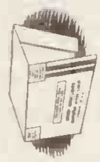

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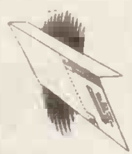

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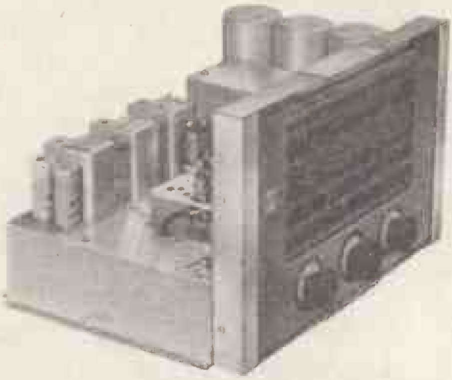

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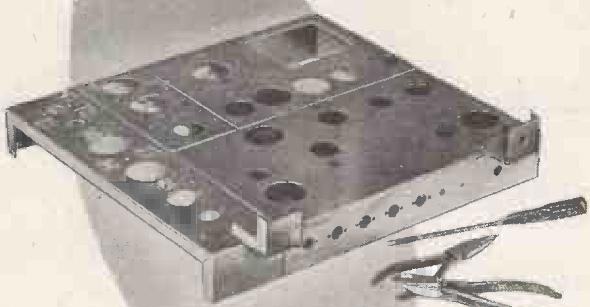

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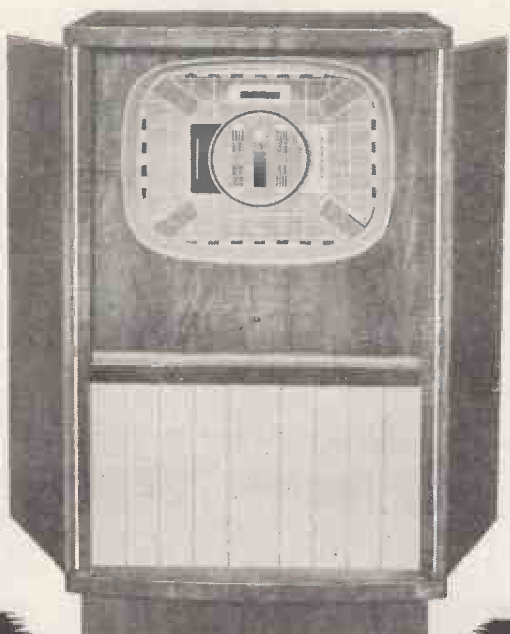

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Telcon Metals announce

a new Mumetal Shield for the 4″ Emitron Cathode Ray Tube type 4 E.P.I.

This Shield has been designed with the assistance of Electronic Tubes Ltd., and is now fully tested and approved to produce maximum magnetic screening.
The Shield is manufactured in two halves in 0.036″ thick Mumetal and is attractively finished with silver hammer stove enamel exterior and matt black heat absorbing interior.
Dimensional drawings are available on request.
Provided that additional tooling is unnecessary slight modifications can be effected to the screen at little extra cost.

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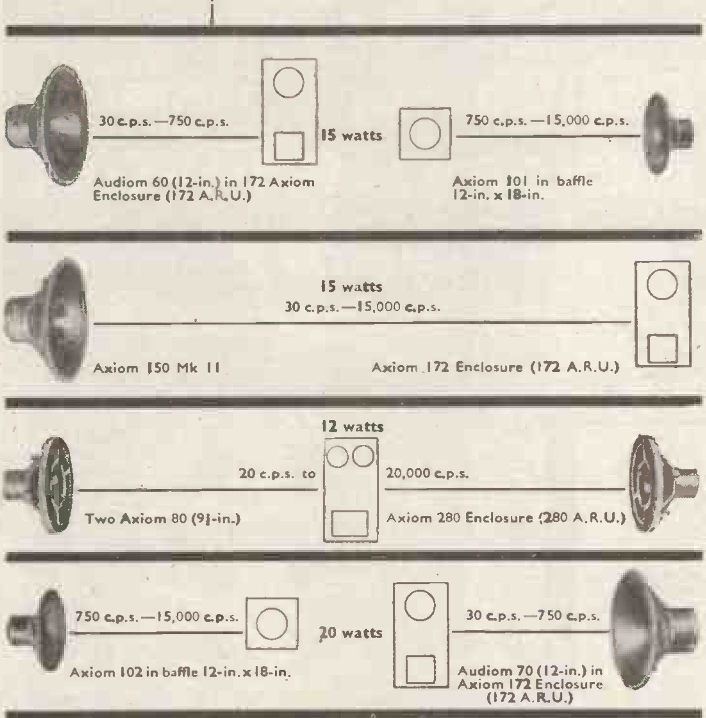
THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO. LTD

Metals Division, Telcon Works, Manor Royal, Crawley, Sussex. Tel: Crawley 1560

HEAD OFFICE: MERCURY HOUSE, THEOBALD'S ROAD, LONDON, W.C.I. HOLBORN 8711



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Incorporating the Acoustical Resistance Unit

AT THE LONDON AUDIO FAIR
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The A.R.U. marks a significant step forward in the design of loudspeaker enclosures. The inclusion of the A.R.U. in a cabinet design enables the same performance to be obtained *in a volume only two-thirds that of the bass reflex chamber for the same loudspeaker.*

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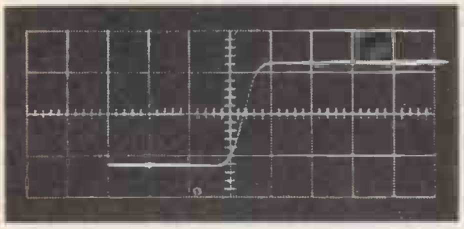
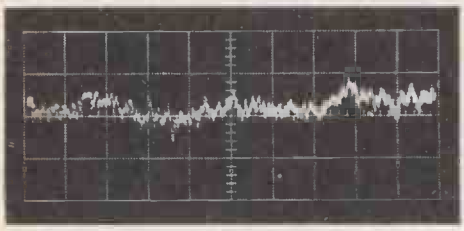


Leading edge of pulse displayed on 0.02 μsec/cm sweep shows clean response of the Type 541 with the Type 53/54K Plug-In Unit.



Noise generated by a 1-megohm carbon-film resistor with 45 v dc applied, displayed on 2 msec/cm sweep of the Type 541 with the Type 53/54E Plug-In Unit at 50 μv/cm sensitivity.

DC-to-30MC Oscilloscope *retains* GENERAL-PURPOSE *utility*

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No longer do you require a highly specialized oscilloscope for your high-speed pulse applications. These applications are now capably handled with an oscilloscope that has general-purpose qualifications, too... the Tektronix Type 541.

The Type 541, although priced lower than specialized instruments, combines an extremely wide sweep range and the inherent characteristics of the high-speed oscilloscope with a flexibility possible only through interchangeable plug-in preamplifiers. You can apply the Type 541 to all ordinary and many unusual tasks with complete confidence. In the many areas covered by this versatile instrument your time and amplitude measurements will be accurate, your waveform displays will be true.

NEED SWEEP DELAY? *The Tektronix Type 545 offers flexible sweep delay in addition to all the characteristics of the Type 541. Delay is accurately calibrated from 1 μsec to 0.1 sec—can be operated in the conventional manner, or triggered for jitter-free display.*

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Triggering facilities. Amplitude-level selection, automatic triggering, and high-frequency sync in addition to all standard triggering modes.

Sweep characteristics. Linear sweeps from 0.02 μsec/cm to 12 sec/cm (600,000,000-to-1 ratio), with 24 calibrated steps from 0.1 μsec/cm to 5 sec/cm. 5x magnifier is accurate on all ranges.

Display characteristics. Full 4-cm by 10-cm linear display, 10-kv accelerating potential, writing rate of 250 cm/μsec.

Versatility. Available plug-in units provide for low-level dc differential and micro-sensitive application in addition to fast-rise applications. Plug-in units covering many other applications are ready for production.

***Type 541 — \$1145 (£441)**
***Type 545 — \$1450 (£558)**
plus price of desired plug-in units
***Type 53/54K Fast-Rise Plug-in Unit . . . . \$125 (£48)**
Prices f.o.b. Portland (Beaverton), Oregon
*Plus duty if applicable.

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This specially adapted 12-channel electro-encephalograph was supplied by Ediswan for electro-medical recording in conjunction with the "man-carrying" centrifuge at the R.A.F. Institute of Aviation Medicine.

Special equipment such as this is regularly being developed and produced by Ediswan for Industry and Government Departments.

Ediswan Engineers have wide experience and they are backed by first-class drawing offices and factories accustomed to working to the appropriate Government specifications.

Enquiries for this type of equipment will receive careful attention.

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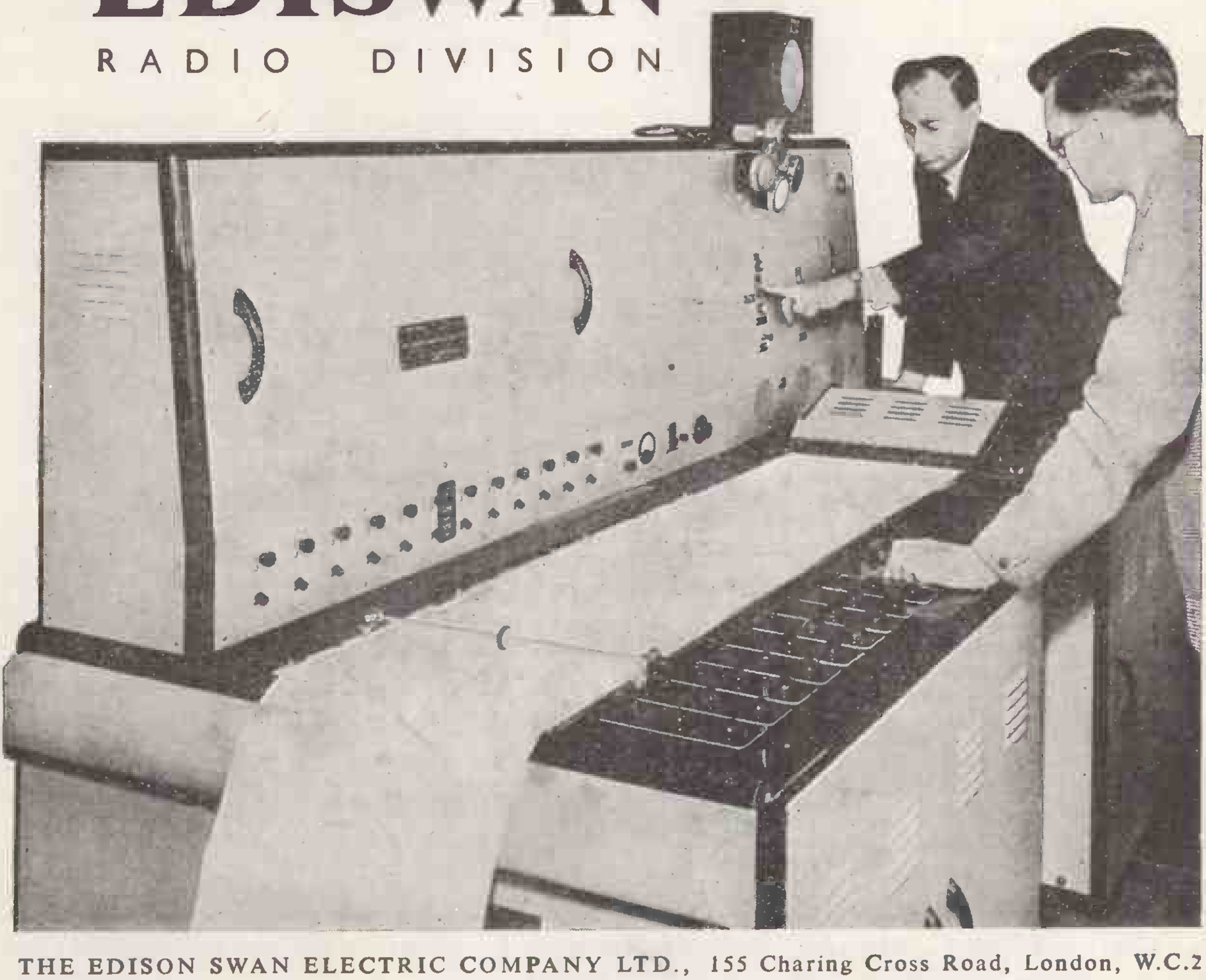
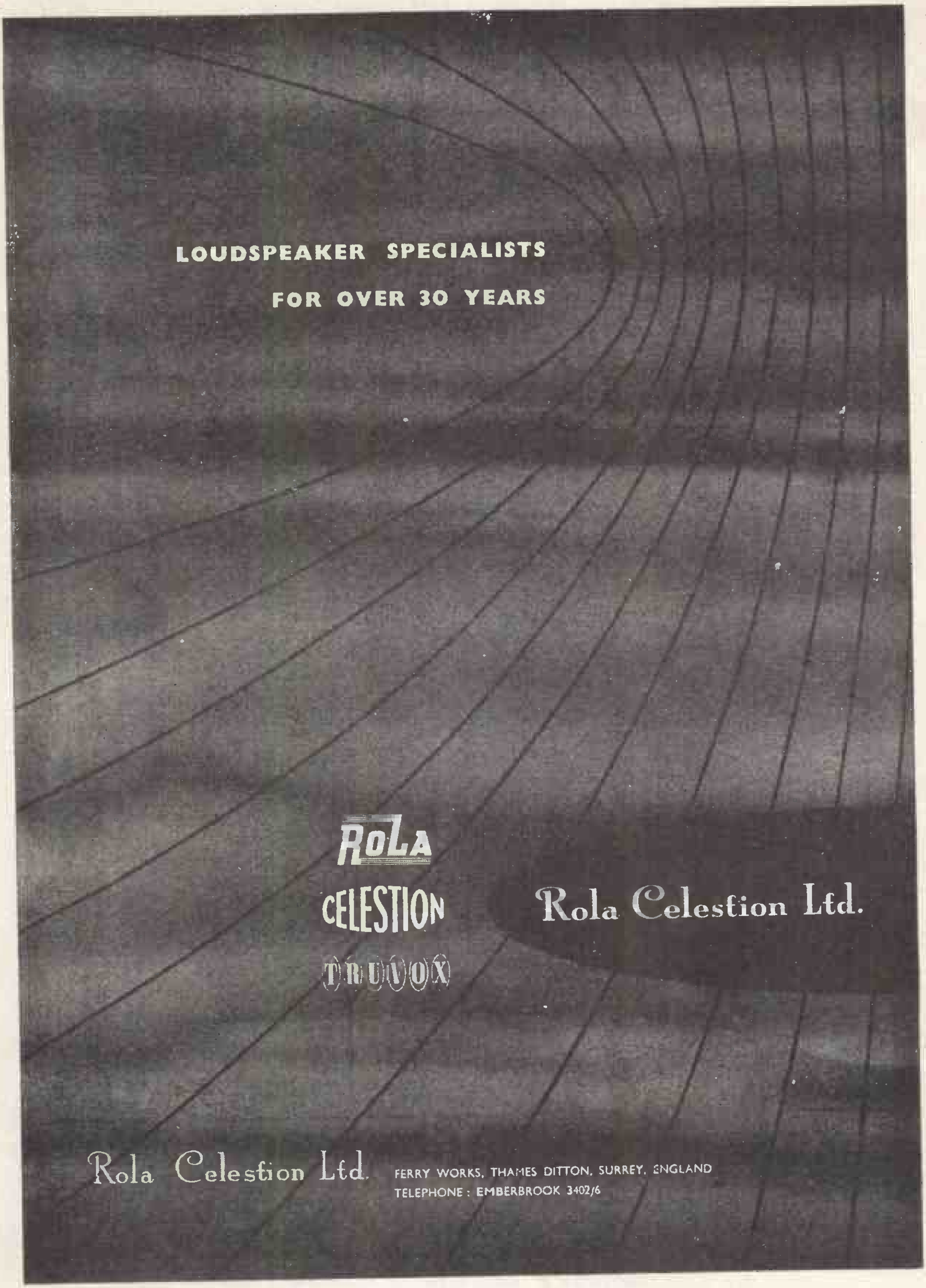


THE EDISON SWAN ELECTRIC COMPANY LTD., 155 Charing Cross Road, London, W.C.2

Telephone: Gerrard 8660 *Member of the A.E.I. Group of Companies* *Telegrams: Ediswan, Westcent, London*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Designed for laboratory use, this new oscillograph provides a Y amplifier with a very useful frequency characteristic extending from d.c. to 6 Mc/s. The display is presented on a new post deflection accelerator tube at an amplitude of not less tham 6 cm over the stated frequency band. The maximum sensitivity of the channel is 0.25 V/cm and calibration is effected by means of the accurate test voltage provided. The time base of the instrument can be switched to fire repetitively from a trigger pulse of either sign derived from the Y amplifier signal or externally. A special refinement, of interest to the Television Engineeer, is the provision for triggering from the Frame or Line sync. pulse in a 1 volt D.A.P. (positive) composite video signal. Five calibrated time base ranges are provided giving spot velocities from 30 cm/sec to 1.5 cm/microsec. An X amplifier with a maximum sensitivity of 0.5 V/cm and bandwidth 20 c/s—250 kc/s (—50%) is included and allows time base expansion, continuously variable, of up to five times. Time measurement is by calibrated shift control. The instrument operates from 100—130 or 200—250 volt mains supplies.

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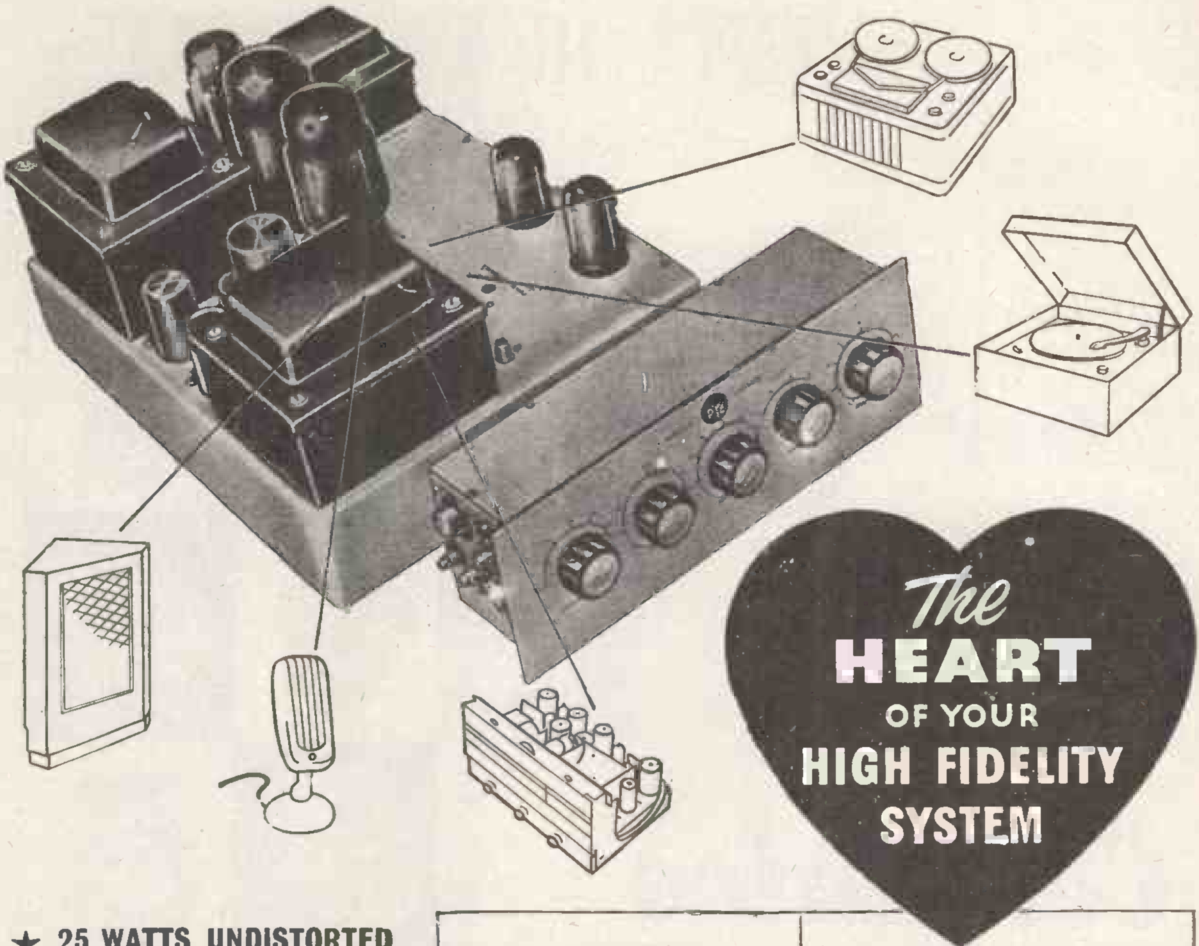

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★ **INFINITE DAMPING FACTOR**

★ **PLUG-IN PICKUP COMPENSATORS**

PRICE
40 GNS
COMPLETE

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26 db. negative feedback and an output from 2-160,000 c.p.s. ● A combination of negative and positive feedback raises the damping factor of the amplifier to infinity, thereby ensuring full control of loudspeaker speech coil movement. ● Output transformer specially designed to meet exacting specification of amplifier ● Amplifier can be controlled from distances up to 20 ft (6m). Cathode follower output from remote control unit minimises cable losses.

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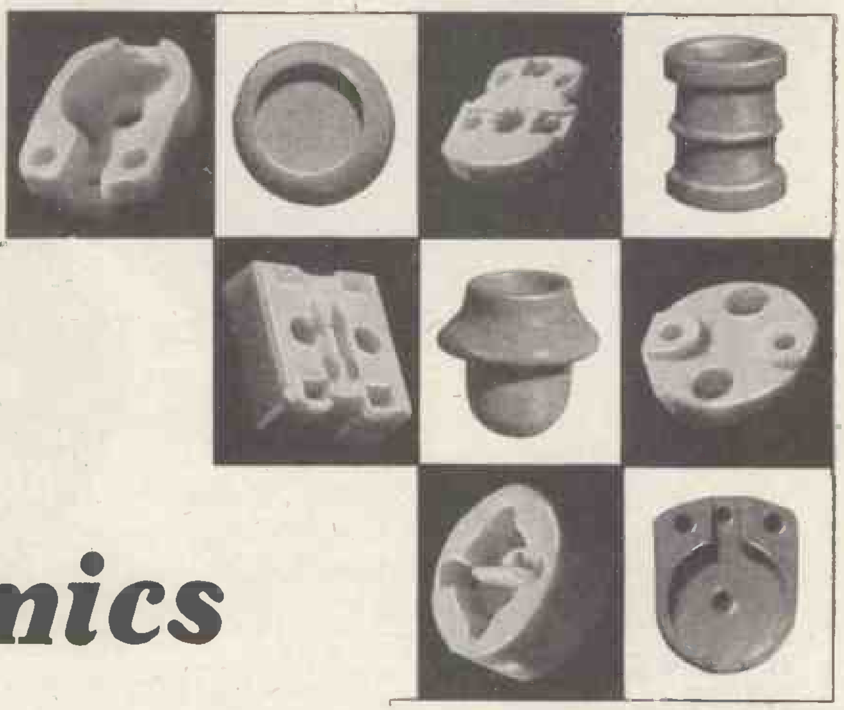

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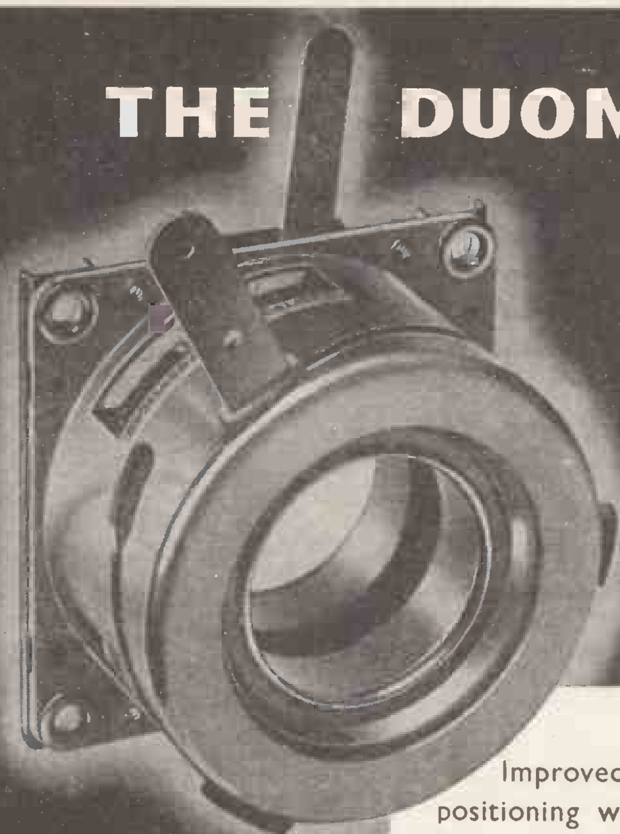

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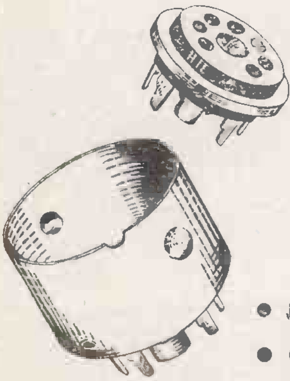

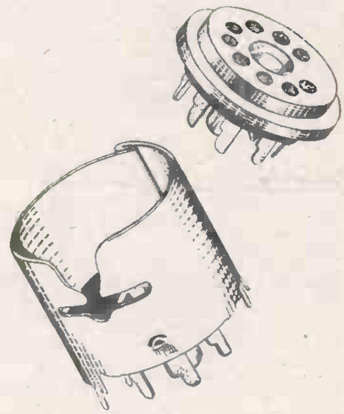

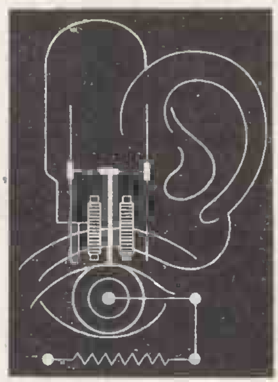

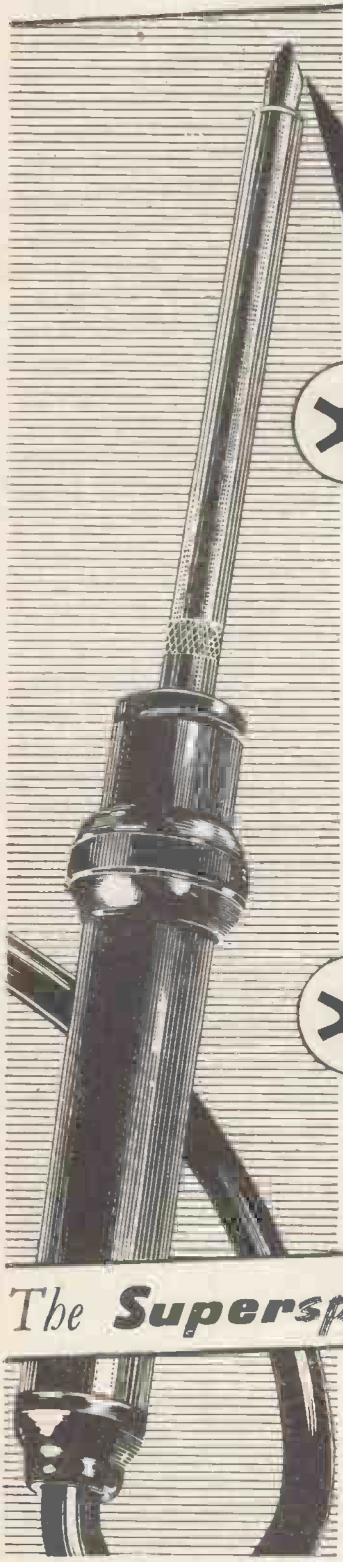

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Alpha 3 valve T.R.F. Kit

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★ Easy to Build.
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★ Walnut cabinet.

Full instructions, point to point, wiring diagram. Circuit diagram and full shopping list 1/- All components may be purchased separately.

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With 2 valveholders for 954, 955 types of valve	5/-

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4 volt 1.5 amp.	5/-
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6.3 volt 3 amp.	9/-
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Measures 8¼in. × 8½in. × 4½in. at base.
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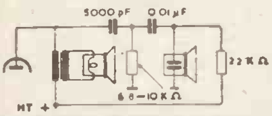
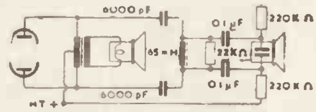
INSTALLATION. TSL electrostatic loudspeakers must be operated from a high impedance source, i.e., from the primary of the existing output transformer. They are not suitable for connection at speech coil impedance.

FITTING A TSL ELECTROSTATIC SPEAKER to any ordinary receiver is simple—it merely entails the addition of resistors and capacitors.



CIRCUIT SUITABLE FOR SINGLE ENDED OUTPUT

To fit an LSH 75 the best method is to suspend the unit centrally in front of the cone of the existing speaker. When two or more electrostatic units are to be added they should be mounted as near to the dynamic loudspeaker as possible. Leads from the equipment to the electrostatic "tweeters" should be kept to the minimum length.



SYMMETRICAL NETWORK FOR PUSH-PULL

CIRCUITS. The circuits illustrated are but two of the many ways in which electrostatic units may be added to existing receivers and amplifiers. Circuit values are the same for each model. Resistor and capacitor, or choke and capacitor values, have been chosen to provide necessary filter constants to prevent frequencies of the middle and lower registers reaching the electrostatic units.

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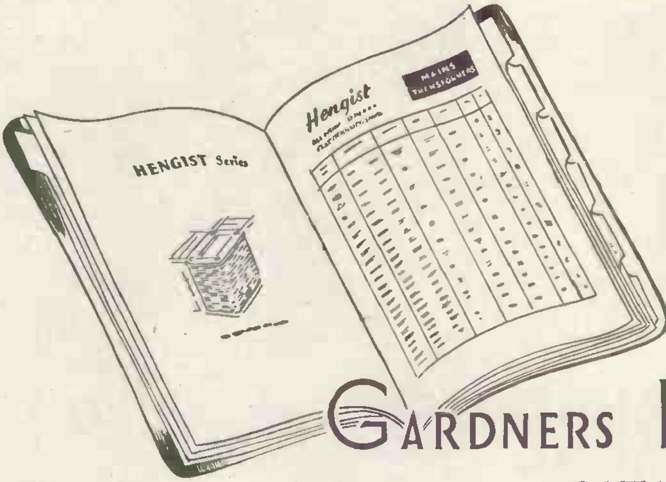

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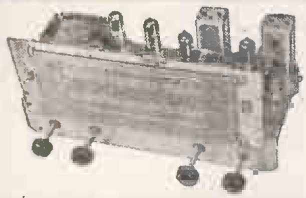

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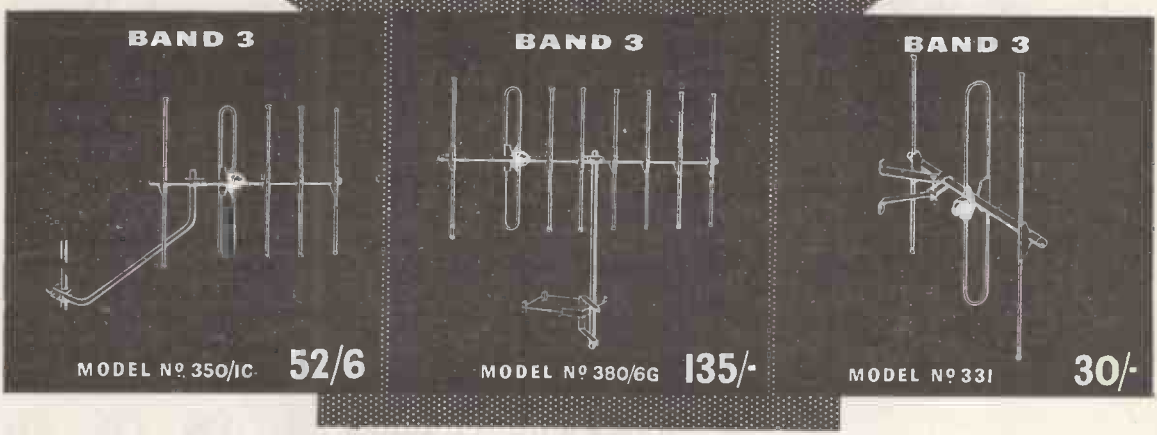

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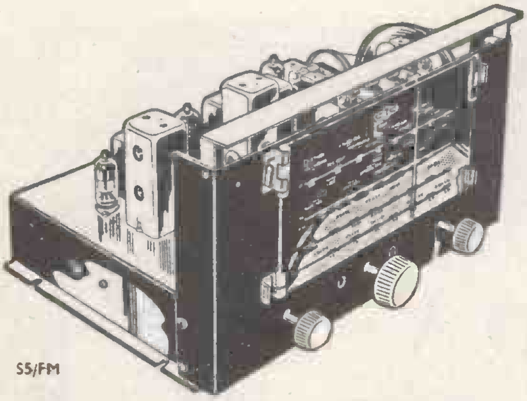
–TUNERS–



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The combined V.H.F. Frequency and World Wide Amplitude Modulation Tuner uses a tuned R.F., self oscillating additive mixer, 2 x I.F. amplifiers, and Radio Detector on the V.H.F band II with completely stable tuning. The AM section uses a tuned R.F. stage, F.C., High gain I.F. amplifier with variable selectivity, and delayed Amplified A.V.C. on all wave bands. A Cathode Ray tuning indicator is fitted and operates on all channels and bands. Available in two types.

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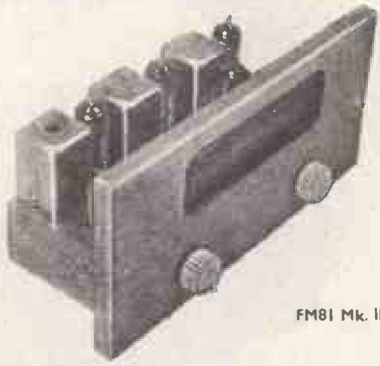

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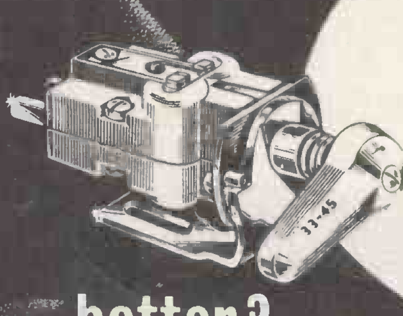

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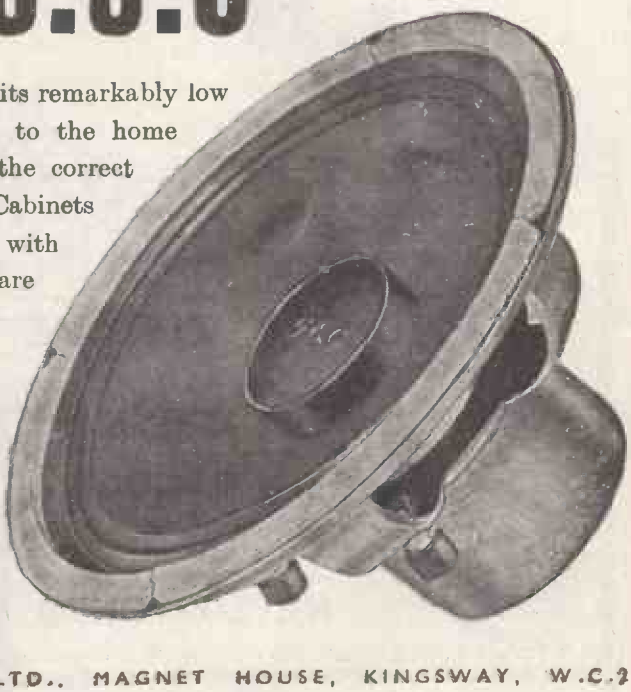

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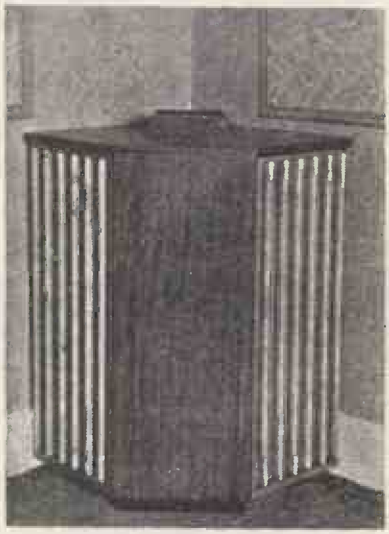

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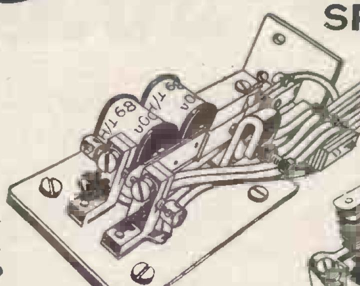

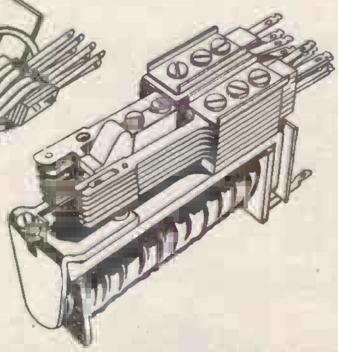

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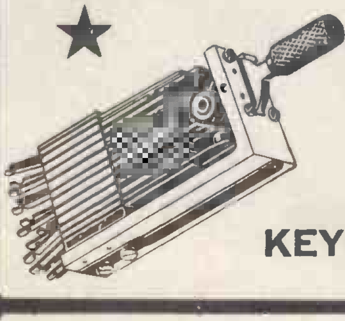

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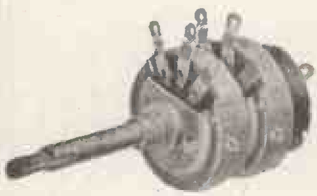

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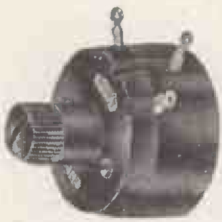

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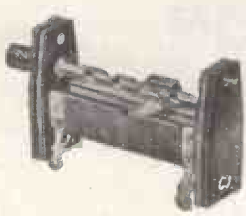

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APS-6	Search/gun aiming	X-band
APS-10	Airborne search/nav.	X-band
APS-13	Aircraft warning	420 MC
APS-15	Search/blind bomg	X-band
APT-4	Radar jammer	165-780 MC
APT-5	Radar jammer	
APX1/2	Transponder, IFF	157-212 MC
CPN-3	Ground beacon	S-band
CPN-6	Ground beacon	X-band
CPN-8	Ground beacon	S-band
CPN-17	Ground beacon	S-band
SCR-682A	Harbor search	S-band
SCR-584	Ground radar	S-band
SCR-602	Ground radar	220 MC
SCR-720	Radar aircraft	S-band
TPL	Mobile ground	S-band
TPS-1	Ground portable	1100 MC
UPN-1	Radar, beacon, IFF	S-band
UPN-2	Radar, beacon, IFF	S-band

SD-SF-SG-SK-SL-SN-SO-SQ Navy Radar
VC-VD-VE-VF-VG remote radar repeaters

DYNAMOTORS—GENERATORS—INVERTERS

Type	Used with	Type	Used with
BD-77	BC-191	MG-149H	
BD-86		MG-153F	
BD-94		MP-10G	TA-2J-24
DA-19A	RTA-1B	PE-59	SCR-240
DM-21	BC-312	PE-73	BC-375
DM-28	BC-348	PE-75	MANY
DM-32	COMMAND	PE-77	EE-97
DM-33	COMMAND	PE-86	RC-19
DM-34	SCR-508	PE-94	SCR-522
DM-35	SCR-508	PE-95	SCR-499
DM-36	SCR-508	PE-98	SCR-522
DM-37	SCR-508	PE-101	SCR-515
DM-40	SCR-506	PE-103	SCR-284
DM-41	SCR-506	PE-104	SCR-284
DM-42	SCR-506	PE-108	SCR-543
DM-43	SCR-506	PE-109	SCR-269
DM-53	RC-103	PE-125	SCR-245
DM-64	SCR-808	PE-218	SCR-519A
DM-65	SCR-808	PE-237	SCR-694 and
DY-1	ARR-2X		GRC-9
DY-2	ARR-2	PU-7	VARIOUS
DY-9	ARC-1	PU-16	VARIOUS
DY-10	ARC-4	800-1	VARIOUS
DY-11	ART-13	PE-110	SCR-534
DY-12	ART-13	PE-112	SCR-518
DY-17	ART-13	PU-6/TPS-1	TPS-3
DY-21	ARC-3	PP-4	APQ
DY-22	ARC-3	PP-51	APQ
GN-35		PP-87	APT-4
GN-37	SCR-178	PP-104	APT-5
GN-45	SCR-284	RA-34	BC-191
GN-50	PE-162	RA-38	SCR-268
GN-58	SCR-694	RA-42	BC-639
HRU-28		RA-62	SCR-624
MG-149F		RA-87	TELETYPE

TELEPHONE AND TELEGRAPH

BC-1016	CW ink tape recorder
BD-71	6 line switchboard
BD-72	12 line switchboard
EE-8	Field phone
EE-65	Line test set
EE-99	Telephone repeater
RC-231	Remote control
TG-5	Code oscillator
TG-10	Ink tape reproducer
TG-34	Code practice keyer
TP-9	Long range field phone

Civilian and military telephone and telegraph centrals, carriers, switchboards facsimile and teletype

TEST EQUIPMENT

TS-3/AP	Power and freq. meter	S-band
TS-7/ASQ	Magnetic compensator	
TS-10/APN	Altimeter test set	Delay line
TS-12/AP	Standing wave ind.	X-band VSWR
TS-13/AP	Sig. gen. freq. mtr.	X-band
TS-14/AP	Sig. gen. pwr. mtr.	S-band
TS-15/AP	Fluxmeter	1.2-4.5K GAUSS
TS-16/APN	Altimeter test set	349-7250 CYC
TS-18/AP	Voltage divider	100 : 1-15 : 1
TS-19/APQ-5	Calibrator	491.04 MC
TS-23/APN	Altimeter test set	
TS-24/ARR-2	Test oscillator	246 MC
TS-27/TSM	Line test set	0-50 MEG, .1-3 MFD
TS-28/UPN	Synchroscope	
TS-32/TRC-1	Test oscillator	1 KC FM, 70-100 MC
TS-33/AP	Frequency meter	X-band
TS-34/AP	Portable oscilloscope	Fast sweep
TS-35/AP	Sig. gen. pwr. and freq. mtr.	X-band
TS-36/AP	Power meter	X-band
TS-45/APM-3	Power and freq meter	X-band
TS-46/AP	Frequency meter	S-band
TS-47/APR	Signal generator	40-500 MC
TS-51/APG-4	Goniometer	
TS-56/AP	Standing wave ind.	L-band
TS-59/APN	Delay line altimeter	High alt.
TS-61/AP	Echo box	S-band
TS-62/AP	Echo box	X-band
TS-67/ARN-5	U/with RC103/ARN5	
TS-69/AP	Calibrator freq meter	.4-1KMC
TS-74/UPM	Attenuator and phantom ant.	S-band
TS-75/U	Test meter	U/with TS76
TS-76/APM-3	Wave guide kit	U/with TS45
TS-78/U	Phantom antenna	100-156 MC
TS-89/AP	Voltage divider	X-and S-bands
TS-91/TPS-1	Echo box	1050-1110 MC
TS-92/AP	Broad band alignment	20-250 MC
TS-98/AP	Decade resistor	22.85 : 1
TS-100/AP	Oscilloscope circular sweep	
TS-102/AP	Range calibrator	Sine wave 327.8 KC
TS-108/AP	RF dummy load	X-band
TS-110/AP	Echo box	S-band
TS-111/CP	Wavemeter	S-band
TS-117/GP	Wavemeter, absorption	S-band
TS-118/AP	RF wattmeter	20-1000 MC, 5-500 W
TS-120/UP	Sig. gen. pwr. meter	X-band
TS-125/AP	Power meter	S-band
TS-126/AP	Radar range calibrator	400 YD. PIPS
TS-127/U	Frequency meter	375-725 MC
TS-131/AP	Field strength meter	20-3000 MC
TS-133/UPM-1	Wavemeter	115-235 MC
TS-134/UPM-1	Wavemeter	460-570 MC
TS-146/UP	FM Sig. gen. wave and pwr.mtr.	X-band
TS-147/UP	Sig. gen. pwr. freq. meter	X-band
TS-148/UP	Spectrum analyser	X-band
TS-155/UP	Pulse generator	S-band
TS-159/TPX	Sig. gen. pwr. freq. mtr.	150-200 MC
TS-170/ARN-5	Test oscillator	332.6-335 MC
TS-173/UR	Frequency meter	90-450 MC
TS-174/U	Frequency calibrator	20-280 MC
TS-175/U	Frequency calibrator	85-1000 MC
TS-182/UP	Signal generator	157-187 MC
TS-184/AP	Echo box	400-430 MC
TS-192/CPM-4	Wavemeter	S-band
TS-204/AP	Reflectometer	
TS-218/UP	Tuned cavity	X-band
TS-226/AP	Wattmeter to K KW	400-425 MC
TS-247/APM-48	Wavemeter	215-275 MC
TS-250/APN	Altimeter calibrator	Delay line
TS-251/UP	Loran sig. generator	1700-2010 KC
TS-258/UP	Sig. gen. pwr. and freq. mtr.	X-band
TS-259/AP	FM signal generator	
TS-263/TPS-10	Sig gen. wattmeter	X-band
TS-268/U	Xtal rect. test set	
TS-270/UP	Echo box	S-band
TS-278/AP	Test set	400-420 MC
TS-297/U	Multimeter	
TS-309/U	Sweep generator	5-65 MC
TS-323/UR	Frequency meter	
TS-352/U	Multimeter	
TS-375/U	Voltmeter	
TS-382/U	Audio oscillator	100 KC
TS-505	Vac. tube voltmeter	
I-48	Megohmeter	0-1000 MEG
I-49	Wheatstone bridge	0-10 MEG
I-56	Tube tester voltohmeter	
I-72	Signal generator	100 KC-32 MC
I-83	Dynamotor test set	
I-86	Generator	470 MC
I-96A	Signal generator	100-156 MC
I-100	Radio ADF test set	
I-130A	Signal generator	100-156 MC
I-203A	Bolometer	S-band
I-208	Signal generator	1.9-45 MC
I-222A	Signal generator	8-230 MC
IE-17	Handy talky test set	
IE-19	SCR522 test set	100-156 MC
IE-36	SCR522 test set	
IE-46	IFF test set	156-166 MC
IE-56	IFF test set	160-186 MC
BC-221	Frequency meter	125-20000 KC
BC-376	Signal generator	75 MC
BC-1063	Test receiver	150-225 MC
BC-1077	Signal generator	S-band
BC-1203	Modulator unit	
BC-1277A	Sig. gen. pulsed	S-band
BC-1287	Oscilloscope	

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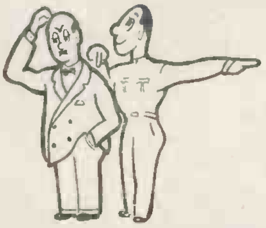

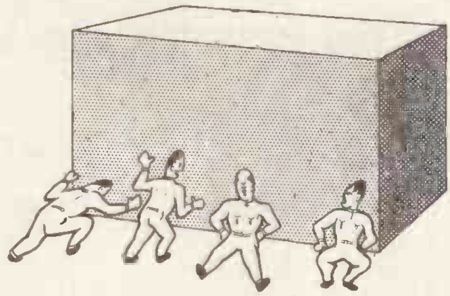

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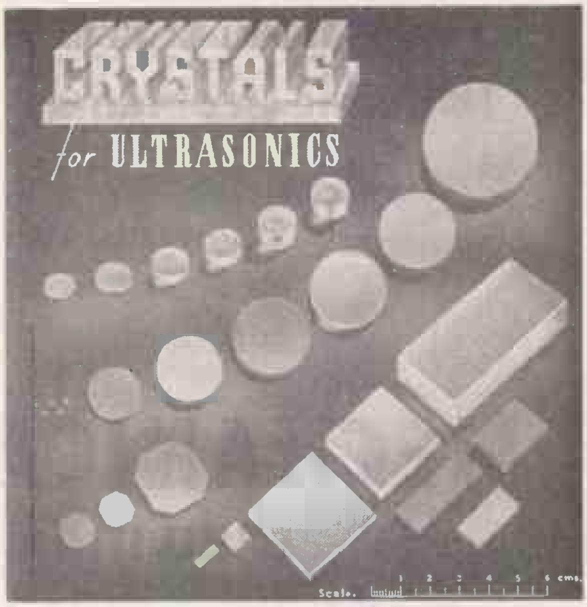

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UBC41	10/-	12AT7	9/-	DAF96	10/-
DK40	10/-	12AU6	9/-	DF96	10/-
EF80	10/6	12BA6	9/-	ECC84	15/-
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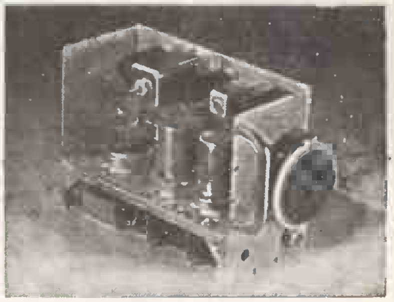
"R.F. 26" F.M. CONVERTOR UNIT—88/100 Mc/s.



We can now offer this self contained Unit comprising 6 Valves—2-6BA6, EB91, VR137, EF54, EF54. Two I.F. stages and separate local oscillator also Muirhead graduated vernier drive assuring easy tuning.

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6K8G, 6K7G, 6Q7G, 25A6G, 25Z5 (or 25Z6G)	37/6 "
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Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-Metal screen, 3 EF50, 4 SP61, and 1 5U4G valves, 9 wirewound volume controls and quantity of resistors and condensers. Offered BRAND NEW (less relay) at 67/6. Plus 7/6 carr. "Radio-Constructor" 'scope circuit included.

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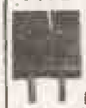

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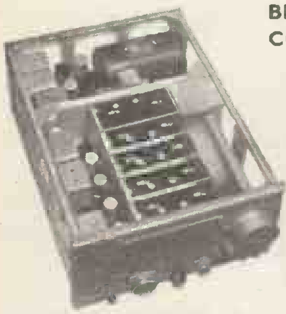

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5 × 6K7, 2 × 6N7, 2 × 6J5, 1 × 6B8, 1 × 6L7, 1 × 6F6. Frequency 3.4 — 7 Mc/s 325 — 695 kc/s, 150 — 325 kc/s. 28V Dynamotor. Loose stored; good condition.

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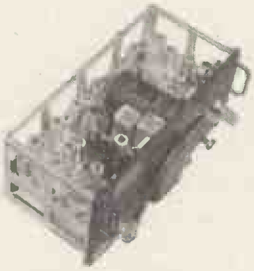
WAVEMETER Type W1310

Continuous coverage of 155-230 Mc/s. Complete with valves, chart and test prods. Input 230 v. 50 cycles. In original crates.

As NEW **£3/19/6.** Crg. 8/6. Loose stored **45/-.** Crg. 6/6.



TRANSMITTER-RECEIVER RT-34/APS-13

17 valves, including 5-6J6 1-VR105, 9-6AG5, 2-D1.

Brand new American equipment in original cartons with instruction manual complete with dynamotor, **79/6.**

TIME DELAY SWITCH

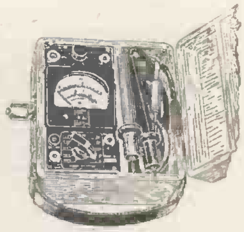
24 volt relay operated, approximately 30 seconds delay, press-button set; beautifully made, **5/11,** post free.

U.S.A. INDICATOR UNIT Type BC929A

Complete with C/R tube 3 BP1, shield and holder. 7 valves. (2) 6H6GT. (1) 6X5GT. (1) 2X2. (1) 6G6. (2) 6SN7GT.

IN ORIGINAL CARTONS.

Price **£2/19/6.**



U.S.A. MULTIMETER

AC/DC 2.5V, 10V, 50V, 250V, 1,000V, 5,000V. 1 mA, 10mA, 100mA, 1 Amp. 3-Ohm ranges. Decibels. Complete with instructions and special test prods in wooden carrying case: **£5/19/6.** Post 2/6.

POCKET VOLTMETER M.C.

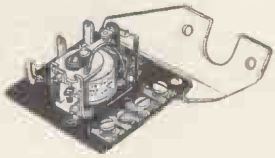
2 ranges. 0-250 v. and 0-15 v. D.C. press-button. At **12/6** each.

GERMANIUM DIODES

B.T.H. **2/-.** G.E.C. **1/6.**

MATCHING TRANSFORMER

For low resistance headphones, **1/9.**

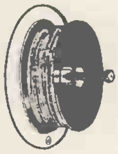


RELAYS

(American manufacture) 1 break 1 change-over 1,000 ohm coil. Complete with mounting bracket, **4/6.**

MOVING COIL MICROPHONE

By famous maker, brand new in original cartons. A high-grade microphone combining excellent close speaking performance with low background pick-up. Attractively styled and finished in black and chromium. List £7/7/-. Our price **£3/19/6.**



DINGHY AERIALS

100 yards woven copper wire on free running reels. Complete with winding handle and locking mechanism, **5/-.**

KELVIN RATIOMETER

Mirror backed. Type MN. HG-ABS KB 630/01 8in. scale. Approximately 6 microamperes, **£5/19/6.**

TRANSFORMERS

E.M.I. Pick-up matching transformers (potted) for low resistance pick-ups. Large: 3in. dia. × 2½in. deep, **4/6.** Small: 2in. dia. × 2½in. deep, **3/9.**

American B.C. 28 volt bulb and holder, **1/3.**

U.S.A. DYNAMOTOR ROTARY TRANSFORMER

D.C. Input 12 volts. D.C. Output 285 volts .075 amps. Unused **30/-.**

WANTED: Communication Receivers, Television Receivers, Tape Recorders, Test Equipment, Valves, etc.

Open daily 10.30 a.m. to 4.30 p.m. Thursdays 1 p.m. Carriage extra on all items unless quoted.

BARGAINS FOR CALLERS—Receivers, amplifiers, power packs, meters, etc.

The RADIO EXCHANGE Co.

9 NEWPORT PLACE . LEICESTER SQUARE . LONDON, W.C.2 . Tel. GER 2613

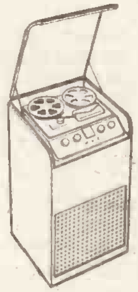
Doin' what comes naturally . .

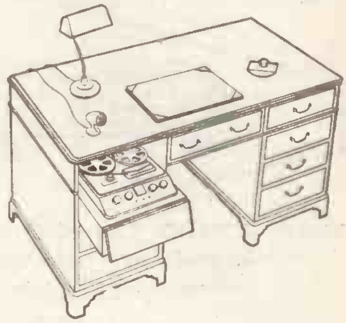
Hitherto almost all Tape Recorders have been designed as portables. But portability isn't much use to the man who doesn't intend to carry his equipment around. It can, indeed, become a serious handicap. The time necessary to connect up and prepare the instrument for use may deprive him of many valuable recording opportunities that will never return.

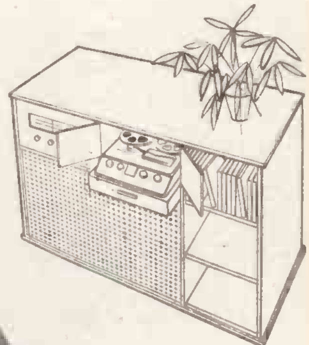
The new Ferrograph "66" shown here is a natural—and logical—development in design. It is our answer to the demand from experienced high fidelity enthusiasts who seek professional results from an instrument which can be easily housed in an existing piece of furniture or which can form part of a larger installation.

By the omission of an inbuilt loudspeaker it has been possible—without sacrificing even one of the many valuable features of the Ferrograph—to design the instrument so that its main baseplate substantially overlaps the high fidelity amplifier beneath it. Thus it is child's play to fit the Ferrograph "66" into a desk, a console, a bookcase, an escritoire or any suitable piece of furniture of period or contemporary design. All that is necessary, in fact, is to cut away an opening 15⅜" x 16½". If a drawer is used, it should be at least 10" deep to carry the instrument mounted on a simple wood surround. Or, of course, a pair of adjacent drawers can be converted for the same purpose.

Most attractively finished in gold bronze with cream knobs and accessories, the whole ensemble will readily harmonise with the most luxurious surroundings and permit tape recording and playing at its best to be always available at the turn of a switch.







Model 66.N
3¾" & 7½" p.s.
84 gns.

Model 66.H
7½" & 15" p.s.
88 gns.

(including 1750 ft. Ferrotape on 8¼" reel)

Ferrograph "66"

BRITISH FERROGRAPH RECORDER CO. LTD

131 SLOANE STREET · LONDON · S.W.1 · Tel: SLOANE 2214/5 and 1510

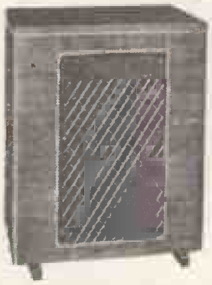
Special Clearing PRICES SLASHED!

★ A.M. CHASSIS

5-valve Superhet, 2 wavebands (medium and long), A.C./D.C. 200-250 volts. Output 4 watts. Controls—tuning on/off volume, wave change. Developed to meet the demand for an inexpensive instrument with no sacrifice in the quality of its reproduction and output. 12in. long x 8¼in. overall depth x 8in. high (approx.). Packing and carriage for all chassis 12/6 **6½ Gns**

★ AUTOMATIC RECORD CHANGERS

Cat. No. RC/A — latest fully automatic 3-speed mixer changer made by a famous manufacturer **£7.19.6**



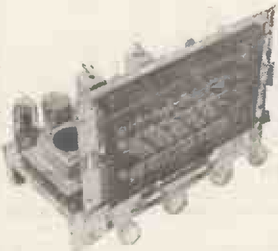
★ CABINETS

A very high quality Cabinet in a modern design. Exterior veneered in a highly figured Walnut. Solid block-board lift-up top with all Interiors veneered in Sycamore. Full silk front.

Packing and Carriage 15/-. **£8**

Extension Speaker Cabinets for 8in. or 10in., 27/6 each.
Packing & Carriage 7/6.

★ STARRED ARTICLES AVAILABLE WHILE STOCKS LAST



RADIO RECEIVER CHASSIS

Built to the highest specifications these chassis offer the finest value to the enthusiast. Supplied with set of selected knobs. Socket panels for aerial, earth, speaker, pick-up and gram. motor. 200/250 v. 50 cycles only.

15in long x 8¼in. overall depth x 7in. high (approx.).

TYPE A 5 VALVES

TYPE A: 5 valves 3 wavebands Superhet with full negative feedback and A.V.C. Full range tone control. **10 Gns.**

Packing and carriage 12/6.

TYPE B 7 VALVES

TYPE B: 7 valves 3 wavebands Superhet with specially designed push-pull output stage. **£15/4/6**

Packing and carriage 12/6

CRYSTAL RECEIVER—TUNER

Designed for reception of medium and large wave-bands with outlet for Tape Recorder on High Quality amplifier. Employing supersensitive Germanium Crystal Diode the tenor is housed in an attractive moulded plastic cabinet, size: 6in. x 4in. x 3½in., weight 1lb. Packing and Carriage 7/6. **£2/10/0**

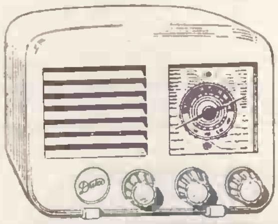
A.M./F.M. CHASSIS

A 9-valve A.M./F.M. chassis with 4 wavebands (long, medium, short and F.M.), push-pull output stage and magic eye for precision tuning. Specially designed, with permeability tuned F.M. circuit and a very high degree of I.F. amplification for fringe-area reception, it offers the finest quality regardless of price. Automatic volume control and a special wide-range tone control. Push-pull output stage and compensated network for electrostatic treble speaker, with an output of 5 watts and the widest possible audible frequency range. Special large 10in. high flux-density F.M. Speaker with hyperbolic cone plus matched high-tone electrostatic Speaker. Co-axial socket for dipole aerial. A.C. 50 cycles only. Provision for external speaker. Packing and Carriage 15/-. **25 Gns.**

★ LOUDSPEAKERS

Cat. No. LS/10—10in. Standard	£1 10 0
Cat. No. LS/E74—7in. x 4in. ELLIPTICAL	£1 1 0
Electrostatic Loudspeaker LSH75. for treble response	11 6

Packing and carriage 3/-.

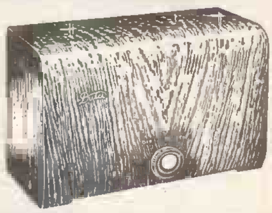


M.L.U.5 TABLE RECEIVER

FIVE Valves superheterodyne, two wavebands (Medium 187-550 metres Long 1,000-2,000 metres). Universal A.C./D.C. with a high sensitivity and stability factor. Negative feedback and compensated A.V.C. Fixed tone control and pleasing bass response. Housed in attractive cabinet. Packing & Cabriage 7/6. **12gns**

T.V. BAND III CONVERTER

Housed in an attractive cabinet this instrument is designed to enable viewers with single band TV receivers to obtain programmes on Band III transmission (I.T.A.). 200-250 volts A.C. only. Simple to connect. Full instructions enclosed. Only **£9/15/0**



SPECIAL F.M. TUNER

A completely self-contained unit transforms an old A.M. set into a modern F.M. receiver. Circuit contains 6 valves; Grounded grid RF stage followed by additive mixer using a FCC85 Twin Triode valve combine these two functions in a completely sealed permeability tuned unit. Two I.F. stages give maximum gain followed by EBGI double diode as ratio detector. Frequency coverage of 85 to 101 megacycles allows adequate overlap at each end of the band and covers all existing and proposed V.H.F. transmissions in the U.K.

UNBEATABLE VALUE TAPE RECORDER

In a superbly fitted Moroccan grained carrying case, this instrument is the very finest of its class, regardless of price. Latest type TRUVOX twin-speed Tapedeck. Input for radio, gram. and microphone. Built-in selected elliptical Speaker of the very finest quality. Recording (with recording/level indicator) or Play-back. 200-250 volts, 50 cycles, A.C. Mains only. Supplied complete with selected Microphone & Recording Tape. **42gns**

Packing and carriage 25/-.

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ALL FULLY GUARANTEED GENEROUS TERMS ON ORDERS OVER £15. All items available from stock.

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Letter from the Canary Islands!

Las Palmas
1st December 1955.

To WHARFEDALE WIRELESS WORKS
Idle, Bradford, Yorkshire.

Muy estimados Sres Mios:

Estas lineas son unicamente para expresarles mi gran satisfaccion por el resultado obtenido con mi Wharfedale 3-speaker system comprado a Uds. a fines del pasado ano. Yo califico este resultado de sensacional y pueden estar seguros de que me he convertido en un elogiador entusiasta de los Wharfedale speakers.

Mi amplifier system es un Acoustical Quad II siendo tambien para mi un motivo de satisfaccion saber que en le Royal Festival Hall y en Carnegie Hall en New York, la demostracion hecha ante el publico ha sido con estos mismos equipos.

(signed) Dr. J. P. CABALLERO.

Free Translation:

These lines are written simply to express my great satisfaction at the result obtained with my Wharfedale 3-speaker system bought from you at the end of last year. I qualify this result as sensational, and you can be sure that it has converted me to an enthusiastic eulogist of Wharfedale speakers.

My amplifier system is an Acoustical Quad II, and it is also a source of satisfaction to me to know that the demonstration before the public in the Royal Festival Hall and in Carnegie Hall, New York, was given with this same equipment.

(signed) Dr J. P. CABALLERO.

OMNI-DIRECTIONAL 3-SPEAKER SYSTEM

W 15/CS SUPER 8/CS SUPER 3

PRICES (TAX FREE)

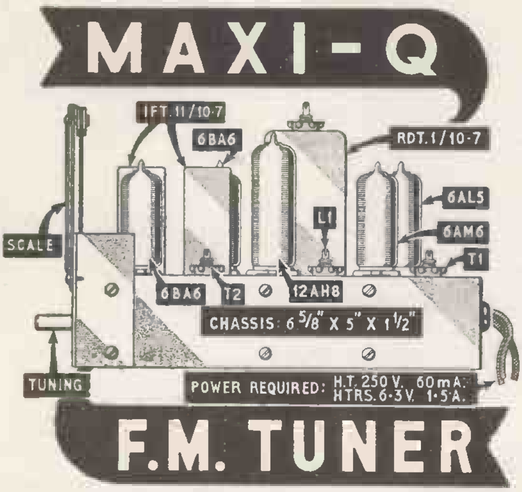
W15/CS in sand-filled Enclosure.	**£47. 0. 0**
Twin Treble Assembly..........	**£18. 0. 0**
HS/CR3/2 Crossover with V.C.'s.	**£ 8.10. 0**
	£73.10. 0

2 Sand-filled Back Panels (40in × 24in) to complete the enclosure, where a suitable corner is not available, can be supplied at £12. 0. 0 per pair.

Wharfedale

WIRELESS WORKS LTD

Idle, Bradford, Yorkshire. *Tel.: Idle 1235-6*



The guaranteed components described below have been acclaimed by thousands as the finest obtainable.

Full constructional details, point-to-point wiring diagram and alignment instructions are given in our Technical Bulletin DTB.8, price 1/6.

F.M. SCALE. A bronze finished scale with yellow markings (0-20 Log) for use with all types of F.M. tuners or receivers. Consisting of metal scale, pointer, cord drive spindle, pulleys, 2¼in. drum, cord and instructions for the assembly of the cord drive. The scale measures 5⅝ × 3in. and is for a cabinet aperture of 4 × 1⅞in., price 9/–.

RDT.1/10.7 Mc/s. A transformer for use in ratio discriminator type circuits. Can size 1⅜in. square × 2¼in. high. Secondary winding of bifilar construction, iron dust core tuning, polystyrene formers and silver mica condensers, price 12/6.

PDT.1/10.7 Mc/s. A miniature phase discriminator transformer for use in frequency modulation detector circuits where the limiter/Foster-Seeley type of circuit is employed. Designed for carrier deviation of ± 75 Kc/s. Qk = 1.5. Screening can 1⅜ × 1⅜in. square, price 9/–.

IFT.11/10.7 Mc/s. A miniature I.F. transformer of nominal frequency 10.7 Mc/s. The transformer is primarily intended for the I.F. stages of frequency modulation receivers and converters. The Q of each winding is 90 and the coupling critical. Dimensions as PDT.1, price 6/–.

IFT.11/10.7/L. As IFT.11/10.7 but with secondary tap for limiter input circuits, price 6/–.

Coil Type L1, T1, and T2. These coils are specially designed for use in the "MAXI-Q" F.M. TUNER, price 3/11 each. **Chassis and screens for the above unit, completely punched in aluminium, price 7/6.**

Obtainable from all reputable stockists or in case of difficulty direct from works. GENERAL CATALOGUE covering technical information on full range of components, 1/- post free.

DENCO (CLACTON) LTD. 357/9 Old Road, Clacton-on-Sea, Essex

STOP PRESS: Available to retail customers only. "Maxi-Q" **F.M. Tuner Unit** assembled and valved at £7/2/6 plus £2/17/- P.T., also Power Pack at £3.

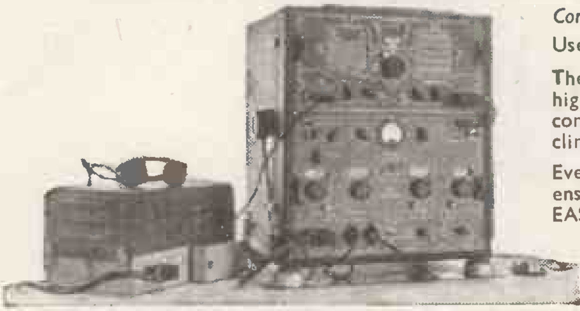
Osram F.M. Tuners completely assembled and valved at £22 plus £8/16/- P.T.

Coil Turret CT.7/B. This turret has been specially designed for use in the "Brittania" communications receiver described in the October and November issues of the "R.S.G.B. Bulletin," price £3/15/–.

Mullard 5-10 T.C.C. Printed Circuit Chassis, 7/9 (plus 1/– postage). The metalwork and coils for the "Viewmaster" Band III converter will be available shortly.

AGAIN AVAILABLE FOR QUICK DELIVERY:

SHORT WAVE TRANSMITTING/RECEIVING INSTALLATIONS T/R-50 SERIES



Complete in every detail for immediate operation

Use: **MARINE · MOBILE · FIXED STATIONS**

The performance of these installations is of the highest order and meets the requirements of commercial telecommunication working in all climates and conditions.

Every design feature has been incorporated to ensure: RELIABILITY — ACCESSIBILITY — EASE OF SERVICING.

T/R-50 Mk. III INSTALLATIONS are designed for use in a communications network and include the following additional features:

- **PRE-SET FREQUENCY SELECTION, CRYSTAL CONTROLLED** (in the Transmitter and Receiver) incorporating a patented FLICK-CONTROL.
- **BUILT-IN AUTO-ALARM SYSTEM**
- **AERIAL MATCHING:** 12-600 ohm impedance over the whole frequency range.

ACCESSORIES AND SPARE PARTS—All accessories and equipment spares for 3-5 years operation can be supplied with the equipment (immediate delivery).

We can supply for IMMEDIATE DELIVERY R.C.A. COMMUNICATIONS & BROADCAST TRANSMITTERS (from 250 w. to 5 kw.)

Brief Specification:—

TRANSMITTER
POWER OUTPUT—50 WATTS.
FREQUENCY RANGE: 1,500 Kc/s. to 12,500 Kc/s. in 3 bands, V.F.O. or CRYSTAL CONTROL with choice of five crystal positions.
EMISSIONS: (a) Radiotelephone (voice) with facilities for full press-to-talk operation.
(b) Radiotelegraph (code) with provision for full break-in keying.

RECEIVER
SUPERHETERODYNE: I.R.F., Mixer, Local Oscillator, 2-I.F.'s, 2nd Detector and 1st Audio, B.F.O., Power Output Stage with built-in Speaker and additional 500-ohm line connections.
Note: The R-50 Mark II can be provided with a muting control (full or partial) on special order.

POWER SUPPLIES
12 v. Dynamotor Unit or A.C. Mains Supply Unit (100/130 v. and 200/250 v. 50/60 cycles).

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Cables: SAROZAL, LONDON *Telephone:* LANgham 9351 *(3 lines)*
A.I.D. and A.R.B. Approved.

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" More output," he says. " They want more output, please," he says.

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You tell **him**. Tell him it might work, perhaps, with Suflex.

Suflex make a tiger almost the size of a pussy cat.

Ask us.

Suflex Polystyrene Capacitors

- High insulation resistance
- Low dielectric loss
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A quality component which may be economically used in commercial equipment

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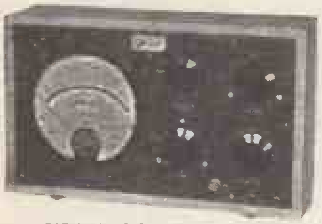
CABLES: HENELEC, LONDON.

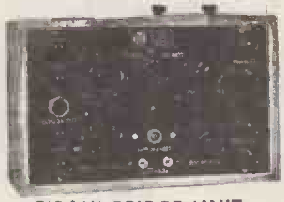
PIRANI HIGH VACUUM TEST EQUIPMENT.

Manufactured by "PYE RADIO LTD." for

M.O.S. ATOMIC RESEARCH STATION.



PIRANI CONTROL UNIT



PIRANI BRIDGE UNIT

PYE SCALAMP GALVANOMETER

PIRANI GAUGE HEAD WITH CALIBRATOR

THIS COMPLETE VACUUM TESTING EQUIPMENT (5 ITEMS AS SHOWN) OFFERED BRAND NEW IN ORIGINAL CARTONS.

£35'-'- CARR. PAID. (LESS THAN HALF COST PRICE)

(SPARE PIRANI GAUGE HEADS, EDWARDS TYPE M6, LESS CALIBRATOR, 15/- EACH.)

The famous MARCONI CR 100

MARCONI CR 100 COMMUNICATION RECEIVER

FREQUENCY RANGES 60 Kc/s to 420 Kc/s, 500 Kc/s to 30 Mc/s, in 6 bands.

RECEIVER INPUT 100 ohms, balanced or unbalanced, or high impedance aerial.

SENSITIVITY For 20 db signal-to-noise ratio on C.W., 60K c/s to 11 Mc/s. 1 to 2 μV. 11 Mc/s to 30 Mc/s. 1.5 to 4 μV.

SELECTIVITY From better than 100 db at low frequency end to 30 db at high frequency end.

CIRCUIT 2 RF stages, 3 IF stages, LF and output stage, AVC, BFO.

AUDIO RESPONSE $\pm 4\frac{1}{2}$ db between 100 and 6,000 c/s.

PASS BAND SWITCH Giving 6 pass bands: 6,000; 3,000; 1,200; 300 and 100 c/s.

RECEIVER OUTPUT 3 watts max. (3 ohms or 1,000 ohms loudspeaker).

PRICE, in excellent condition, aligned and tested **£20**
Crg. & Pkg. extra.

*Completely rebuilt to original specification for laboratory use—**Price on request.***

STILL AVAILABLE: Our normal range of equipment including British and U.S.A. Laboratory equipment. Receivers etc

★U.S.A. FREQUENCY METERS
Type BC 221
125 Kc/s—20 Mc/s Complete with calibration charts.
Available from stock. CONDITION PERFECT

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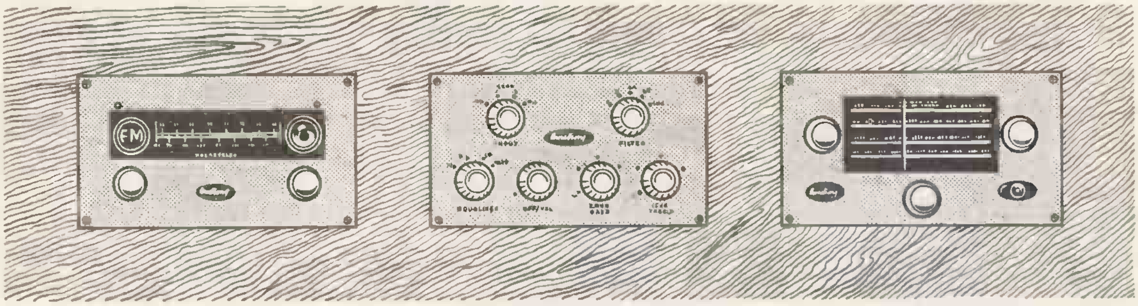
Shop hours, 9.30 a.m. to 6 p.m. *Thursday 9.30 a.m. to 1 p.m.*

to complete the set

Armstrong announce the A.M. 44 Tuner, which together with the F.M. 56 Tuner and A.10 Amplifier give you completely matched Control Units. Finished in Florentine Bronze and all the same dimensions (9¾in. x 5¼in.) these Panels will look well together in your cabinet.



F.M. 56 Tuner

● Permeability Tuning ● Freedom from drift ● Automatic limiting ● Magic Eye tuning ● A.F. Attenuator ● 3 position H.T. supply socket

£22 . 10 . 0

(or without Bronze panel assembly £18.15.0)

A.10 Amplifier with Control Unit

Output: 10-12 watts. Ultralinear. Distortion: 0.1% total harmonic at 8 watts. Frequency Response: within 1 dB 15-30,000 cps. Controls: 1. Input—4 position. 2. Equaliser—4 position. 3. Filter—5 position with built-in "rumble" filter and Presence Control. 4. Treble and 5. Bass—Both lift and cut giving ± 15 dB continuously variable.

Complete £29 . 10 . 0

A.M. 44 Tuner

● 4 wave-band ● Variable selectivity ● Infinite Impedance detector ● Magic Eye tuning ● Cathode follower output

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All models are sold under full and unconditional money-back guarantee of satisfaction. Prices include Purchase Tax. HIRE PURCHASE facilities are available. Demonstrations at your local High Fidelity specialists, or at our showrooms in Holloway. (9-6 Weekdays and Saturdays). For descriptive literature and details of Home Trial facilities write to us (mentioning "Wireless World")

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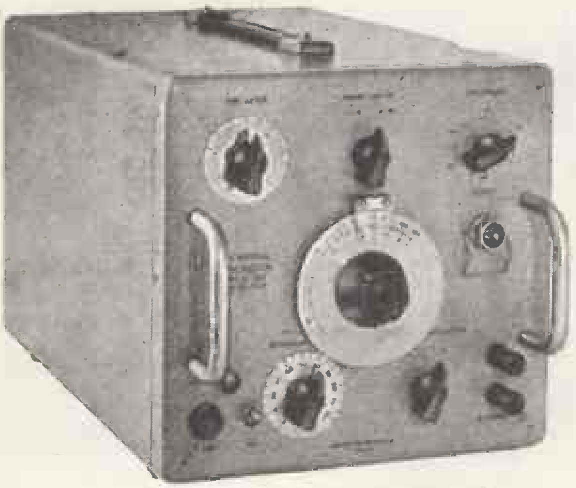

LE. 200B.

Prompt delivery is now offered on this and other instruments in our new range. ***Send for further details.***

★ ***Two Frequency Ranges***—I.F. 3-20 Mc/s. R.F. 81-105 Mc/s.

★ ***Modulation:***
Sinewave—Frequency 400 c.p.s.
Deviation variable ± 0-100 kc/s.
Sawtooth—Frequency 50 c.p.s.
Deviation variable 0-1,000 kc/s. (peak to peak).
Amplitude modulation less than 1%
The deviation is substantially linear.

★ ***R.F. Output***—Variable from 1 uV—100 mV. Output impedance 75 ohms.

★ No Troublesome Spurious Responses.

This F.M. Signal Generator is the only instrument on the market which has stable built-in sine and sawtooth oscillators. The deviation for either modulation can be accurately set by means of the calibrated dial. Visual alignment of selectivity curves and discriminator characteristics are easily obtained with the simplest of oscilloscopes since the time base for the "X" deflection is obtained from the Signal Generator.

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This electrically reliable and mechanically robust tube is contained in a 10mm round bulb, 32 mms in length Vsa≮ 200V: Vma≏ 70V: Vst≏ 68V.

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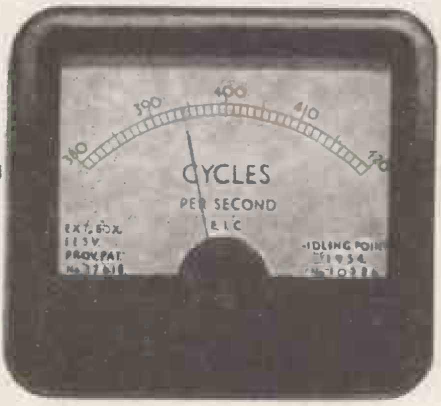

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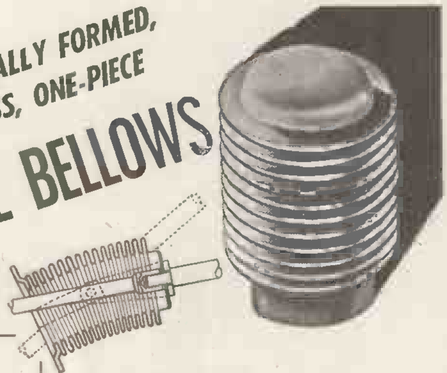

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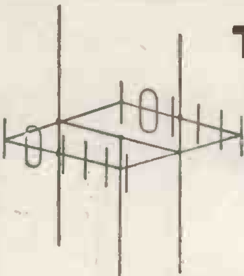

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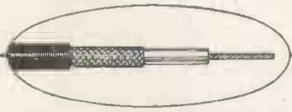
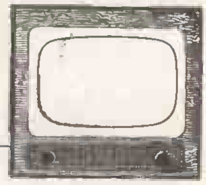
This new range of 75 ohm coaxials has been especially designed for the reception of Band II (FM sound 87.5 – 100 Mc/s.) and Band III (Television 174-216 Mc/s.).

Attenuation db/100 ft.	ET5M	ET6M	ET7M	ET8M	ET10M
10 Mc/s.	1.3	1.5	1.0	1.1	0.6
50 ,,	3.0	3.4	2.3	2.6	1.5
100 ,,	4.3	4.8	3.2	3.6	2.2
200 ,,	6.3	7.2	4.9	5.3	3.3
Dimensions (inches)					
Centre Conductor	1/0.022	7/0.0076	1/0.029	7/0.010	1/0.044
Over Cellular TELCOTHENE	0.093	0.093	0.128	0.128	0.200
Over Wire Braid	0.117	0.117	0.152	0.152	0.230
Over TELCOVIN sheath	0.157	0.157	0.202	0.202	0.290





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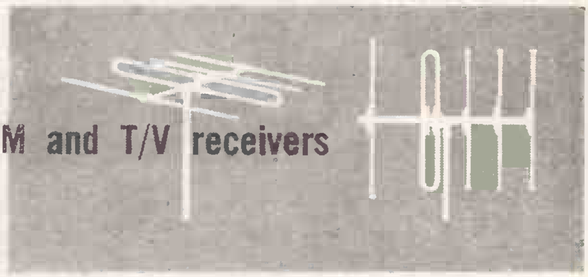
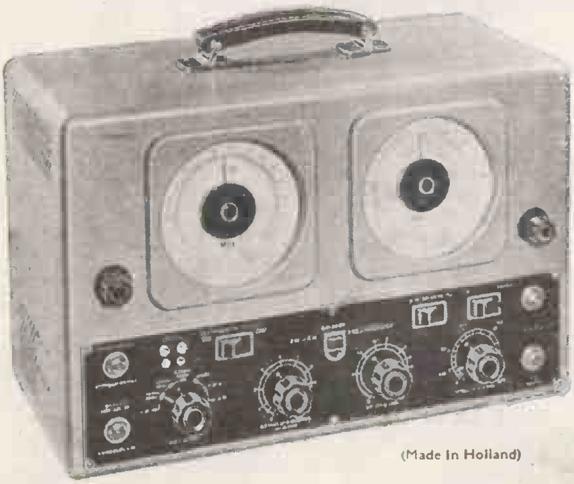


PHILIPS TYPE GM 2889/01



(Made in Holland)

- Range: 5-225 Mc/s in one range.
- Marker generator: 15-30 Mc/s. Accuracy ±50 Kc/s.
- Built-in crystal oscillator.
- 50 c/s modulation with ± 7.5 Mc/s sweep.
  50 c/s modulation with ± 0.75 Mc/s sweep.
  400 c/s modulation with ± 125 Kc/s sweep.
- Output voltage: 40-60 mV in range 5-225 Mc/s for F/M.
- Marker oscillator output: 200 mV.
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- Internal and external amplitude modulation possible.

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BLOCK CONDENSERS

All unused. .5 mfd. at 2,500 v., 3/6; 4 mfd. at 750 v., 3/6; 8 mfd. at 500 v. 5/-. 4 mfd. at 500 v. 2/6; 4 mfd. at 1,500 v. 6/6.

SCRAMBLER EQUIPMENT

As used by Ministries and Forces for holding secret conversations. Works in conjunction with normal telephone equipment.
Items available, all new and unused, are:—
Frequency Changer, Type 6AC, Ref. No. YBO2700, price £20. Standard G.P.O. desk type instrument with scrambler switch, complete with lead and junction box, price £2/10-. Hand-ringing generator in wooden box, 15/- Junction box with three multiple relays and cable strips 35/-. Bank of three drop indicators in box, 15/-. Instruction book. £1 refunded if returned within 14 days.

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VCR97. Brand new and unused, "cut-off type," ideal for 'scope, etc. Price 12/6. Carriage and insurance 5/- extra.

VCR517. 6¹/₂in. guaranteed full picture, 29/6, plus 5/-carriage and insurance.
VCR139A. 2¹/₂in., 32/6, plus 2/6 carriage, etc.
VCR138. 3¹/₂in., electrostatic short persistence, suitable for T.V. and ideal for 'scope work, 37/6 plus 3/6 carriage, etc.
VCR112. 5in. electrostatic, persistence not known, 15/- each, plus 5/-carriage, etc.
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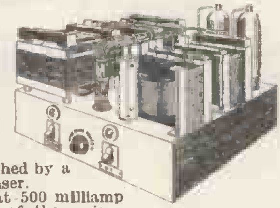
CV1140, CV1500, CV1546. All 12in. magnetic, long persistence, £4/10/-, plus 10/- carriage.

HEAVY DUTY POWER PACKS

500 WATT 1,000 v. (VARIABLE)



Master switch controls the whole unit and whenever this is on current is supplied to the rectifier filaments, thus keeping them always in the emissive state. The H.T. transformer is supplied via a tapped choke with a selector switch giving variations from low power" to "high power."
Two directly heated rectifiers give a full wave output which is smoothed by a 10 Henry choke and 4 mfd. condenser.
Continuous rating is 1,000 volts at 500 milliamp (500 watts). But the proportions of the various components are such that 100 per cent. overloading can be allowed for pulse work or other intermittent operations. The size of the power pack is approximately 16 ¹/₂ in. × 13in. × 13in. and its weight approximately 87 lb. Price; Kit of parts £27/10/-, or made up ready £37/10/-

500 WATT 2,000 v. (VARIABLE)

The maximum continuous rating of this is 250 milliamps at 2,000 volts. Rectification is half wave. Specification otherwise as for the variable 500/1,000 v. Price : Kit of parts £32/10/0, ready to work £42/10/0.

1,000 WATT 2,000 v. (VARIABLE)

The continuous power rating of this is 500 milliamps at 2,000 volts. But the tapped choke and selector switch enables this to be reduced in ten steps. Weight approximately 120 lb. size 16 ¹/₂ in. × 13in. × 13in Price £37/10/- in kit form, or made up ready to use £47/10/-.

1,000 WATT 1,000 v. (VARIABLE)

The maximum continuous rating of this is 1 amp. at 1,000 volts. Rectification is full wave, output is variable. Weight approximately 120 lb., size 16 ¹/₂ in. × 13in. × 13in. Price £37/10/- in kit form, or £47/10- made up ready to work.

FIXED MODELS

Any of the models mentioned above can be supplied without the tapped choke and selector switch. The prices are as follows:—
Fixed 500/1,000 v. £22/10/- in kit form, or £30 made up.
Fixed 250/2,000 v. £22/10/- in kit form, or £30 made up.
Fixed 500/2,000 v. £32/10/- in kit form, or £40 made up.
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All prices quoted are ex Works.

UNITS FOR CONTROLLED AUTOMATIC ROTATION

We have brand new, still in original unopened packing cases as shipped from America two items of equipment which form part of the radar system RC84. These two units work together to form a Tower rotating device, with remote control.
Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, Beam array, etc., etc. Item 2, known as Indicator 1-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely, it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain selsyn transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards. The equipment intended for 117 volt A.C. mains but will operate from our mains if connected through step down transformer of 1 K.W. rating.
Prices 1-221-A £25 plus carriage. TR24A £35 plus carriage.
Special discount of £5 for cash with order or C.O.D. if both units purchased together.

CHARGING SWITCHBOARD

Feed this Switchboard through a Mains Transformer and Rectifier giving 24 volt D.C. up to 50 amps. and you have an excellent multicircuit charger for simultaneously charging several batteries at different currents. This is an ex-Government switchboard rated at 550 watts 18 volts fitted into steel cases with doors. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are brand new, in original cases. Price £4/10/-, carriage 10/-.
We can supply a 12 volt, 50 amp. Mains Transformer at £4/5/-, plus 5/- carriage.

HIGH CYCLE MOTOR ALTERNATOR

TYPE 1. Has a motor 230 v., 50 cycle single phase 2.800 r.p.m., coupled to a generator output 250 v., 1,728 cycles at ·24 amps. Good condition, with wiring diagram, £12/10/-. plus 7/6 carriage.
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10 flexible copper conductors well insulated suitable for mains work. Covered Overall with hard rubber, 1/6 per yard.

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Owing to the bulkiness of many of the items listed on these two pages it may not be possible to keep stocks at branches, therefore please telephone confirmation that the item is actually at the branch before journeying specially to see it.

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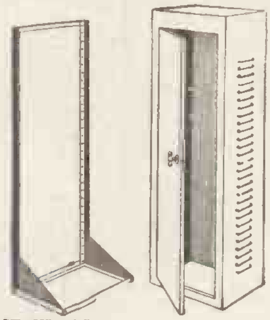
RACKING EQUIPMENT ALL EX-MINISTRY EQUIPMENT



STANDARD OPEN RACK
6ft. high and 19 in. wide, heavy steel construction. Holes drilled and tapped at the standardized spacings. Price £3/15/-, plus carriage.

ENCLOSED RACK
As above but rectangular and with sheet metal enclosed sides (vented), fitted handle and closing bars, Price £6/15/-, plus carriage.

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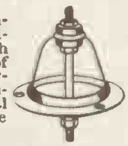
0-30 mA. moving coil	10/6
0-300 mA. moving coil	10/6
0-500 mA. moving coil	10/6
5-0-5 mA. moving coil	17/6
0-1 amp. moving coil	17/6
2in. Flush mounting	
0-2 amp. R.F.thermo	7/6
0-3 amp. R.F. thermo	7/6
0-5 amp. R.F. thermo	7/6
0-20 amp. moving coil	10/6
0-40 amp. moving coil	12/6
Hot Wire Amp. Meters	
0-9 amp. 2¹/₂in. flush	12/6
0-10 amp. 5in. surface	25/-

PYREX AERIAL INSULATORS



Ideal for aerial connections through cabin walls or through panels. Consists of glass dome with threaded rod and terminal ends and metal fixing flange. Price 2/-each.

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This brass cased plug and socket is extremely robust and ideal for P.A. or outside work. Ideal also for taking power to units as it insulates the ends of the wires. Contacts are quite suitable for carrying up to 10 amps. so this can be used for lighting or power. 2/6 per pair.

JUMBO VALVE BASE

Ceramic 4-pin for transmitting valves, 805, etc. Price 3/6 each.

30 AMP ROTARY SWITCH

Single pole ON/OFF, a very robust switch, made by one of our most famous firms. Will give life-time of service. Price complete with pointer knob, 4/9.

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WILLARD AIRCRAFT BATTERIES. 24 v. 11 A.H. Size 8in. x 7½in. x 7½in. NEW IN MAKER'S CARTONS, 49/6, carr. 7/6. **EXIDE,** 10 volt, 5 A.H. **GLASS ACCUMULATORS,** size 7in. x 2¾in. x 5in. Suitable for H.T. unit construction and models, etc. New in maker's cartons, 8/6, P.P. 1/6. **MINIATURE,** 36 v. 0.2 amp. **ACCUMULATORS** made by Willard Co., size 3¾in. x 1⅜in. x ⅞in., weight 5½ oz. New and uncharged, 3/6, P.P. 6d. **HEAVY DUTY SLIDING RESISTORS.** We have London's largest selection. Listed below are a few types of our range. 0.4 ohms, 25 amp., with geared control, 17/6; 5.3 ohms, 8 amp., with geared control, 35/-; 60 ohms, 1.5 amps., with geared control, 17/6; 2.6 ohms, 8.5 amps., with geared control, 17/6; 1 ohm, 12 amp., slider control, 12/6; 100 ohms, 1.5 amps., slider control, 22/6; 50 ohms, 1 amp., S.M., geared control, 8/6; 100 ohms, 3.5 amps., geared control, 15/-. Carr. on all resistors 2/-.

HEAVY DUTY VARIABLE RESISTORS. American Ohmite, 6 ohms, 2.5 amps., 5/6, P.P. 6d. 350 ohms, 25 watt, 3/6, P.P. 1/6. **BERCO,** 1,350 ohms, 10 watt, 3½in. pots, 7/6, P.P. 9d.; 17,000 ohms, 20 watt, 3½in. pots, 10/6, P.P. 1/6.

LOW WATTAGE 230-250 v. TUBULAR HEATERS. Ideal for garages. Aviaries, Greenhouses, Lofts, etc. 6ft. long, 2½in. dia., 360 watt, 45/-, carr. 3/-.; 12ft. 2½in. dia., 720 watt, 85/-, carr. 5/-.

CONSTANT VOLTAGE TRANSFORMERS BY SOLA, U.S.A. Pri. 90-125 v. or 190-250 v., Sec. 115 v. at 2 KVA. Pri. and Sec. are completely isolated for 50 or 60 cycle operation. Approx. weight 200 lb., £18/10/- each, £35 per pair. Limited supply, carr. according to distance.

S.T.C. D.C. SUPPLY UNITS. A.C. input, 200-250 v. D.C. output 220 v. 1.5 amps. at 50 degrees C. Built in strong metal grey cabinet, completely fused, £12/10/-, plus carr.

ROLLS-ROYCE COOLANT PUMPS. A heavy duty turbine type pump driven directly from a splined socket 1,000-1,500 G.P.H. 1½in. bore outlet. Brand new in maker's carton, 47/6, carr. 4/-.

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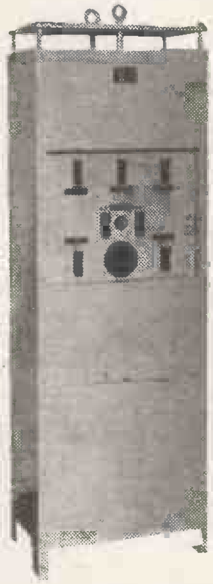
BANKS OF FOUR RESISTANCE MATS. 690, 150, and two at 80 ohms. Size of each mat 8 x 6½in., 10/6 per set, p.p. 1/6. **U.S.A. 20 AMP OVERLOAD SWITCHES,** 5/6, P.P. 6d.

VARLEY 6 VOLT DELAY SWITCHES, 5/-, p.p. 6d. **SUNVIC CONTROL TYPE 602A.** 4-pin hot wire replacement tubes, 7/6, P.P. 9d.

EXCLUSIVE PURCHASE ! !

S.T.C. RECTIFIER SUPPLY UNIT No. 11 TYPE ZB 10235



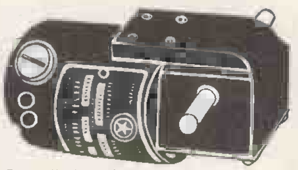
Specification: — A.C. input 100-260 volts. 45-65 cycles. D.C. output 24 volts 11 amps. and 130 volts 600 mA., very conservatively rated. L.T. and H.T. completely smoothed. All circuits fused. Mains on/off switch. Built in grey metal cabinet as illustrated. Height 5ft. 0in., width. 1ft. 7½in., depth 1ft. 1½in. Weight 200 lb. These units were originally designed to supply L.T. and H.T. power in conjunction with Bay Power No. 3 to S.O.S./T. 3 channel telephone system, but are ideal heavy duty L.T. and H.T. supply units for the electronic industry, research laboratories, schools, etc., etc. Complete with Instruction Book and circuit. Supplied brand new at a fraction of the maker's price.

£17.10.0 ex-warehouse.

If further technical details are required, Instruction Book will be forwarded against a deposit of One Pound. Export enquiries are welcomed. We have a limited number of these units ready packed in original transit cases at a small extra charge.

36FT. AERIAL MASTS. R.A.F. Type 50. Complete kit consists of a tubular steel sections. Length 4ft. Dia. 2in. Set of pickets. Top plate. Base plate. Guys and all fittings. Supplied new in canvas carrying bags. Ideal for T.V. aerial masts. £7/10/-, carr. 7/6. Extra sections 15/- each, carr. 2/-.

AMERICAN MINIATURE GEARED MOTORS



12-24 volts 2 amp. A.C./D.C. approx. 400 r.p.m. Double shaft 1⁄16in. dia. spindles.

Overall length of motor 7½in. Brand new. 39/6. P.P. 2/-.

TELEPHONE CABLE TYPE D3 TWIN. ½ mile drums, 65/-, carr. 7/6. **TYPE D8 TWIN.** 1 mile drums. £7/10/-, carr. 10/-. Commando assault telephone cable. P.V.C. 1,000-yard drums. Ideal telephone cable and very useful for the home and garden. 12/6 per drum, P. and P. 1/6.

ARMY FIELD TELEPHONES. Type D5. Buzzer calling. Complete with hand set and batteries. Built-in strong metal cases. Suitable for farms, building sites, workshops, etc., 49/6, carr. 3/-.

SPECIAL OFFER OF HIGH GRADE BLOCK CONDENSERS. Brand new, tropically packed in maker's cartons, T.C.C. 10 mfd. 500 v. wkg. at 140 degrees F. Sub chassis mounting, 6/-. T.C.C. 0.5 mfd. 2,000 v. wkg. at 60 degrees C., 3/6. G.E.C. 8 mfd. 600 v. wkg., tropical, 6/6. B1 4 mfd. 800 v. wkg. at 160 degrees F., 5/6. P.P. on all conds. 9d.

SPECIAL OFFER OF SELENIUM RECTIFIERS. 80 v. D.C., 3 amp. F.W., 65/-. P.P. 2/6. 72 v. D.C., 1.5 amp., F.W., 27/6. P.P. 2/-. 36 v. D.C. 1.5 amp., 22/6. P.P. 2/-. 24 v. D.C., F.W., 2 amp., 17/6. P.P. 1/6. 12 v. D.C. F.W., 4 amp., 15/-. P.P. 1/6. H.T. 230 v. D.C. 600 mA. F.W., 15/-. 200 v. D.C. 150 mA., F.W., 10/6. 45 v. D.C. F.W., 80 mA., E.H.T. 900 v., 2 mA., 6/6. P.P. 1/-.

ALKALINE BATTERIES. Crates of five cells giving 6 v. at 53 A.H. Size of wood crate 15 x 5¾ x 11½in., £5/19/6, plus carr. 7/6. Single cells 2.4 v. 18/20 A.H. Size 4½ x 6 x 3¾in., 15/-, carr. 2/-.

BRAND NEW METERS by famous makers. 4in. round flush MI ammeters, 0-40 amp., 500 c/s. Maker's tolerance slightly less at 50 c/s., 35/-. P.P. 2/-. 3½in. round flush MC 0-400 mA., 30/-. P.P. 2/-. 2½in. round flush 500 mA., 100 mA., 50 mA., 15/- ea. P.P. 1/6. 0-20 c/s. A.C. 50 c/s. 2½in. Round Flush blank scale or calibrated, 10/6. P.P. 1/6. 0.5 amp. RF 2in. sq. flush, 8/6. P.P. 1/-.

INSTRUMENTS, ADMIRALTY INTEGRATORS, TYPE A 591. Incorporating very fine Galvo movement, coil 40 ohms. Centre zero to F.S.D. 1 microamp. Small mirror one metre radius. A very useful laboratory instrument, 65/-, carr. 2/6. **METRO-VICKERS MASTER VOLTMETERS,** 0-20 volts A.C. 50 cy. M.I. 6in. mirrored scale, 25/-. P.P. 1/6.

36FT. AERIAL MASTS. Comprising nine tabular steel sections, length 4ft. dia. 2in. Top plate and base. Pickets and guys not supplied. £5/10/-, carr. 7/6.

HEAVY DUTY CANADIAN ADMIRALTY 6in. BLOWERS. Motor Spec. 220 A.C./D.C. 1 h.p. R.P.M. 2,600. Series wound, continuous rating, £17/10/-, plus carr.

HIGH GRADE SLEEVING, 1½ mil-5 mil mixed bundle, 2/6, P.P. 6d.

FROST 1/6 H.P. A.C. 230 V. MOTORS. R.P.M. 1,425 cont. rating. £4/2/6, carr. 7/6. **G.E.C.,** 1/6 h.p., A.C., 110 v., R.P.M. 1,440. £4/7/6, carr. 7/6.

Brand new in maker's cartons. American C.R. **TUBES,** 5CP1, 30/-, carr. 4/-. A.M. 7in. C.R. **TUBES,** NC13 (CV961), 45/-, carr. 5/-.

FERRANTI 5 AMP. KWH METERS. Less case, brand new, 12/6, P.P. 1/6.

NUTS, BOLTS, WASHERS. Special bargain offer, 5/- cartons of mixed 2, 4, and 6 BA nuts bolts and washers P.P. 6d.

CARBON RESISTORS, ½-2 watt 10/- per 100, large selection of values P.P. 6d.

ALL MAIL ORDERS TO OUR EDGWARE ROAD BRANCH PLEASE. THIS IS OPEN ALL DAY SATURDAY. HOURS 9-6. 9-1 THURSDAY.

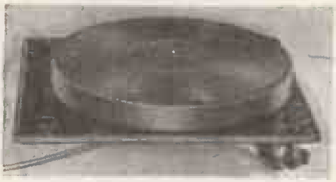
169/171 EDGWARE ROAD, LONDON, W.2.
TEL.: PAD 7851
AND
125 TOTTENHAM COURT ROAD, W.1.
TEL.: EUS 4982

PERSONAL SHOPPERS WELCOME. ORDERS ACCEPTED M/A FROM COLLEGES, SCHOOLS, LABORATORIES, ETC.

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

SPECIAL OFFER



FAMOUS MAKE 3-SPEED TRANSCRIPTION MOTORS

All component parts can be supplied for building this handsome unit at home. Heavy lathe turned non-ferrous turntable with rubber mat, metal motor board size 12in. × 13in., 4-pole motor, etc. Condenser starting. All parts brand new and available separately, list on request. CAN BE ASSEMBLED BY YOU IN ABOUT ONE HOUR at a cost of **£6.19.6**. Full assembly instructions and diagram supplied.

OSRAM 912 & MULLARD 510 AMPLIFIERS — BUILT ON T.C.C. PRINTED CIRCUITS

All specified components are used and you have your choice of transformers and chokes by Partridge, Haddon, W/B or Ellison. Demonstrations given any time.

MULLARD 510 AMPLIFIER, built on T.C.C. printed circuit, supplied fully assembled complete with valves, ready for use. Price, depending on make of transformers used,

15 Gns.

Printed Circuit separately, 22/6.
New Mullard Amplifier Book, 3/6.

OSRAM 912 AMPLIFIER, built on T.C.C. printed circuit, supplied fully assembled complete with valves, ready for use. Price depending on make of transformers used,

19 Gns.

Printed Circuit separately, 50/-.
Book of the Osram 912, price 4/-.

All components for either above amplifiers supplied separately. Price Lists on request.

Its performance will amaze you!

LASKY'S NEW 1956 AM/FM SUPERHET RADIOGRAM CHASSIS

Very latest circuit covering L, M, and S wavebands as well as F.M. 8 valve p.p. output, Ferromagnetic aerial, p.u. sockets, ext. speaker sockets and provision for electrostatic Tweeter. Magic eye tuning indicator. For A.C. mains 200-250 v. Valve line up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6 (p.p.), 5Y3 rect. Incorporates latest Gorler F.M. components including the well-known front end UT340. Large full vision dial, actual size 14¾ × 6in. Overall measurements of complete chassis, 15 × 7½ × 8in. high.

LASKY'S PRICE **26 GNS.** Carriage 10/6 extra

HI-FI ELECTROSTATIC SPEAKERS

Popularly known as "Tweeters." An absolute MUST for FM reception, high quality L.P. recordings and television sound reproduction. Easy to fit to any radio, TV receiver, or amplifier. Supplied with full data and circuit diagram.

LSH100 (as illus.), 7-18 kc/s., 20 dbs., inherent cap. 1,100 p.f. For outputs up to 20 watts. Size: 5 × 4 × ⅞in., **21/-**

LSH518. As above, for outputs of 10-12 watts (wide angle sound distribution). Size: 7 × 2 × ½in. Price **17/6.**

LSH75. Inherent cap. 800 p.f. For outputs up to 6 watts. Size 3 × 3 × ½in., **12/6.**

All post free.

SPECIAL OFFER OF PICK-UPS

Standard play. Offered at ALMOST HALF PRICE Goldring Bantam magnetic, post free **25/-**

P.M. SPEAKERS

Large stocks of all sizes. A few examples:—

Elac. Elliptical, 7 × 4	19/6
Plessey 12in.	32/6
2½in. miniature	17/6
6½in.	19/6

PICK-UPS, HEADS, ARMS

L.P. or standard, by Collaro, Garrard, Goldring, Acos, B/J., Decca, etc., all types. Full stocks of all styli.

DRILLED CHASSIS AND DIAL ASSEMBLY

Size 13½ × 7 × 2½in., drilled for five latest type miniature valves, mains trans., I.F., etc. Dial 13 × 14in., for horizontal or vertical mounting. Spin wheel tuning. All pulleys and spindle supplied. LASKY'S PRICE **19/6** Post 3/-.

ALUMINIUM CHASSIS

18 S.W.G., undrilled, 4 sides, reinforced corners. Depth 2½in.

6 × 4 4/-	12 × 8 7/-	16 × 10 8/3
8 × 6 5/-	14 × 9 7/6	12 × 3 4/9
10 × 7 6/-	16 × 9 8/-	12 × 6 6/6

Post 1/- per chassis extra

GANG CONDENSERS

.0005, less trimmers.
2-gang, standard, 5/6 min., 6/6.
3-gang, standard, 7/6, min., 10/6.
4-gang, standard, 10/6.
With Trimmers:
2-gang, standard, 7/11, min., 7/6.
Post extra.

3-WATT MIDGET A.C./D.C. AMPLIFIER. PUSH-PULL.

VERY HIGH GAIN. 4 valves; 2 UL41 in push pull, 1 UCH42 and 1 UAF42. Input voltage 100/100 A.C./D.C. Very easily converted to 230 volts. Supplied with circuit diagram and all details. Size 9 × 4 × 4in. Uses two metal rectifiers, one each RM2 and RM3. Ideal for ships, record players, tape recorders, home record players, baby alarms, etc., etc. Supplied complete fully assembled and wired, with four valves. LASKY'S PRICE **65/-** Carr. free.

4-WATT A.C. AMPLIFIER KIT

Uses 1 each 6SL7, 6V6, 5Z4. All components, chassis, valves, output trans., mains trans. Carriage and packing 2/6. **£4/5/-**
INSTRUCTION BOOK and shopping list, 1/- post free.

PLATED MIKE FLOOR STANDS, telescopic, folding base, height 3ft. to 5ft. 3in., 32/6. Post 3/6.

OVER 50,000 VALVES

One of the largest stocks in England. All makes and types, B.V.A. and ex-Govt. Also C.R. Tubes.

HIRE PURCHASE TERMS AVAILABLE

On certain items. Write stating requirements.

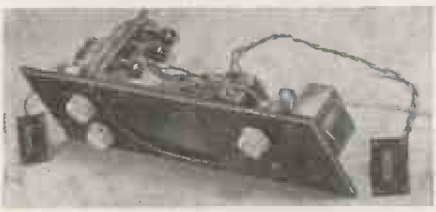
TAPE DECK MOTORS

Anti-clockwise, shaded pole. Special offer. Limited quantity only. COLLARO, 25/-. GARRARD, 26/6. Post extra.

LATEST BRENNEL TAPE EQUIPMENT

The DECK. Three-speed, 3¾, 7½ and 15in. per sec., three motors, record and play-back. All latest refinements. **18 Gns.**
The AMPLIFIER Mk. II. 5 watts, for use with 3 ohms speakers. Magic eye, high fidelity. **18½ Gns.**
The CARRYING CASE, £5/18/-.
Write for full details.

PORTABLE GRAM AMPLIFIER



Uses 3 latest miniature valves, U78, N78, DH77 Volume, bass and treble controls; extension L.S. socket and internal L.S. switch, indicator lamp. Mounted on wood baffle, overall size 14 × 4¼in. with speaker centralised. All top quality new components. For A.C. mains, 200-250 v. Ideal for portable record players, input will match Monarch, RC54, RC3/554, etc.
Price, complete with 3 new Osram valves, 7 × 4in. Goodmans elliptical speaker, metal speaker grille, mains lead, and knobs. **£5.9.6**
Post and Pkg. 5/-.

RECORDING TAPE

Kraft base, length 1,200ft. Cyldon metal spools, 12/11. Post 1/-. All makes of Tape stocked—Scotch Boy, EMI, Grundig, Puretone, Ferrograph, Basf, Agfa, Gevaert, All types of spools stocked.

CYLDON TAPE SPOOLS
5in., each 1/6.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

SAVE POUNDS ON THIS FINE 6-valve RADIOGRAM CHASSIS

Famous maker's surplus. Brand new and complete, six valves, 3-wave superhet, 13-50 m. short 200-550 m. medium, 1,000-2,000 m. long. Brand new Mullard valves ECH42, EF41, L63, EB41, 6V6, g.t., EZ40, and finest quality components. Gram. switch 465 Kc/s I.F., tone control, 3-colour dial. Overall size: 13½ × 5, height 12½ in. Aperture required for dial and controls. 11 × 3½in. Complete with valves, output trans., knobs, etc.

LASKY'S PRICE **£10/19/6**

Carr. and pkg. 7/6 extra.

V.H.F./F.M. TUNERS

THE "EMPRESS"

This high-grade unit is complete with power supplies and will transform your present A.M. radio set or radiogram into a modern V.H.F. receiver. Incorporates the latest Gorler components, including the permeability tuned front end. Freq. coverage 86-103 Mc/s. Two controls. Valve line-up: ECC85, two 6BJ6, 6AL5, EZ80. CHASSIS only, **£13/15/-** Post 3/6.

IN CABINET, as illustrated, with magic eye tuning indicator. **£17/17/-** Post 3/6.

This Tuner can be built for 10 gns. HANDBOOK giving full details for home construction, 2/6 post free. *All components available separately for home construction.* Front end UT340 59/5. Chassis, drilled, 10/-. Dial and drive assembly, 37/6. I.F. Trans. UF376, 7/-. Ratio/Det. URF377, 10/6. Full list on request.

DULCI F.M. TUNER

Incorporates its own power supply and provides complete F.M. coverage, including Police, Fire Brigades, etc. Operates with most radio receivers and any make of Amplifier. Valve line up: ECC85, two EF89, EABC80, 6X4 (Rect.), EM80 Indicator. Incorporates GORLER Inductance Tuning Heart, and magic eye tuning indicator. Dial 10½ × 6in. Overall size of chassis: 9 × 6 × 5¼in. high. **£16/16/-** Carr. & Pkg. 7/6.

12-CHANNEL TV TUNER

Famous make. Covers Bands I and III. Complete with valves EF80 and ECC81. Ceramic valveholders, finest quality components, precision made. Switch and fine tuning. I.F. output 20-25 Mc/s. Freq. coverage 50/87 Mc/s and 175-215 Mc/s. Supplied with full details and circuit diagram. Post 3/6. Knob 2/9 extra. **89/6**

"THE UNIVERTER" FOR ALL AREAS

A Band III Converter for home-constructed or factory-made Band I receivers. Uses two 6AM6, one 12A7M, one 6X4. Contains its own power supplies. Complete unit, in Cabinet. Post free. **£8/10/-**

TELETRON BAND III CONVERTER COIL SET

For use with TRF and superhet Band I TV receivers. Uses two Z719. Circuit, wiring diagram, alignments, full details with each set **15/-** Post 1/6.

TELETRON BAND III CONVERTER MK. I

The complete Kit to build this Converter, drilled chassis, condensers, resistances coils, 2-E880 valves, etc., **48/6** Post 1/6.

Full instructions and circuit diagram supplied. Drilled chassis only, 3/9.

TELETRON BAND III CONVERTER MK. II

Uses latest type valves, Cascode R.F. amp. and triode pentode F.C. ECC84 and EC82 etc. The COIL SET, **17/6**

Complete Kit of parts, including valves, drilled chassis and diagram, 59/6. Post 1/6. Circuit Diagram only, 3d.

VALRADIO BAND III TUNERS

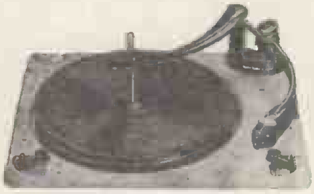
Full range in stock. Price £6. Post extra.

FERROMAGNETIC RODS

With full instructions for winding a high "Q" aerial, post free, **5/11**

LASKY'S RECORD VALUE IN 3-SPD. AUTO-CHANGERS

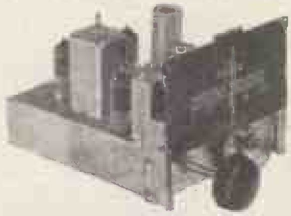
SPECIAL OFFER! FAMOUS MAKE 3-SPD. AUTO-CHANGERS



Latest model. Brand new and unused, in makers' cartons. Complete with turnover crystal pick-up. Incorporates automatic record size selection (mixer). Cabinet space required: 14 × 12½ × 4in. above and 2¾in. below motor board. Cream and brown enamel finish. Complete with instruction book. Limited quantity only.

LIST £14/13/-. LASKY'S PRICE **£8/19/6**

Carr. 5/-. CABINETS AVAILABLE. Prices on request.



DENCO F.M. FEEDER UNIT

Uses 6AM6, 12AJ8, EB91, and two 6BA6. Complete parcel, **£6/7/6** Post extra.

DATA BOOK 1/6 post free. All components available separately.

DENCO F.M. COMPONENTS

Coils, each, 3/11. I.F.s, each, 7/-. Ratio Discriminator, 12/6. Chassis and Screens, 7/6. Dial and Drive, 9/-. VALVES, complete set of five, 42/6. Post 1/-.

FAMOUS MAKE 3-SPD. AUTO-CHANGERS

Latest model. Full length arm with two Decca XMS heads. Limited number only. List £20/15/-.

LASKY'S PRICE **15 gns.**

Also available with GC.2 turnover crystal head at same price. Carriage 5/-.

B.R.S. MONARCH 3-SPD. AUTO-CHANGERS

LATEST MODEL NEW IN MAKER'S CARTONS

Takes 10 records of all sizes (mixed) in one loading. HGP.37 crystal turnover pick-up. Cream finish.

LASKY'S PRICE **£7/19/6**

Post 3/6.

JASON F.M. TUNER

Special Parcel containing Data Book, chassis, dial and drive, tuning condenser, full set of coils, I.F.s, ratio detector, etc., Post 2/6. **68/9**

Book only, including itemised price list 2/-, post free. This Tuner uses four 6AM6 and two crystals, and can be built for £6/15/-, plus 2/6 post.

We can also supply this Unit built by the Jason Co., aligned and tested, for £15/17/- including Purchase Tax.

COLLARO RC.54

3-speed High Fidelity Mixer Changer, Studio O crystal turnover pick-up.

LASKY'S PRICE **£9/19/6**

Carr. 3/6. Also supplied with Studio P crystal pick-up. 15/- extra.

SPECIAL OFFER FAMOUS MAKE 3-SPD. SINGLE RECORD PLAYER

A.C. mains, complete with two Decca XMS fff high fidelity pick-up heads. Limited quantity only. List £14/14/-. LASKY'S PRICE **12 gns.**

HI-FI AMPLIFIERS

LEAK, Point One	£28 7 0
LEAK, TL12	43 gns.
ROGERS Minor	£12 17 6
ROGERS Junior	£26 0 0
TRIXETTE	£16 10 0
ACOUSTICAL QUD	£42 0 0
GRAMPIAN 510	£21 0 0
UNITELEX	£8 18 6
UNITELEX-UNISON UL3	£11 0 6

CERAMIC CONDENSERS for F.M. All values 9d. each.

● **HIRE PURCHASE TERMS on certain items. Write stating requirements.**

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

LASKY'S RADIO

SPECIAL OFFERS OF CABINETS

BUREAU RADIOGRAM CABINETS
Handsome design, solidly constructed. beautiful Walnut veneer finish, generous record storage space. Further details and illustrations on request.
LASKY'S PRICE **14 gns.** Carriage 17/6. Available on H.P. Terms.

OCTAGONAL SPEAKER CABINETS
Special design for use with the G.E.C. metal cone Speaker. Exactly per specification. Carriage 6/6. **£12/10/-**

SPECIAL OFFER ! GOODMANS "H" type OUTPUT TRANS.
30 watts. 10,000 ohms. 3×15 ohms. Listed at £4 **LASKY'S PRICE 45/-** Post 3/6.

MAINS TRANSFORMERS
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.
MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board, 22/6.
MBA/7. 250-0-250 v. 80 mA. 6.3 v., 3 a., 5 v., 2 a. Both filaments tapped at 4 volts, 18/-.
MBA/10. 500-0-500 v. 150 mA. 6.3 v. 4 a., 5 v. 3 a., 32/6.
AT/3. Auto trans. 0-10-120, 200-230-240 v. 100 watts, 17/6.

OUTPUT TRANSFORMERS
Min. type (3S4, etc.) 3/6
Midget 3/3. .... Multi ratio .. 3/11
Standard pentode, 4/6.
All other types by Partridge, Ellison, Haddon, Parmeko, etc.

SPECIAL OFFER. MINIATURE OUTPUT TRANSFORMERS. Overall dim.: ⅞ × ½ × ½in. For use with hearing aids, transistors, etc. 3/11.

FILAMENT TRANSFORMERS
6.3 v. 1.5 amp. 5/11
6.3 v. 3. amp 7/6
200-250 v., special 0-30 v. tapped, all voltages at 2 amps. 18/-

BRIMISTORS

CZ1	CZ2	CZ3	WX6
2/6	1/6	6d.	1/6

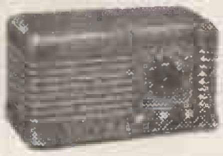
LARGE STOCKS OF BAND III AERIALS OF ALL TYPES
KING PIN, indoor loft 7/6
WOLSEY MINOR, indoor loft 12/6
WOLSEY TWIN-LOFT, combined Bands I/III 17/6
AERIALITE 3-element loft 32/6
AERIALITE 5-element loft 42/6
LABGEAR, 3-element loft 19/6
LABGEAR, combined Bands I/III .. 27/6
Outdoor Band III Aerials for fitting to existing masts:—
AERIALITE, 3-element 30/-
AERIALITE, 4-element 36/6
AERIALITE, 5-element 42/6
Wall-fitting Bracket and Arm, 20/- extra. Chimney lashing and Mast, 32/6 extra. Antiference, Belling Lee, K.A., Transvision and other well-known makes of Aerials in stock.
CROSSOVER BOXES: Labgear, 15/-. Antiference, 12/6. Wolsey 15/-. Belling Lee Diplexes, 12/6.

CO-AXIAL CABLE, semi-air spaced, yd. 9d. AERAXIAL, yd. 10½d. 300 ohms FEEDER, yd. 9d.

AERIAL MASTS
2 teles. section, extending to 15ft. Complete with guys, etc., 25/-. Carriage 3/6.

AERIAL RODS
Steel, heavily copper-plated. Any number fit together. 12in. long 2/6 doz., post free.

★ LASKY'S RADIO CONSTRUCTOR PARCELS



With choice of Cabinets as illustrated.

PARCEL No. 1
Contains everything to build a 4-valve 3-wave superhet for 200/250 A.C. mains. Uses 6K8, 6K7, 6Q7, 6V6 valves. Attractive wood cabinet, walnut veneer, or plastic cabinet as illustrated. Size 12 × 6½ × 5½in. deep. CAN BE BUILT FOR **£7/19/6** Carr. and packing 2/6.

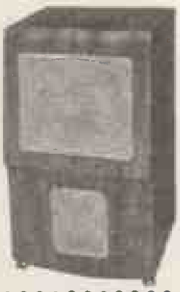
PARCEL No. 2
Contains everything to build a T.R.F. 3-valve set for 200/250 A.C. mains, medium and long wave. Uses 6K7G, 6J7, 6V6, and metal rectifiers. Neat plastic cabinet, walnut or ivory finish, or wood cabinet. Size 12 × 6½ × 5½in. deep. CAN BE BUILT FOR **£5/10/-** Carriage and packing 2/6.

INSTRUCTION BOOK for either above sets, 1/- post free.
CABINETS ONLY, plastic or wood, 17/6. Carriage 2/6.
All components available separately

★ COMPLETE PROJECTION TV UNITS ★
(Mullard). Consisting of optical unit and E.H.T. unit, complete with valves and c.r. tube.
LASKY'S PRICE **£21**
Carriage 21/- extra. Limited quantity only. Full details on request.

VALUE IN MAGNIFICENT TV CABINETS

THE DE LUXE. Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker, fret and baffle board. Finished in beautiful figured medium light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "Viewmaster," "Practical Television," "Tele-King," "Magnaview," "Wireless World," etc. Supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost. An allowance of 4/6 will be made if the mask is not required.
Inside dim.: Depth 16¼in., width 17¾in., Height 28in. Overall height 32in. Width 18½in. Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required
LASKY'S PRICE **£8/10/-**
Carriage 12/6.



THE ROTHESAY. Outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. C.R.T. aperture frame is detachable, supplied to suit any size tube to order. NOTE SIZES:
Outside dim.: 34½in. high, 21⅜in. wide, 21½in. deep. Inside dim.: 18⅜in. wide, 19½in. deep. Size of top: 22½ × 21⅜in. Thickness ⅝in.
LASKY'S PRICE **£9/19/6** Carriage 15/- extra. WITH FULL-LENGTH DOORS veneered both sides, polished to match the cabinet and mounted with full-length piano hinges. £14/9/6. H.P. Terms arranged for any of above Cabinets.

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Large selection.
Plastic, tygan, cloth, expanded metal.

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Line E.H.T. trans., ferrox-cube core, 9-16 kV 25/-
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For use on 200-250 v. A.C. mains. Complete with two valves. In metal case, size: 12 × 7 × 5½in., 79/6. Carriage 5/-.
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This is the point where the full beauty, richness and " presence " of the modern recording are recreated; where electronic know-how and the finest precision engineering speak for themselves.

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ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
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MARCH 1956

In This Issue

VOLUME 62 NO. 3
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR
OF PUBLICATION

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oscilloscope mark 2

. . . two input signals displayed for direct comparison and their characteristics accurately measured by the turn of a knob . . . such are the facilities and convenience afforded by the Mullard Dual Trace Oscilloscope, type L.101.

Well-engineered and reliable, the L.101 Oscilloscope is *the* oscilloscope where the demand is for a high grade general purpose instrument. It employs two identical amplifiers with bandwidths of 4 Mc/s irrespective of sensitivity. Each amplifier is aligned for good transient response, has a rise time of 0.1 μsec, and a maximum sensitivity of 20 mV pk-pk/cm.

The time base may be free running, synchronised or triggered. Its velocity is continuously variable between 0.1 μsec/cm and 10 msec/cm. Both time and voltage may be measured by the nul method and a well-regulated power supply preserves calibration accuracy.

mark 2 features

- **Post Deflection Acceleration** gives a brighter display at low repetition rates.
- **R. C. Probe** ensures that only negligible damping is imposed on high impedance circuits. (This probe is also available to users of the Mark 1 model.)
- **Improved Triggering Circuit** starts the time base with the minimum delay from either positive or negative signals of only 1½V amplitude.

Full details of the L.101 Mark 2 are readily available from Mullard at the address below or from any of their distributors.

Belfast: James Lowden & Co. Ltd., Tel. 57518. **Birmingham:** Gothic Electrical Supplies Ltd., Tel. CEN 5531. **Bristol:** T. Neesham & Co. Ltd., Tel. 22732. **Glasgow:** Land Speight & Co. Ltd., Tel. CEN 1082. **Manchester:** F. C. Robinson & Ptners. Ltd., Tel. Chorlton 5366. **Newcastle:** Electricals Ltd., Tel. 28617.

London: Mullard Equipment Division, Tel. CHA 8421.

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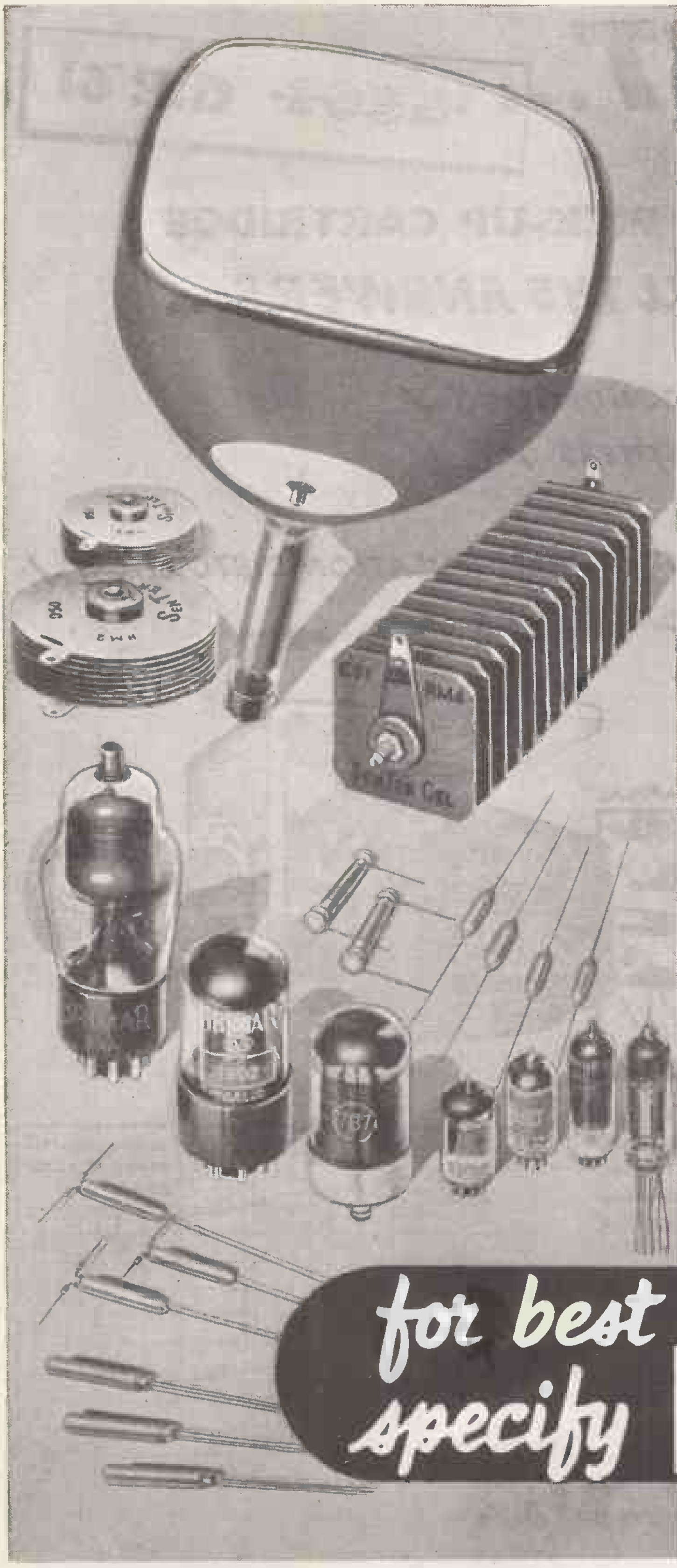


"BELLING-LEE" NOTES

Winter Hill Transmissions.

We are truly indebted to the engineers of Marconi's Wireless Telegraph Company for their assistance in the erection of our aerial array at Winter Hill and we are optimistic that we will be able to adhere to our schedule, in which case we will have been transmitting for over a month by the time you read this column. Times of transmissions:

Weekdays 10.00 a.m. to 1.00 p.m.
2.00 p.m. to 5.30 p.m.
Saturdays 10.00 a.m. to 1.00 p.m.
No transmission Sundays or bank holidays.

Do please send reports to us in Enfield, each will be acknowledged by a Q. S. L. card.

Because of the mountainous nature of the terrain to the north and east, reports from this site will be more useful than ever before. There are so many important "pockets" of population in the valleys and on hillsides remote from the transmitter that reception is bound to be patchy. Many more will have heard of the difficulties of the reception of Holme Moss in Hebden Bridge than have experienced it, yet Hebden Bridge is only twelve miles from that most efficient transmitter. There may be many localities like that but the industry is learning that what we have written so often about standing waves, can be applied to band III to a far greater extent than to band I.

Finding the Signal.

A prominent radio engineer telephoned us the other day, admitting that he had "taken with a pinch of salt" our often repeated statement that if you don't find a good signal where you first put your aerial, change its position. We often have to "probe" the roof area till we find a signal, then fix the aerial in that position. This engineer came to the conclusion that the only place on his roof where there was a signal was four feet higher and eight feet to one side of where he wanted to fix his aerial. He admitted that he could hardly believe it but he was convinced against his will. "If at first you don't succeed try, try, try again" then write to us.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 23rd. January, 1956

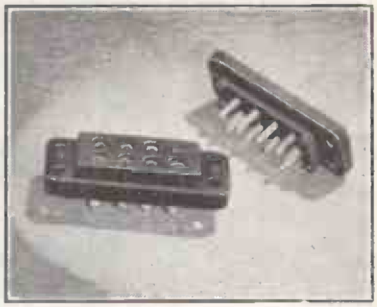
'BELLING-LEE' UNITORS

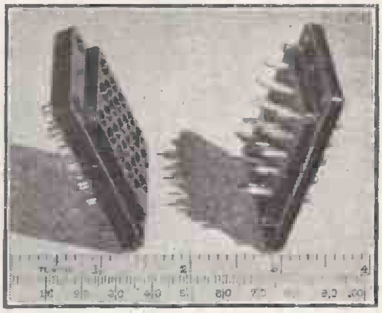
Inter-unit connectors for 4 to 25 contacts

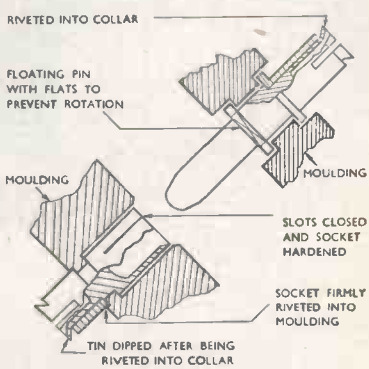
These Unitors are now widely used to facilitate the uncoupling of sub-assemblies for servicing or replacement. They conform to R.C.S. 321 and have Joint Service and A.R.B. approval.

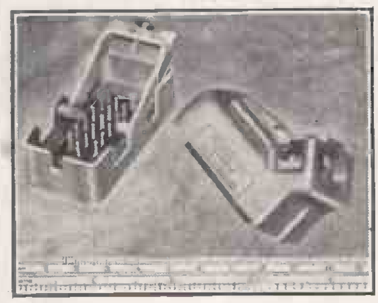
Each coupling consists of a block of plugs and one of sockets, arranged so as to be non-reversible. Bodies are moisture and tracking-resistant, being moulded from a nylon-filled phenolic material. Pins are of high grade brass silver-plated. Hard gold-plated pins for lower contact resistance will be available shortly as an alternative finish. Pins carry 3 amp, but each block has two larger pins carrying 10 amp each. All pins are fully floating. Sockets are of differentially hardened beryllium copper; solder spills of both plugs and sockets are slit to facilitate soldering. All plugs and sockets are numbered on both sides of the moulded body.

Die-cast light alloy covers provide a flex lead connector. Newer types of covers and retainers are under development and these will be freely interchangeable with all existing types, which will be continued as standard until the new versions are freely available.









LIST NO.	PINS	BODY SIZE
L.653/P&S	4	1.7/16" x 13/32"
L.654/P&S	8	1.31/64" x 37/64"
L.655/P&S	12	1½" x 25/32"
L.656/P&S	18	2" x 27/32"
L.657/P&S	25	1¾" x 1.3/16"

Working volts: 500V. Peak, pin to pin

U.K. Pat. 649,739. French Pat. 990017. Swiss Pat. 277799

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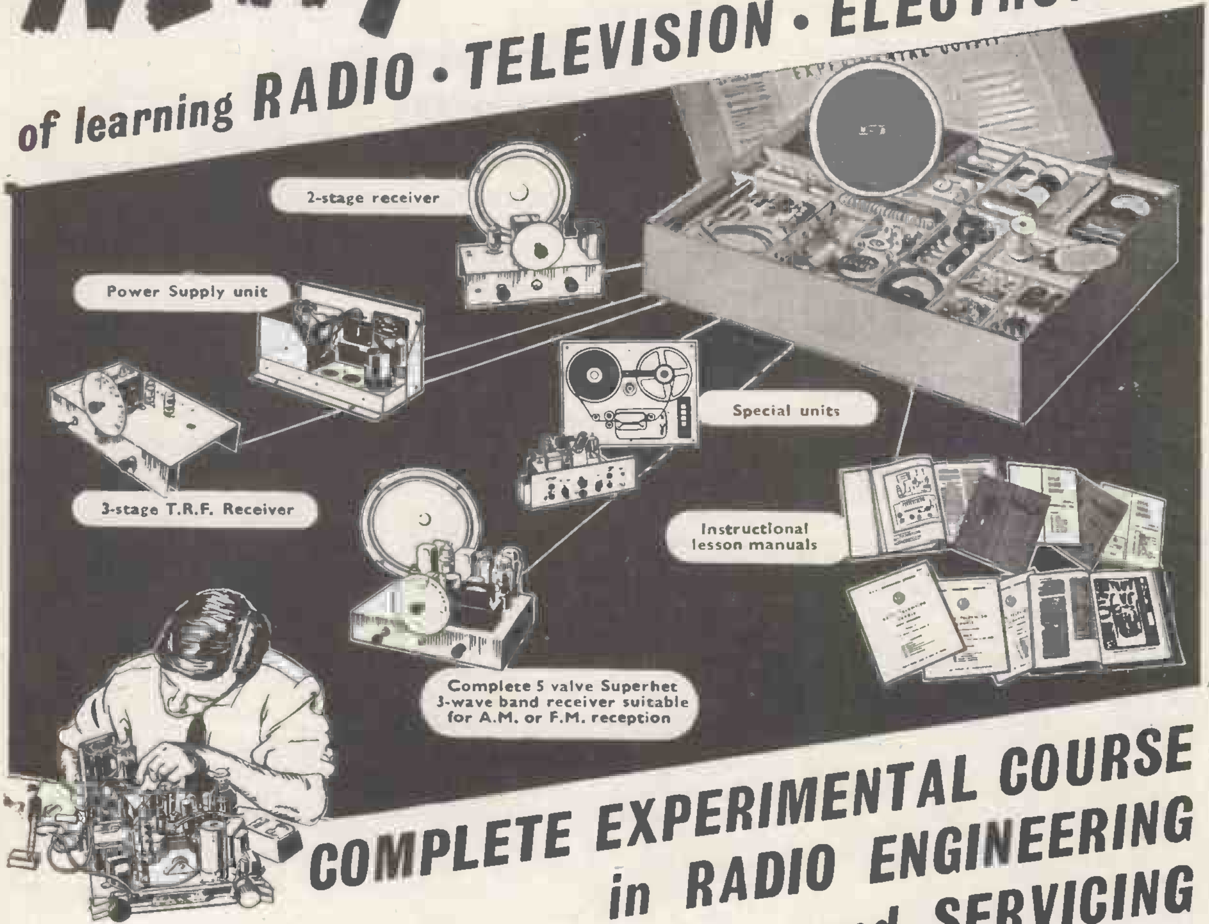

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An entirely new series of courses designed to teach Radio, Television and Electronics more quickly and thoroughly than any other method. Specially prepared sets of radio parts are supplied and with these we teach you, in your own home, the working of fundamental electronic circuits and bring you easily to the point when you can construct and service radio receivers, etc.

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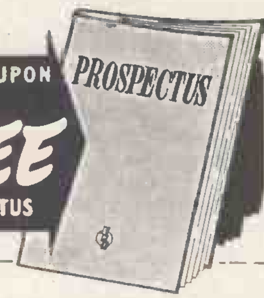

NEW TELEVISION COURSE including a complete set of equipment dealing with the design, construction and servicing of a high quality television receiver.

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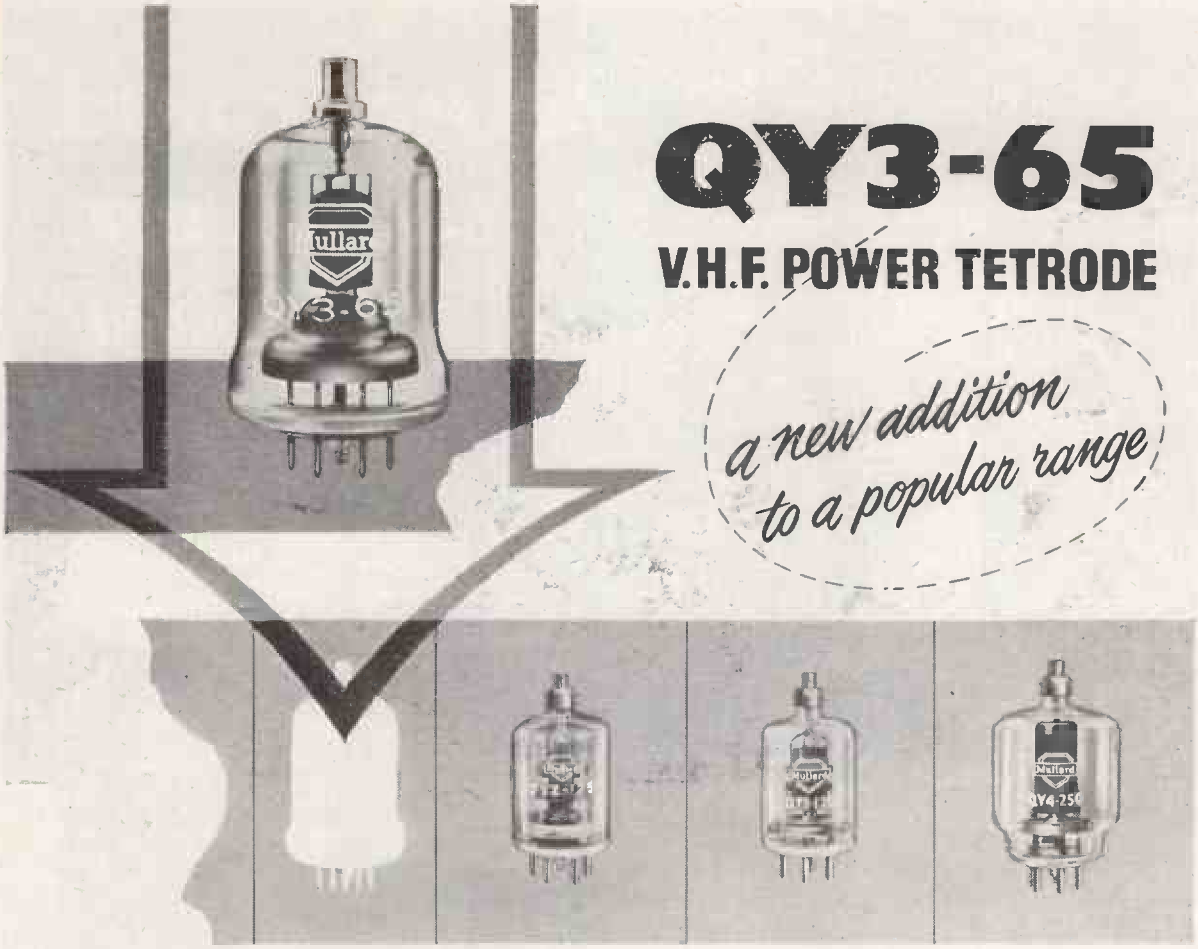

QY3-65

V.H.F. POWER TETRODE

a new addition to a popular range

This new tetrode, the QY3-65, embodies a similar technique and construction to the Mullard range of all-glass transmitting valves which are already well established in communications and industry. It has an anode dissipation of 65 watts and a maximum frequency of 250 Mc/s and is directly interchangeable with the American 4-65A.

Relatively high outputs can be obtained from the QY3-65 at low anode voltages, and its quick heating filament allows power consumption during standby to be reduced to a minimum.

Write for detailed information on this valve, power triodes and other tetrodes made by Mullard.

MAXIMUM OPERATING CONDITIONS (CLASS C AMPLIFIER) AT 50 Mc/s									Maximum frequency at reduced ratings (Mc/s)
Valve	Type	V_a (V)	V_{g1} (V)	I_a (mA)	I_{g1} (mA)	V_{in} (peak) (V)	P_{load} (W)	η	
QY3-65 (CV1905)	**TETRODE**	**3000**	**-100**	**115**	**10**	**170**	**224**	**81**	**250**
TY2-125 (CV1924)	TRIODE	2500	-200	205	40	390	310	76	200
QY3-125 (CV2130)	TETRODE	3000	-150	167	6.5	300	300	75	200
QY4-250 (CV2131)	TETRODE	4000	-225	312	9	374	800	80	120

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, WC2

Mullard

MVT184

As the Signal Generator is the basic tool in radio research, it is not surprising that Marconi Instruments have had long and unrivalled experience in this fundamental field. Generators are available which will fulfil practically every requirement, and new types are continually being added to the already large range at present available.

F.M./A.M. SIGNAL GENERATOR

TYPE TF 1066

Carrier Frequency Range : *10 to 470 Mc/s.* ● No spurious sub-multiple outputs; *r.f. oscillator generates direct at carrier frequency on all bands.* ● F.M. monitored and variable *up to 100 kc/s deviation.* ● A.M. monitored and variable *up to 80% depth.* ● Output Level variable *from 0.2 µV to 200 mV.* ● Precision Incremental Tuning *with frequency change indicated on a directly-calibrated meter.*

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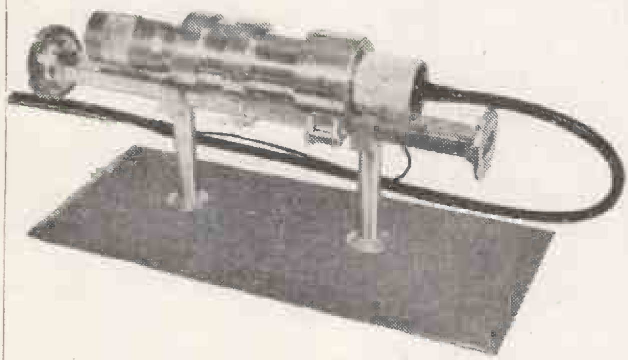


Price £150 net ex works (valve extra).

X-BAND OSCILLATOR TYPE S.381

A variable frequency oscillator for the range 3.0 to 3.55 cms. using a CV.2346 Klystron in a co-axial cavity. The output remains constant within ± 2 db over the whole frequency range and the power will be between 15 and 35 mW according to the valve employed. Frequency stability 2 in 10^4 and calibration 3 in 10^4.

R.F. BRIDGE—TYPE B.601 15 Kc/s TO 5 Mc/s

A highly accurate transformer ratio arm bridge for the measurement of capacitance, resistance and inductance within the range 0.01 pF to 0.02 μF, 10 Ω to 10 M Ω and 0.5 μH to 50 mH. It can be used to measure complex impedances, balanced or unbalanced, or between any pair of terminals in delta formation.

Price £125 net ex works.

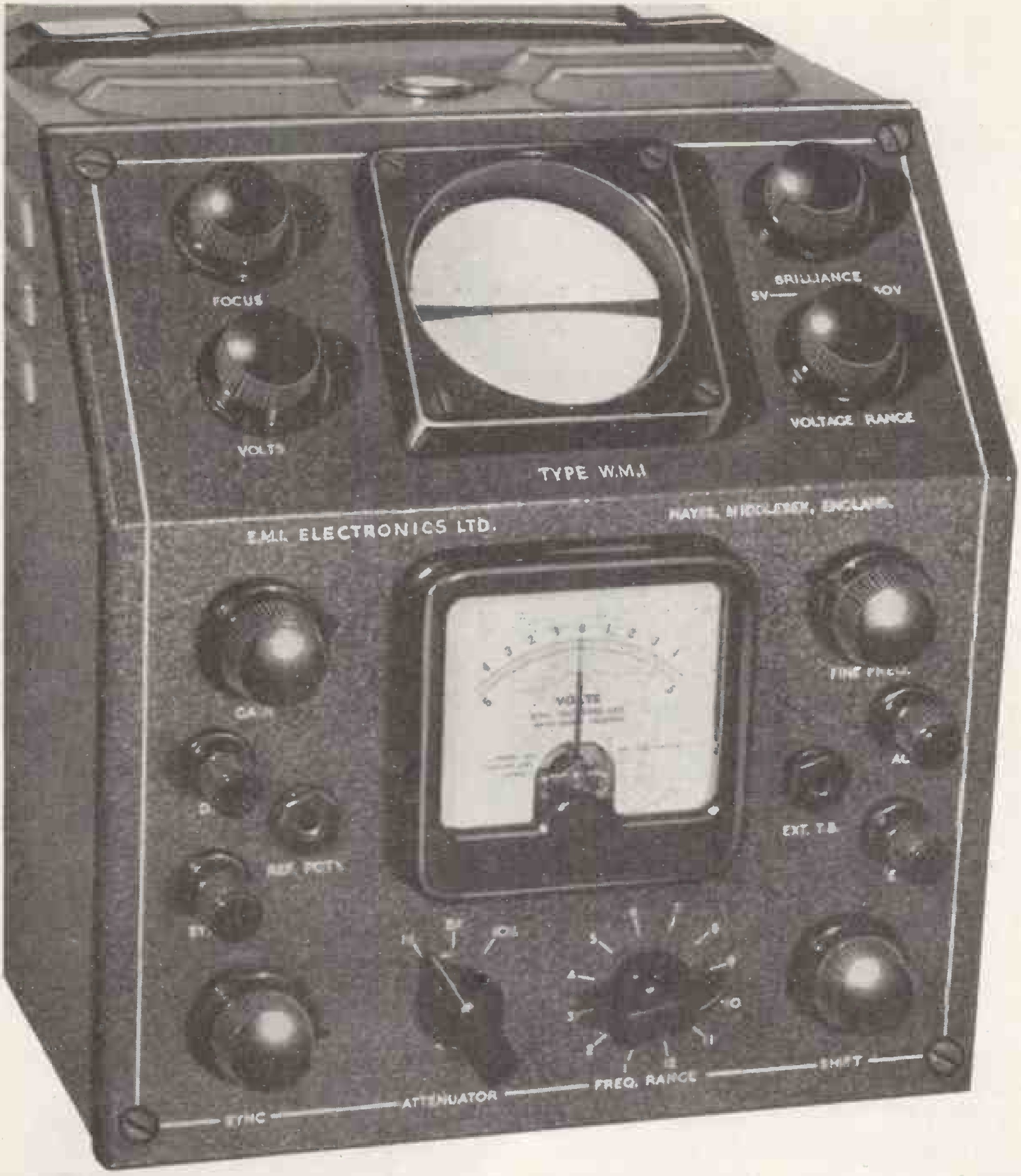
D.C. DECADE POTENTIOMETER—TYPE K.112

Five decades of Minalpha wire resistors arranged in potentiometer form to give ratios between 0 and 1 in steps of .00001. For ratios between 0.1 and 1, the accuracy is better than .01%. Total resistance 100,000 ohms—applied input voltage 300V maximum. The assembly is specially aged for long-term stability.

Price £225 net ex works.

FOR FURTHER DETAILS WRITE OR TELEPHONE

THE WAYNE KERR LABORATORIES LIMITED · NEW MALDEN · SURREY · MALDEN 2202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VOLTAGE RANGE
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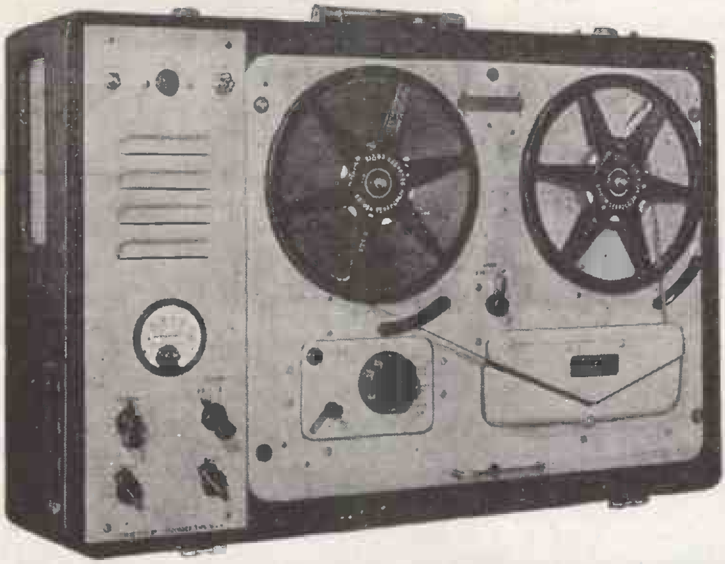
Ferranti Cathode Ray Tubes
FERRANTI
The Electronics Department of Ferranti Ltd. manufactures a wide range of Valves and Cathode Ray Tubes for Radio and Television receivers. Illustrated is a 17" rectangular tube, one of a range of Cathode Ray Tubes available in all the popular sizes,
17"

VORTEXION TAPE RECORDER



★ The total hum and noise at $7\frac{1}{2}$ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.
★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.
★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.
★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.
★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.
★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

The amplifier, speaker and case, with detachable lid, measures $8\frac{1}{4}$in. x $22\frac{1}{2}$in. x $15\frac{3}{4}$in. and weighs 30 lb.

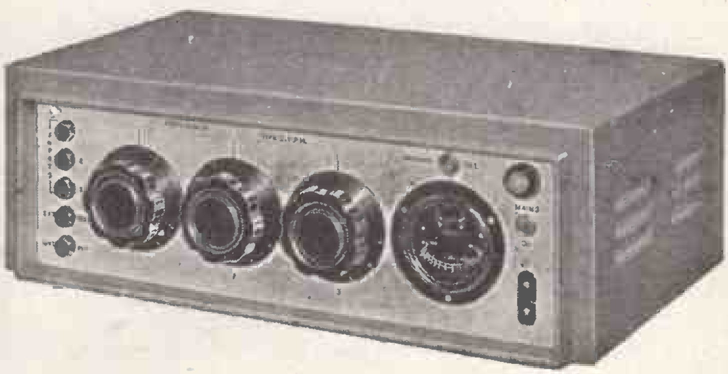
PRICE, complete with WEARITE TAPE DECK £84 0 0

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.
★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.
★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

3-WAY MIXER AND PEAK PROGRAMME METER

FOR RECORDING AND LARGE SOUND INSTALLATIONS, ETC.



One milliwatt output on 600 ohm line (.775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.
Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient packs.
Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

Manufactured by

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

SPECTONE

5-10 MULLARD AMPLIFIER

This remarkable development will meet the most exacting high fidelity requirements at an extremely low price.
Meticulous inspection at each stage ensures that the Spectone Mullard 5-10 Amplifier fully meets Mullard specification.

TWO INPUTS
One for radio tuner, microphone, etc., and one for pickup. The pickup input has two switch positions for equalisation—L.P. and Standard. Plug-in equalisers are available to suit various pickups.

CONTROLS Besides the input and equalisation selection switch, volume, treble and bass controls are provided. The treble control is continuously variable from + 10db to −10db and the bass + 11db to − 5db.

MAXIMUM OUTPUT
15 watts

HUM & NOISE
−73db referred to 10 watts.

OUTPUT IMPEDANCE
15 ohms

FREQUENCY RESPONSE
± 0.5db 10 c/s to 20,000 c/s.

POWER OUTPUT for pre-amplifier
300 volts at 12 milliamps. 6.3 volts at 2 amps.

Price **18** GNS.

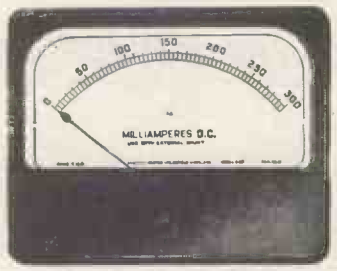
Pickup Equaliser Plug 12/6

Write for leaflet and specifications of the SPECTONE Monaural and "Stereophonic" Tape Reproducers.

SPECTO LTD. Vale Rd Windsor

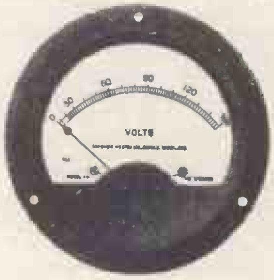
WESTON panel instruments

Both round and rectangular models of moving iron, moving coil, A.C. rectifier and H.F. thermocouple types are offered. In the range of rectangular instruments, which have been introduced to give the advantage of long, easily-read scales and to harmonize with rectangular panels, certain models are available with illuminated dials. Full particulars of types and ranges available are to be found in leaflets List Nos. W.1 and W.2, copies of which are available on request.



Rectangular panel instruments are available with scale lengths of 2.5", 3.2", and 4.2". These offer the advantage of an increase in scale length of approximately 50% over their equivalent round models, for which they can be used as direct replacements using the same panel fixing holes.

Larger instruments, both round and rectangular and for switchboard or panel mounting are also available. These have scale lengths of 6" and 6½" respectively.



Round models are housed in cases of 2", 2½" and 3½" diameter and have scale lengths of 1.7", 2.1" and 2.8" respectively.

SANGAMO WESTON LIMITED

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TRADITION

IN A YOUNG INDUSTRY

The oldest high fidelity amplifiers in the world are of LEAK manufacture. In 1945 as the result of war-time research in our laboratory we were able to offer, to an astonished world of audio engineers, amplifiers with a distortion content as low as 0.1%. A survey of engineering literature will confirm that we were the first manufacturers in the world to design and market amplifiers with such a small distortion content, and the magnitude of this advance can be gauged when it is remembered that the then accepted standard for laboratory amplifiers was 2% distortion. Our figure of 0.1% was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and this criterion is still an accepted world-wide standard.

With this clear lead on low-distortion amplifiers we were able to build up an export market much greater than the domestic one, and the increased volume of manufacture resulted in lower prices, which, in turn, brought real high fidelity amplifiers within the reach of the music-lover at home.

We have devoted 21 years entirely to the development and manufacture of audio products and we are proud of our position as the leaders in this field. We are also proud of the fact that the " Point One " amplifiers supplied to our first customers are still giving them results which, even now, cannot be surpassed. Our research and development departments are ever active, our pre-amplifiers have been re-designed for use with the latest input devices, and we have made great progress in the war on prices. From long experience, by the employment of new techniques and by extreme attention to design details during development work on the pre-production models, we enable our labour force to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at reasonable prices.

To our old customers we give our thanks for their support and recommendation—the basis on which our Company has grown. Those who are seeking to obtain the highest quality of gramophone and radio reproduction would be wise to hear and inspect LEAK products which, with their tradition of excellence, represent the best that can be obtained.

LEAK

HIGH FIDELITY EQUIPMENT

LEAK TL/10 AMPLIFIER & 'POINT ONE' PRE-AMPLIFIER

27 gns. *complete*

TL/10 POWER AMPLIFIER

Circuitry
A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.

Maximum power output: 10 watts
Frequency Response: ± 1 db 20 c/s to 20,000 c/s.
Harmonic Distortion: 0.1%, 1,000 c/s, 7.5 watts output
Feedback Magnitude: 26 db, main loop
Damping Factor: 25.
Hum: — 80 db referred to 10 watts.
Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

★ *Write for leaflet W* ★

"POINT ONE" PRE-AMPLIFIER

The handsome gold escutcheon plate contributes to the elegant appearance, and blends with all woods.

★ **Pickup**
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

★ **Radio**
The radio input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

★ **Distortion**
Of the order of 0.1%

★ **Hum**
Negligible, due to the use of recently developed valves and special techniques.

★ **Input selector**
Radio, tape, records; any and all records can be accurately equalised.

★ **Treble**
Continuously variable + 9 db to — 15 db at 10,000 c/s.

★ **Bass**
Continuously variable + 12 db to — 13 db at 40 c/s.

★ **Volume Control and Switch**
The switch controls the power supply to the TL/10 power amplifiers

★ **Tape Recording Jacks**
An exclusive feature Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

ELECTROSTATIC LOUDSPEAKERS

Reprints of "The Gramophone" article (May, 1955), by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

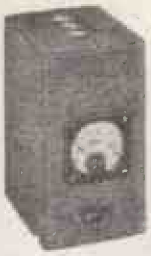
H. J. LEAK & CO, LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

Phone : SHEpherds Bush 1173/4/5 *Telegrams : Sinusoidal, Ealux, London* *Cables : Sinusoidal, London*

R.S.C. BATTERY CHARGING EQUIPMENT.

All for A.C. MAINS 200-250 v., 50 c/cs. Guaranteed 12 months.

ASSEMBLED CHARGER
6 v. or 12 v. 2 amps.
Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use With mains and output leads, Double Fused.



Only **45/9** carr. 3/6.

ASSEMBLED CHARGERS

6 v. 1 amp.	19/9
6 v. or 12 v. 1 amp.	25/9
6 v. 2 amps.	29/9
6 v. or 12 v. 2 amps.	38/9
6 v. or 12 v. 4 amps.	56/9

Above ready for use. Carr. 2/9

HEAVY DUTY KIT
12 v. 30 amp. Suitable for Garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers. 2 Meters, 4 Fuses, 4 Terminals, 2 Rheostats and circuit. Only 9 gns., carr. 15/-.

BATTERY CHARGER KITS
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp.	22/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 4 amps.	49/9

BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and variable charge rheostat with knob. Only 45/9.

Assembled 6 v. or 12 v. 4 amps.
Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 3/6. **69/6**

SELENIUM RECTIFIERS

L.T. Types		6/12 v. 6 a.	19/9
2/6 v. ½ a.h.w.	1/9	6/12 v. 10 a.	25/9
6/12 v. ¼ a.h.w.	2/9	**H.T. Type H.W.**	
F.W. Bridge Types		120 v. 40 mA.	3/9
6/12 v. 1 a.	5/9	250 v. 50 mA.	5/9
6/12 v 2 a	8/9	250 v. 80 mA.	7/9
6/12 v. 3 a.	12/9	250 v. 150 mA.	9/9
6/12 v. 4 a.	16/9	300 v. 275 mA.	12/11

CO-AXIAL CABLE. 75 ohms ¼in., **8d.** yard. Twin screened feeder, **11d.** yard.

T.V. CABINETS. Console type for 15, 16 o: 17in. tube. Half length doors, 9 gns. Table model with doors for same size tube, 69/6. Table type for 12in. Tube 29/6. All famous manufacturers surplus.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF). .002 mfd. (2,000 pfd.). All at **5d.** each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 6/9 doz.; 4 v. 0.3 a., 5/9 doz.

ELECTROLYTICS (current production). NOT Ex-Govt.

Tubular Types		Can Types	
8μF 450 v.	1/9	8 mfd. 350 v.	1/3
8 mfd. 500 v.	2/6	8 mfd. 600 v.	2/11
16μF 350 v.	2/3	16 mfd. 500 v.	3/9
16μF 450 v.	2/9	16 mfd. 350 v.	1/11
16μF 500 v.	3/9	16μF 450 v.	2/9
32μF 350 v.	3/9	32μF 350 v.	2/11
32 mfd. 500 v.	5/9	32 mfd. 450 v.	4/9
8-16μF 500 v.	4/11	100 mfd. 450 v.	4/9
25μF 25 v.	1/3	8-8μF 450 v.	2/11
50μF 12 v.	1/3	8-16μF 450 v.	2/11
50μF 50 v.	1/9	16-16μF 450 v.	3/11
100 mfd. 12 v.	1/9	16-32μF 350 v.	4/9
100 mfd. 25 v.	2/3	32-32μF 350 v.	4/9
		32-32μF 450 v.	5/9

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

VIBRATORS. Oak 2 v. 7 pin, synchronous, 7/9.

EX GOVT. E.H.T. CONDENSERS

.5 mfd., 2,500 v. Blocks	3/9
.5 mfd., 3,500 v. Cans	3/3
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v.	1/9	4 mfd. 1,500 v.	4/9
4 mfd. 500 v.	2/9	8 mfd. 500 v.	5/9
4 mfd. 1,000 v.	4/3	8-8 mfd. 500 v.	5/11
		15 mfd. 500 v.	7/9
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137, EA50, EB34. 11d.; SP61 2/3, 4SHA 1/3. EL32 3/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G etc., trans., L.F. choke, Rectifier etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6. Transmitter Receivers type TR9D complete with all valves 45/-, carr. 6/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob. 2 S.P.S.T. switches, various plugs and sockets. Only 1/6.

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

EX GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s. input.

8.8 v. 4 a., 9/9. 24 v. 1 a.	7/9
300-0-300 v. 150 mA. 4 v. 3 a.	9/9
120-0-120 v. 40 mA.	5/9
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. Potted 4¼-3¼-3in.	11/9
460 v. 200 mA., 6.3 v. 5 a.	22/9
0-16-18-20 v. 35 a. 79/6 Carriage 5/- extra.	

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a. 5 v. 3 a., 33/9. Clamped type 250-0-250 v. 70 mA., 6.3 v. 2.5 a. 9/9, post 1/9.

EX GOVT. SMOOTHING CHOKES

250 mA., 10 H., 50 ohms.	14/9
250 mA., 3 H., 50 ohms.	8/9
150 mA., 10 H., 50 ohms.	10/11
150 mA., 6-10 H., 150 ohms., Tropicalised	6/9
100 mA., 10 H., 200 ohms., Tropicalised	3/11
50 mA., 50 H., 1,000 ohms.	6/9
L.T. type 1 amp., 2 ohms.	2/9

SPECIAL OFFERS. Small 2 gang variables .0005 mfd., 4/9. 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, 1/6 ea.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/cs. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams 39/9, or ready for use, 46/9.

Type BM2. Size 8 x 5½ x 2¼in. Supplies 120 v., 90 v., and 60 v., 40 m.A. and 2 v. 0.4 a. to 1 amp., fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS.** When connected to A.C. mains supply 200-250 v. 50 c/cs. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit of parts with diagrams and instructions 49/9, or ready for use 59/6.

TYPE BM1A. An all dry battery eliminator size approx. 5 x 4 x 1⅞in. Supplies approx. 69 v. at 10-15 mA. and 1.4 v. at 250 mA. For 4 valve receivers using L.T. current of not less than 230 mA. Complete kit 35/9 or ready to use 42/6.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. for R1355 conversion	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a. suitable Williamson Amplifier, etc.	49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	69/6

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a. c.t., 5 v. 3 a.	22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2a., 5 v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 .... 36/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	0-2-4-5-6.3 v.	
6.3 v. 3 a.	8/11	4 a.	16/9
12 v. 1 a.	7/9	6.3 v. 6 a.	17/6
6.3 v. 2 a.	7/6	12 v. 3 a. or	
0-4-6.3 v. 2 a.	7/9	24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a., 18/9. 0-9-15 v. 5 a., 19/9. 0-9-15 v. 6 a. 23/9.

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA.	7/11
130 v. 50 mA., 6.3 v. 3 a.	14/9
120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v., 250 mA.	9/11

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000 to 3Ω	4/9
Battery Pentode, 10,000 ohms to 3 ohms.	4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 8 Watts 6V6 to 3 ohms.	8/9
Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω, sectionally wound	16/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms.	21/9
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type exact to spec.	85/-

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms.	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11

R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

WE ARE PROUD TO INTRODUCE OUR NEW 1956 DESIGN. A high Fidelity Push-Pull Unit employing six valves. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 30 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 m.a. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.**
Price in kit form with easy to-follow wiring diagrams. Only **9 GNS.** Carr. 10/-
Or Factory built with 12 months guarantee, 50/- extra. **H.P. TERMS ON ASSEMBLED UNITS: DEPOSIT 28/6 and 12 monthly payments of 21/-.** If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. Extra cost for this 13/-. Cover as illustrated 17/6 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.**
We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on H.P. terms with amplifiers.

EXPORT ENQUIRIES INVITED

R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox and Collaro 3-speed transcriptor chassis. Size 12-7-3in. Overall size 12-7-6½in. For 230-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response ±3 D.B. 50-11,000 c/cs.
11 GNS. Ready for use. Carr. 7/6. Facilities for recordings at 15in., 7½in., or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. **PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST. LEAFLET 6d.**

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. **BRAND NEW. CARTONED.** Only £3/19/6 (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type. 50/-. Piezzo with heavy floor base and telescopic stem. £6/19/6.

PLESSEY SINGLE SPEED AUTO-CHANGERS with Crystal Pick-up for standard 78 r.p.m. records 10in. or 12in. Very limited number. Only £5/17/6, carr. 5/6.

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal pick-up and dual point sapphire styli for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. For A.C mains 200-250 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions. Only **£7/19/6** plus 3/6 carr.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. Low impedance with matching trans., brand new, boxed at fraction of normal price. Only 33/-.

R.S.C. MASTER INTERCOMM. UNIT. With provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only 7 gns., carr. 5/-. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet can be supplied at 35/- each.

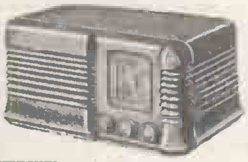
R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible, being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-, carr. 3/6 or factory built 22/6 extra.

THE SKY FOUR T.R.F. RECEIVER



A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list. 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite veneered walnut.

R.S.C. ULTRA LINEAR 12 WATT AMPLIFIER

AS NEW 1956 Model High-Fidelity Push-Pull Amplifier with "Built-in" Tone Control, Pre-amp. stages. High sensitivity. Includes 5 valves (807 outputs), High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture, **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut."** Frequency response ±3 db 30-30,000 c/c. Six negative feedback loops. Hum level 71 db. down. **ONLY 70 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and practically all microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT. H.P. TERMS ON ASSEMBLED UNITS. DEPOSIT 31/-** and nine monthly payments of 21/-. Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Unapproachable value at £7/15/-, or factory built 45/- extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6.

FOUR-STAGE RADIO FEEDER UNIT

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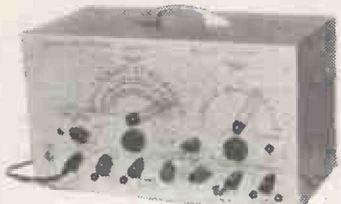

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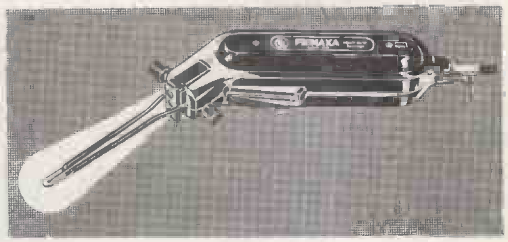

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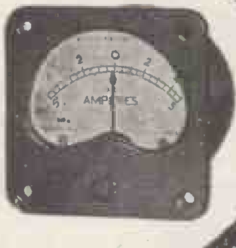

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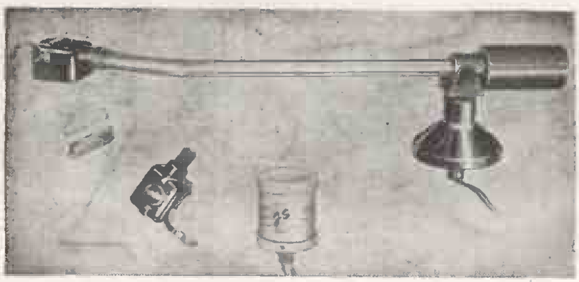

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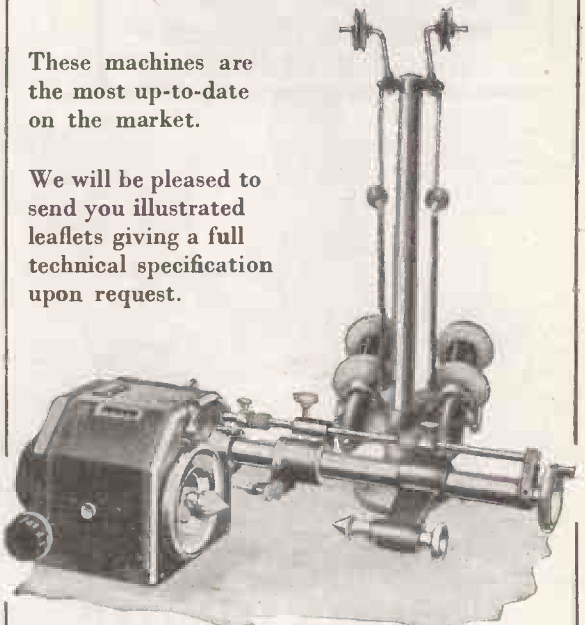

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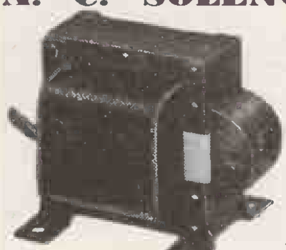

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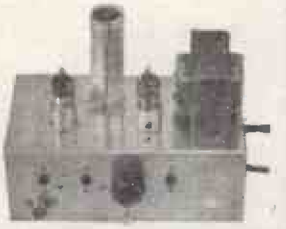

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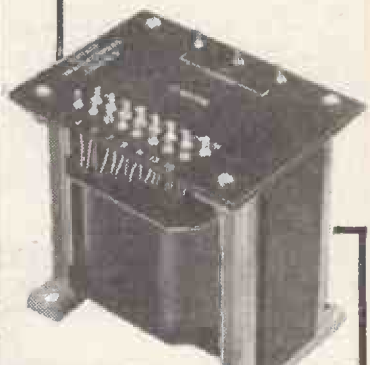

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BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strong bow Rd., Eltham, S.E.9. [0031

SCHOLARSHIPS

THE INSTITUTION OF ELECTRICAL ENGINEERS SCHOLARSHIPS.

THE Council of The Institution of Electrical Engineers will consider for award this year five Research Scholarships, two Graduate Scholarships and ten Student Scholarships.

RESEARCH SCHOLARSHIPS—Ferranti, value £500 p.a. for two years, I.M.E.A., value £420 for one year, may be extended; Oliver Lodge, value £420 for one year, may be extended; Swan Memorial, value not exceeding £300 for one year, C.P. Sparks Fund, value £100 for one year.

GRADUATE SCHOLARSHIPS—for full-time post-graduate study. Duddell, value £400 for one year; Silvanus Thompson, value £400 for one year. (Alternatively these may be awarded as Student Scholarships).

STUDENT SCHOLARSHIPS..for study at undergraduate level at a university or a technical college. Duddell, value £200 p.a. for three years; Silvanus Thompson, value £200 p.a. for three years; Paul, value not exceeding £150 p.a. for four years; Manville, value £150 p.a. for three years; Arthur Fleming, value £120 p.a. for four years (for a Sandwich Diploma course); Salomons, value £60 for one year; David Hughes, value £60 for one year; Sir Charles A. Parsons, value £60 p.a. for three years; Ceipel, value £50 p.a for a period not exceeding four years; Thorrowgood, value £25 for one year.

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MAINS TRANSFORMERS all 200/250 volts primaries (New) Heavy duty Output combination of 0/6/12/18/24/30/36 volts 4/5 amps., 38/6 each. Ditto 6/8 amps., 51/6 each. Ditto 15 amps. Output 75/- each. Another with combination of 0/6/12/18/24 volts 6/8 amps., 51/6 each. Ditto 10/12 amps., 58/6 each. Ditto 25/30 amps. Output 85/-each.

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EX-R.A.F. ROTARY TRANSFORMERS. Input 24/28 volts D.C. OUTPUT 1,200 volts 70 M/amps. ½ hour rating, 10/- each. Ditto 18/24 volts D.C. Input 450 volts 50 M/amps, Output constant, 25/- each. These latter ones can be used as motors off A.C. mains with a little alteration.

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MAINS TRANSFORMERS, (By Well known makers) Input 110/250 Volts output 300/0/300 Volts 70 M/amps 12 volts 1 amp. 5 volts 2 amps., useful for Wireless, small electric trains, etc or as an auto transformer 60/80 Watts 110/250 volts or vice versa, guaranteed 10/9d. each. Another as above 350/0/350 Volts 80 m/amps., 6.3v3a, 5v2a, drop through type 22/250 volts input 12/9 each.

P.M. SPEAKERS mounted on small baffle board 8 inch speakers useful as extensions 10/9 each fully guaranteed.

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SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

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OF a company of established reputation requires able and experienced.
SENIOR Electronic Engineers.
TO undertake a responsible part in the development of a wide variety of specialised equipment.
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CANDIDATES should preferably possess an Honours Degree or the equivalent, although a lack of academic qualifications should not serve as a deterrent to engineers of proven ability.
EXPERIENCE should include several years of circuit design, and a sound knowledge of radio communications circuits is an advantage.
APPLICATIONS will be treated as confidential and should be made to The Superintendent, Electronic Development Division, R. B. Pullin & Co., Ltd., Great West Rd., Brentford, Middlesex. [0209

A DRAUGHTSMAN with mechanical design experience is required for the ELECTRONICS DIVISION of Saunders-Roe, Ltd. Applications are invited from suitably qualified men, especially those with a basic knowledge of the principles of Electronics plus experience in the design of electromechanical transducers, servomechanisms and electronic assemblies.
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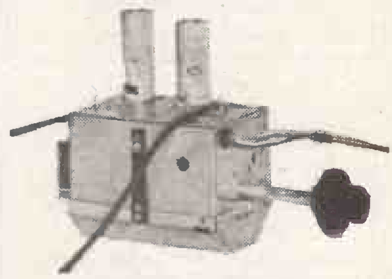

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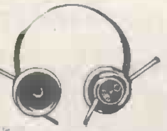

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AN electronic engineer, with knowledge of audio frequency circuitry, is required to carry out vibration tests on guided weapons and their components and to assist in the design and development of additional test gear; excellent opportunity for obtaining experience and advancement in new techniques of increasing scope; good salary and bonus; pension scheme.—Apply (quoting Ref. WW/19A) to the Assistant Manager. The Fairey Aviation Co., Ltd, Weapon Division, Heston Aerodrome, Hounslow, Middx. [5563

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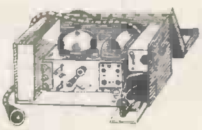

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GRADUATE engineers 25-30 years of age are required for interesting development work involving a sound knowledge of L.F. amplifier techniques, applicants should have had several years' responsible experience in the design of specialised electronic equipment and in carrying projects through to production stage, a generous salary will be paid to the selected applicants, company superannuation and insurance scheme available.—Please reply, in confidence, giving full details of qualifications and experience, to Box 8407. [5574

DECCA RADAR, Ltd., invite applications for posts as Site Engineers on locations in U.K. and abroad. Applicants should preferably have had previous experience of the installation of maintenance of radar equipment, though consideration will be given to men with corresponding experience of other electromechanical apparatus. Applications with full details should be addressed to the Manager, Heavy Installations Division, Decca Radar, Ltd., Malden Way, Kingston By Pass, New Malden, Surrey, quoting reference HID.17. [5489

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref R.G. [0259

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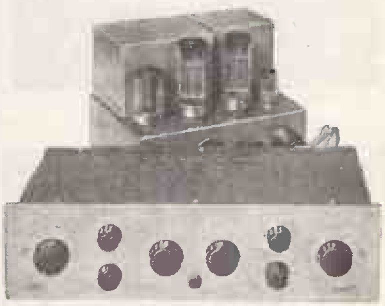

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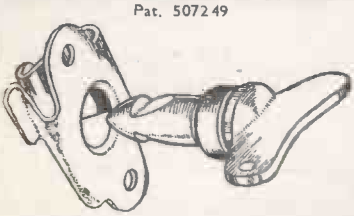

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SERVICE Manager required for the rapidly growing radio and electrical department in large departmental store. APPLICANTS, who should not be over 31 years of age, must have had experience of servicing well known makes of radio and electrical equipment and preferably have been in charge of a radio service department in this country.
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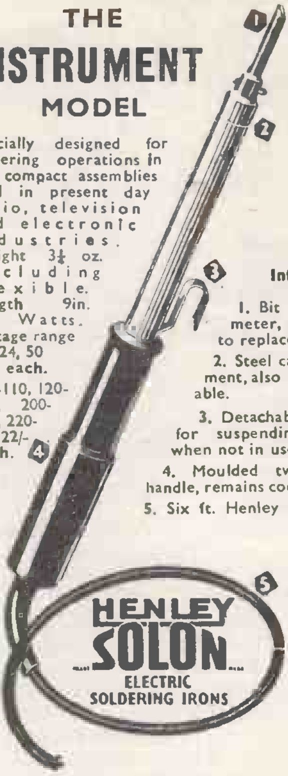

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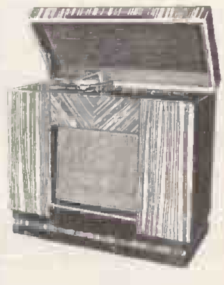

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JUNIOR Research Engineer required for development work on miniature accustic and electronic components. Good technical educotion essential. Salary £750 p.a. Phone Wembly 5906, Amplivox Ltd. Wembley. [5659

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BRITISH EUROPEAN AIRWAYS require a RADIO DEVELOPMENT ENGINEER, Project and Development Branch, London Airport. Qualifications: a full technological certificate (telecommunications) of the City and Guilds Institute or the equivalent; five years' experience on the development of radio or radar equipment or circuit techniques. Equivalent experience in other spheres acceptable. Salary £905-£1,290 per annum according to qualifications and experience. Applications giving age, education, qualifications and experience to Senior Personnel Officer, B.E.A. Engineering Base, London Airport, Hounslow, Middx. [5657

PAMETRADA RESEARCH STATION, WALLSEND, have a vacancy for a Test Engineer to work in the Electronics Section. The duties consist mainly of maintenance and calibration of special electronic instruments. Candidates should have several years' experience of electronic works, together with City & Guilds Examination in Radio Communications, No. 3, or equivalent. Knowledge of television circuits would be an advantage. The salary offered compares favourably with what men with similar qualifications can earn in industry. Apply in writing to the Research Director, Pametrada Research Station, Wallsend, Northumberland. [5614

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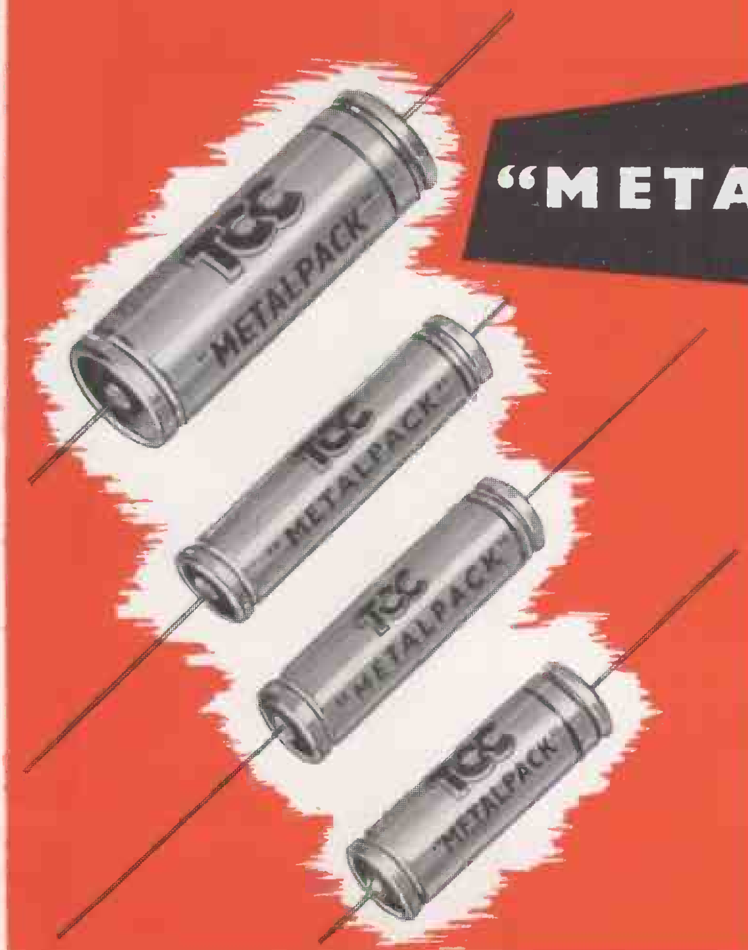

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0·1	500	350	2	½	CP46S	2/2
0·25	500	350	2¼	¾	CP47S	2/10
0·5	500	350	2¼	1	CP91S	3/10
0·02	750	500	1½	½	CP45U	1/10
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C 16018	60/40	18	51 feet
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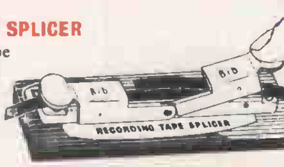

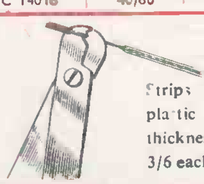

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