Wireless World

ELECTRONICS, RADIO, TELEVISION

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In This Issue

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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 activities. 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.

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. (Monchester)
Colloro
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
Electra-Methods
Electronic Components
Electronic Engineering
Electrothermal Engineering
English Electric
Enthoven Solders
Erg Industriol 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
Hassatt and Harper
Hellermann
Henley's
Hunt (Capacitors)
Igranic
Imhof
Insulating Components and Materials
Jackson Bros.
J. Beam Aerials
Labgear
Lengley
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 Cotherall
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
Plannair
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
Wandlesida 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 consider-

ably 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	Plessey
Armstrong	Pye
Collaro	*Record News*
Cosmocord	Reslosound
Decca	Rogers Devlopment
E.M.I.	Rola Celestion
Garrards	R.C.A. Photophone
G.E.C.	Simon
Goldring	Specto
Goodmans	Sugden
Grampian	Tannoy
Gramophone Record Review	*The Gramophone*
Grundig	Thermionic
H.M.V.	Trix
Leak	Truvox
Lowther	Vitavox
Lustraphone	Wharfedale
M.S.S. Recording	Whiteley
Mullard	*Wireless World* and
Pamphonic	*Wireless Engineer*
Philips	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 defence 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 Engineers' 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 31. Dr. Westcott, who is 35, graduated from London University and undertook post-graduate research on servomechanisms 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

The late
H. C. VAN DE VELDE

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.

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 33⅓% 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 ± 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 ± 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°.

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.

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 research staff of ten.
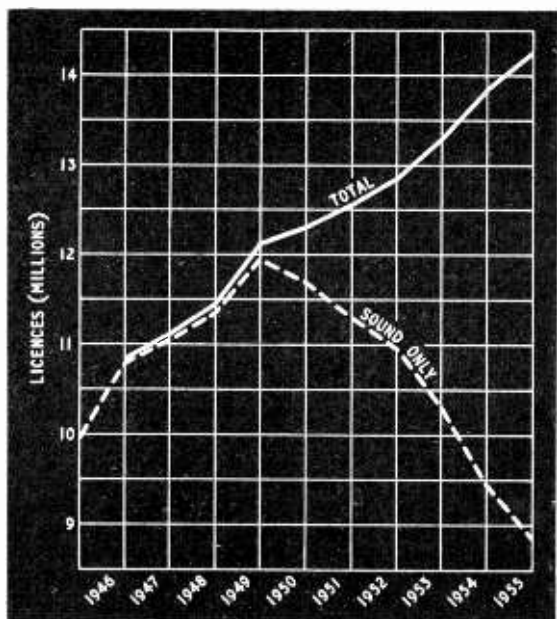
DECEMBER's INCREASE of 138,384 in the number of television licences brought the total to 5,400,083. The number of sound licences was 8,818,297 (including 289,455 for car radio) which gave an overall total of 14,248,380. The increase in the number of television licences in the United Kingdom during the 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.

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 $V_c I_c$. 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 $V_c I_c$. For a sine-wave output, the output power to the load is $E_c I/8 = 4V_c I_c/8 = V_c I_c/2$. 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 $V_c I_c = P_c$. Now $V_c = E_c - I_c R$; that is, the collector voltage is the supply voltage minus the voltage drop in the resistance. So $P_c = I_c E_c - I_c^2 R$. 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 $13/0.11 = 118\Omega$. To avoid power overload, the included resistance must not be under $169/0.18 = 935\Omega$. If operation is to be at 13V, 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 $3/0.11 = 27.2\ \Omega$ to prevent current overload and $9/0.18 = 50\ \Omega$ 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 $2.25/0.18 = 12.5\ \Omega$. 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.
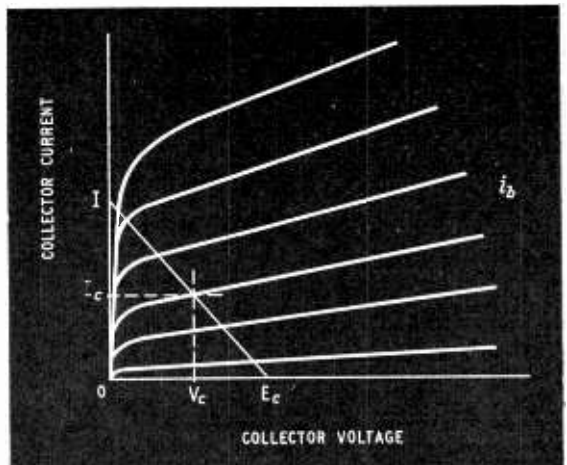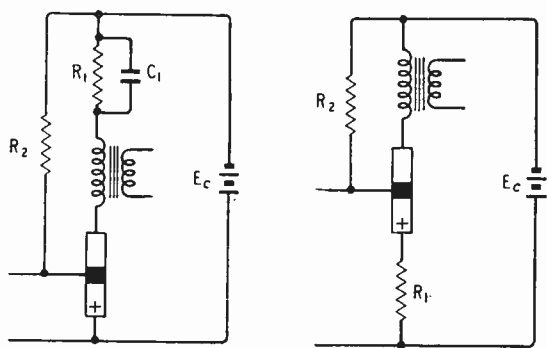

Fig. 1. Typical transistor characteristics.

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.

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.

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 $E_c R_2$.

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 $R_1 = 90$ Ω and $R_2 = 9$ kΩ 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.
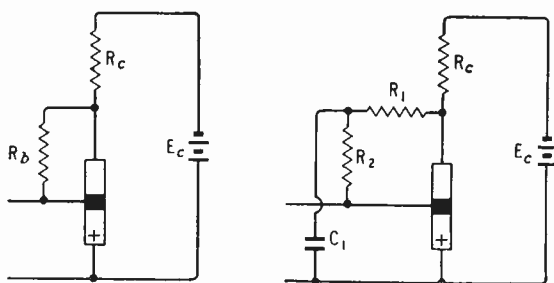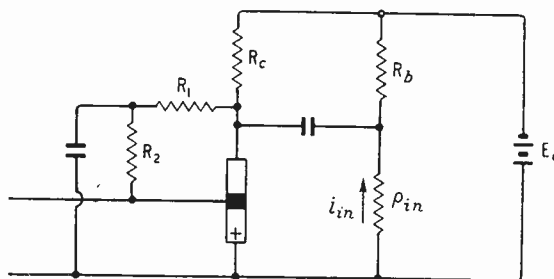
Taking this figure, the emitter current is 12.37 mA and the R_1 drop becomes 1.1133 V and the base current $2.2867/9 = 0.3652$ mA. By repeating the process one can reduce the error to negligible proportions, but it can be seen that it is, in reality, negligible in the first instance. With 12 mA at 4.4 V, the input power is 52.8 mW. The loss in the resistance is $0.14 \times 0.012^2 = 20$ 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 $R_c = 10$ kΩ 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 $i_c R_L$ and so the input current to the transistor is $i_{in} = i_c R_L/ρ_{in}$. We must have, therefore

$$i_c = i_{in} ρ_{in}/R_L.$$

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

$$i_c = i_{in} ρ_{in}(R_c + R')/R_c R'$$

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

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

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, $ρ_{in} = 3$ 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

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

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

Crystal drive, pulse and waveform generating units of the Midlands I.T.A. transmitter being set up by Pye engineers.
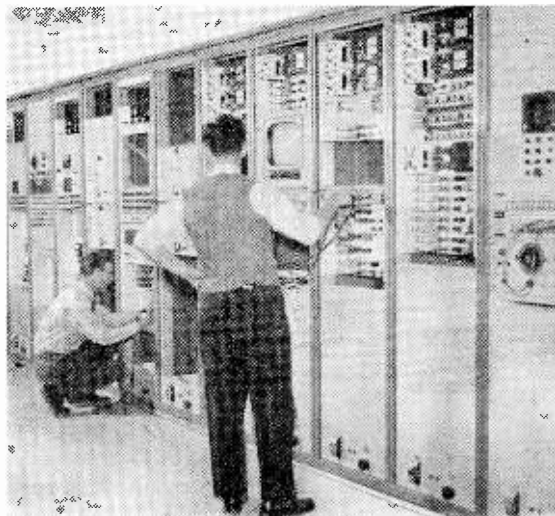
the 5 kW modulated driver stages with an effective radiated power of 60 kW from the high-gain aerial. When the 20 kW final amplifier has completed its trial period the power will be increased to 200 kW (e.r.p.) which will make the I.T.A. Midlands station one of the most powerful Band III transmitters in the world.

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.

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

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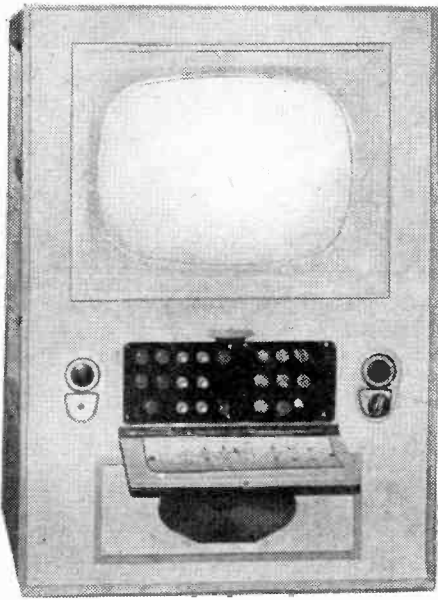 the case of the triniscope and to a lesser degree the three-tube projection method, rather too cumbersome. There was likewise little argument over the basic design of the receiver, which, as it was to be used to assist in the assessment of the N.T.S.C. system as a possible colour system for Great Britain, had to give the best possible picture on a colour trans-

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Colour Receiver

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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 bands.† 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

† "Colour Television Standards", *Wireless World*, August, 1955.
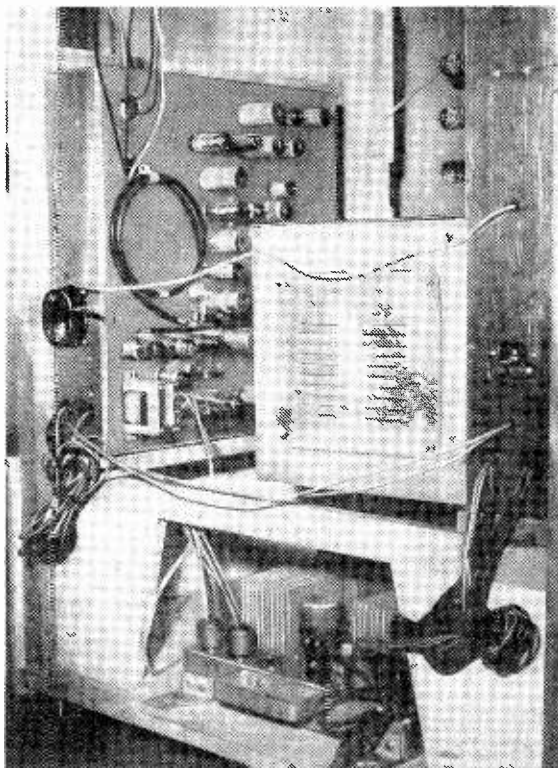
In this interior view of the receiver the delay-line cable in Fig. 2 (next page) can be seen arranged in a coil.

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.

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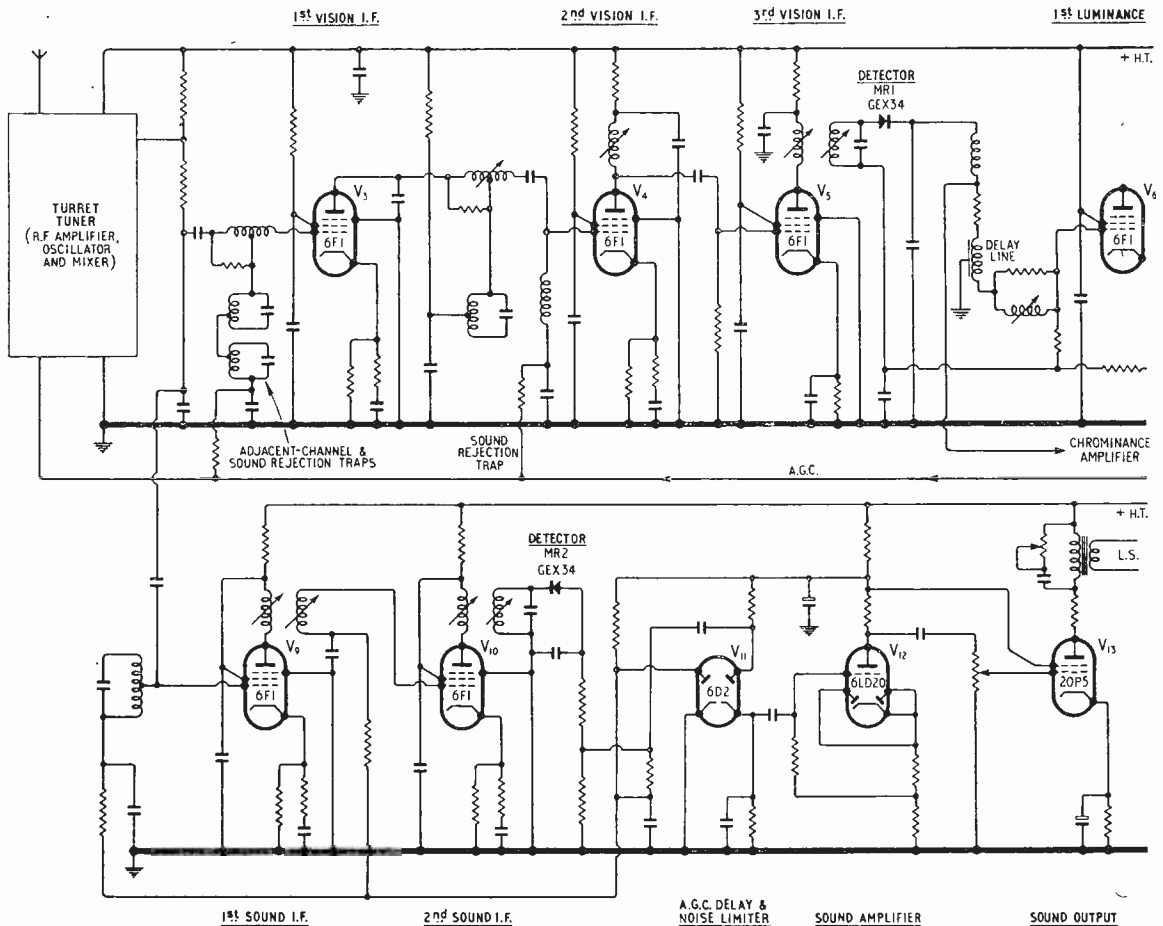
Fig. 2. Vision and sound receiving circuits, showing where the sound and chrominance signals are taken off and also the arrangement of the "bifilar-T" traps in the vision channel.

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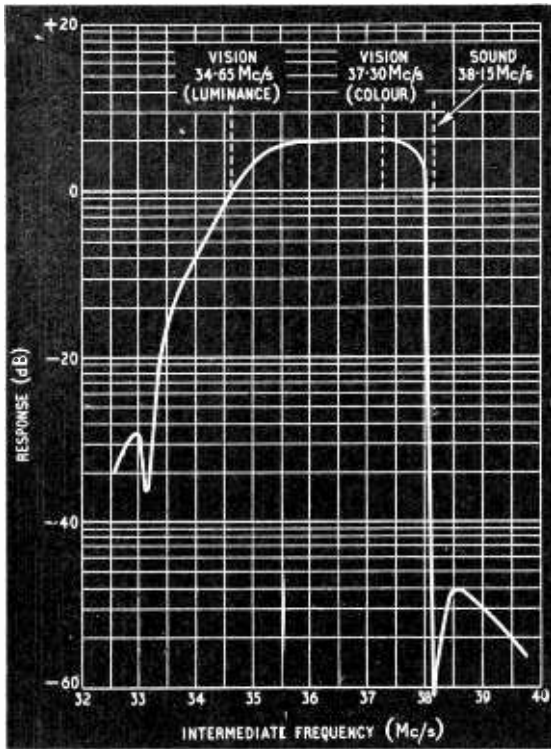
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Fig. 3. Response curve of the "bifilar-T" traps in the vision i.fs of Fig. 2.

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.

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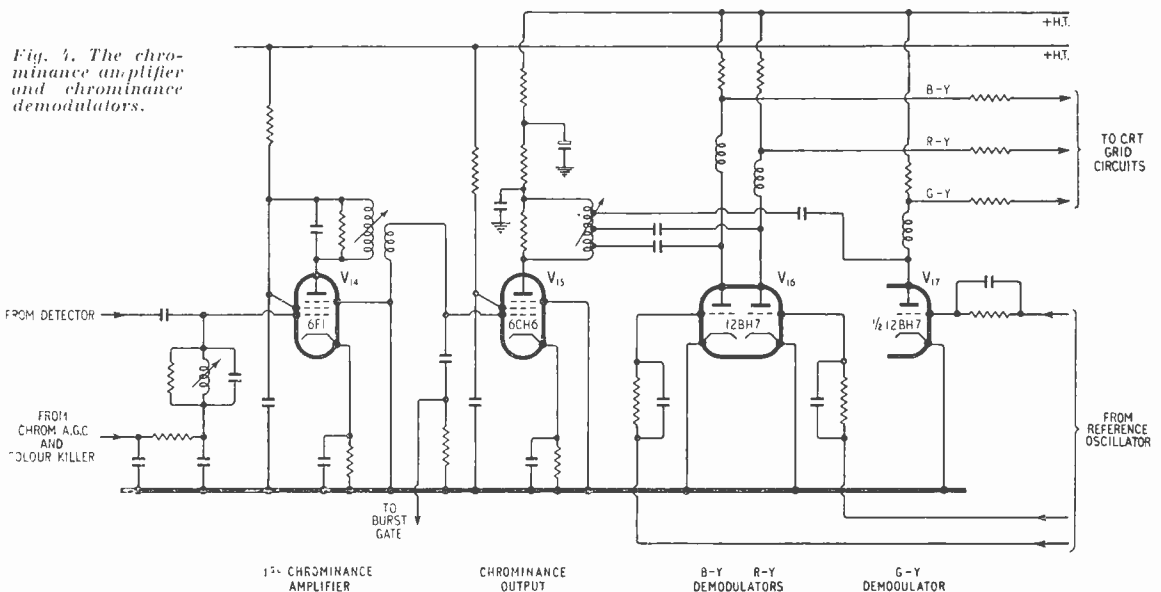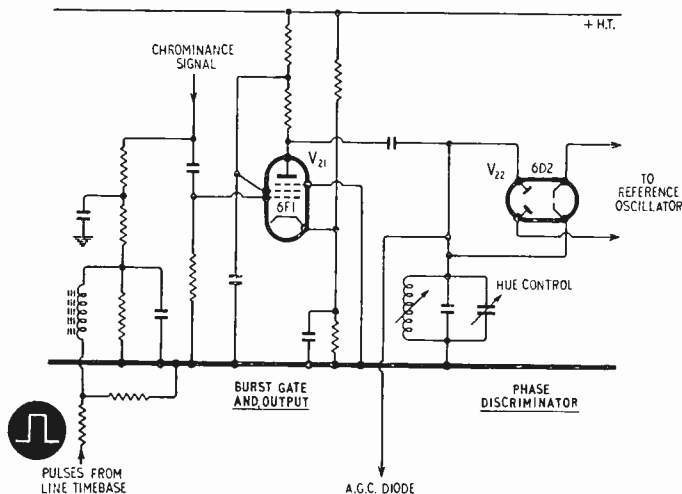
Fig. 5. The burst gate and phase discriminator.

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 trans-formed 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 band-width of the demodulator is made more than that of the " Q " signal, so direct demodulation of the signal automatically implies a colour band-width 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 demo-dulation 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 cir-cuit 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 appro-priate R-Y, B-Y and G-Y signals in the appro-priate phases to the three grids. At one stroke this system avoids all the chrominance video amplifiers that would otherwise be necessary, 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

** G.G. Gouriet, "An Introduction to Colour Tele-vision", Norman Price Publications. Also "Trans-mitting Colour Information", Wireless World, Aug. 1955.

of the system of demodulation chosen, its band-width 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.
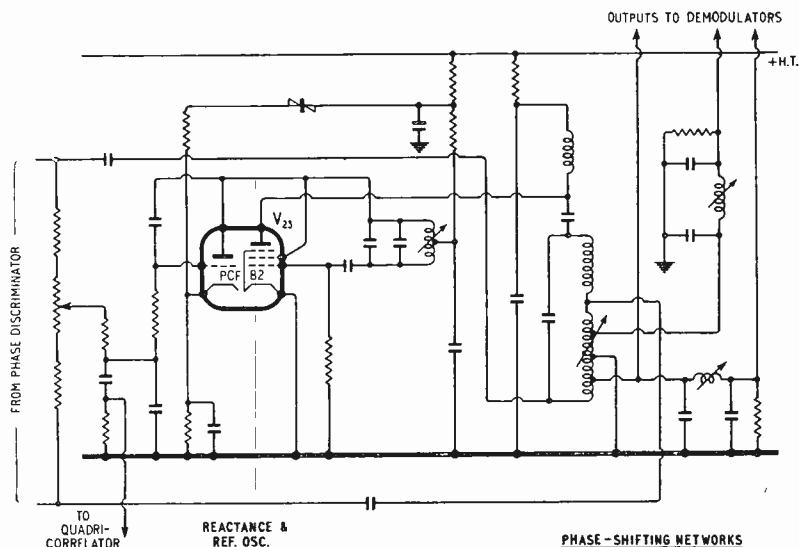

OUTPUTS TO DEMODULATORS

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.*

†† *Proc. I.R.E.* Convention Record Part 1, pp. 3-17, Jan., 1954. 2nd. Colour Issue, pp. 106-133.

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.

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 10μV 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.
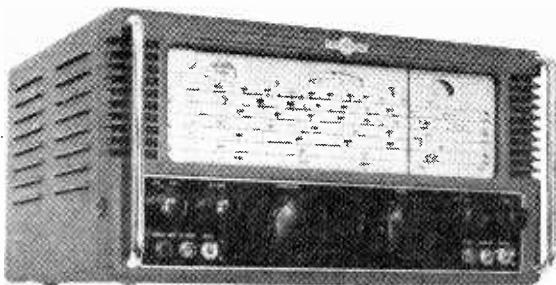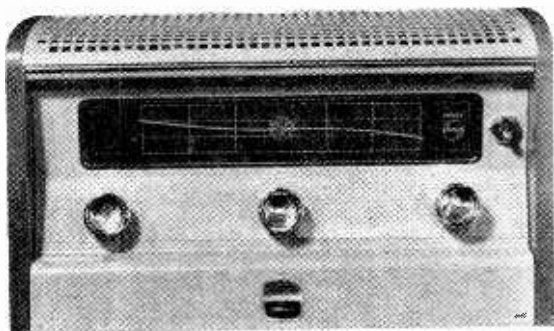
A visual tone control indicator in the form of a variable response curve is incorporated in the AG9000 amplifier, which forms part of the Philips "Novosonic" sound equipment.

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 graticule 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 complete 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)
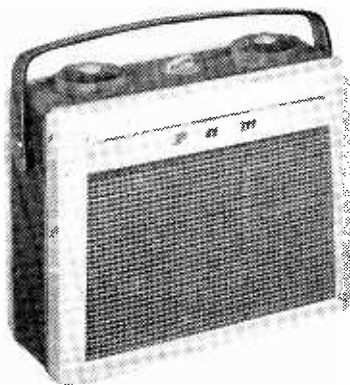
Pam transistor portable radio receiver (Model 710).

on medium and fixed tuning (1500 metres) for the long-wave Light Programme.

The circuit employs eight transistors and the sequence is as follows: 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
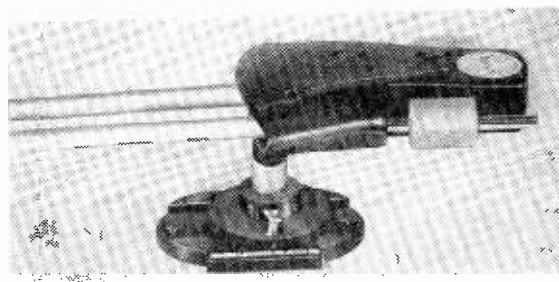
Adjustable counterweights and calibrated pedestal slide in the B.J. "Super 90" pickup arm.

Burne-Jones and Company Limited, Magnum House, Borough High Street, London, S.E.1.

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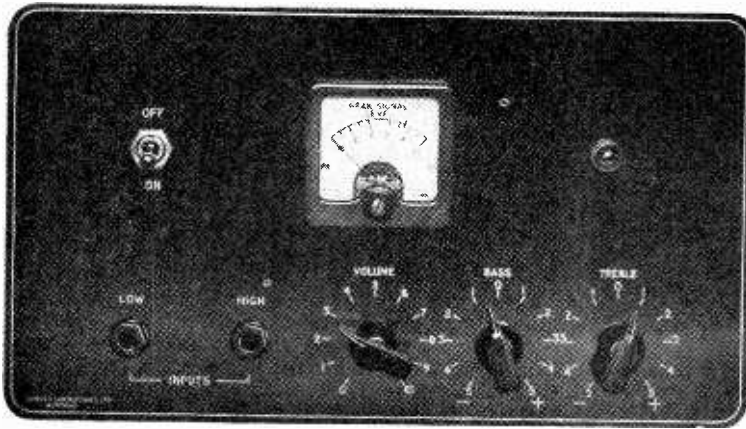
Control panel showing level indi- cator, main switch, pilot lamp, high and low-level inputs and the volume and tone controls.

MAGNETIC

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 includ- ed 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 pro- fessional 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 fre- quency 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 ".
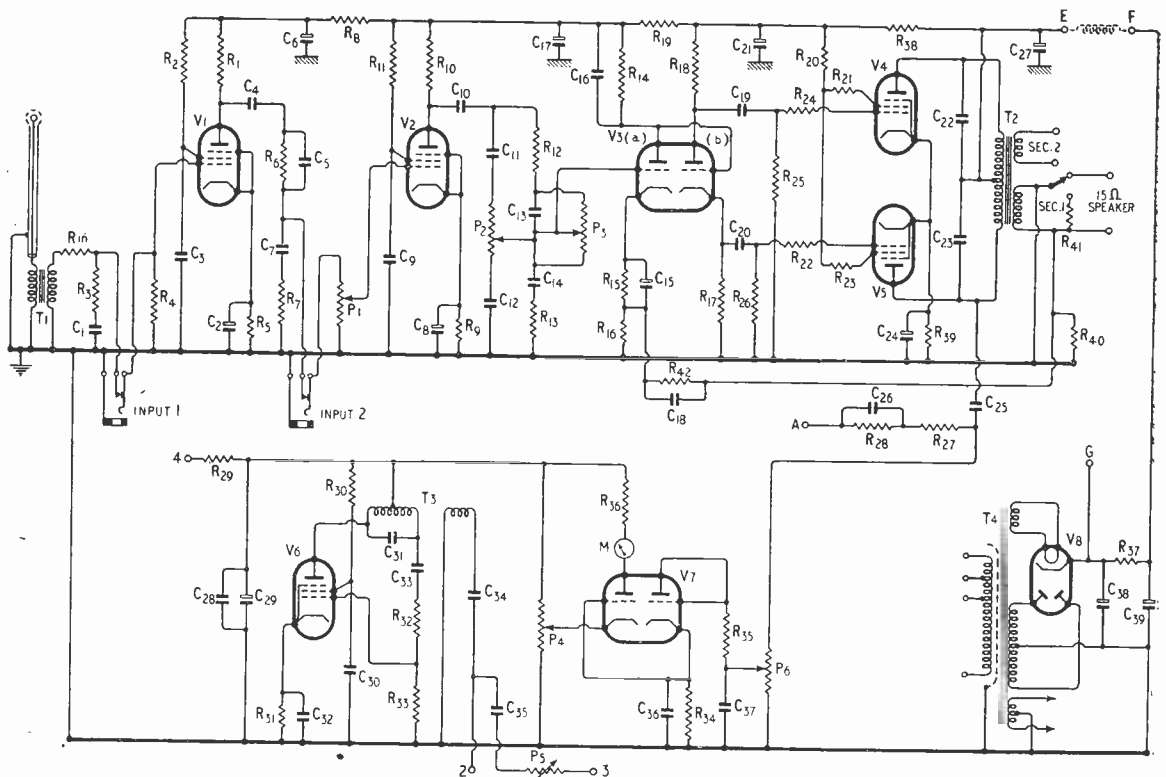
TAPE AMPLIFIER

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_{1n}, 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_{1n} 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 preamplifier, 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_{1n}	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_{29}	50 µF
C_{30}	50 µF

Potentiometers

P1	500 kΩ, log.
P2	2 MΩ, log.
P3	2 MΩ, log.
P4	1 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).
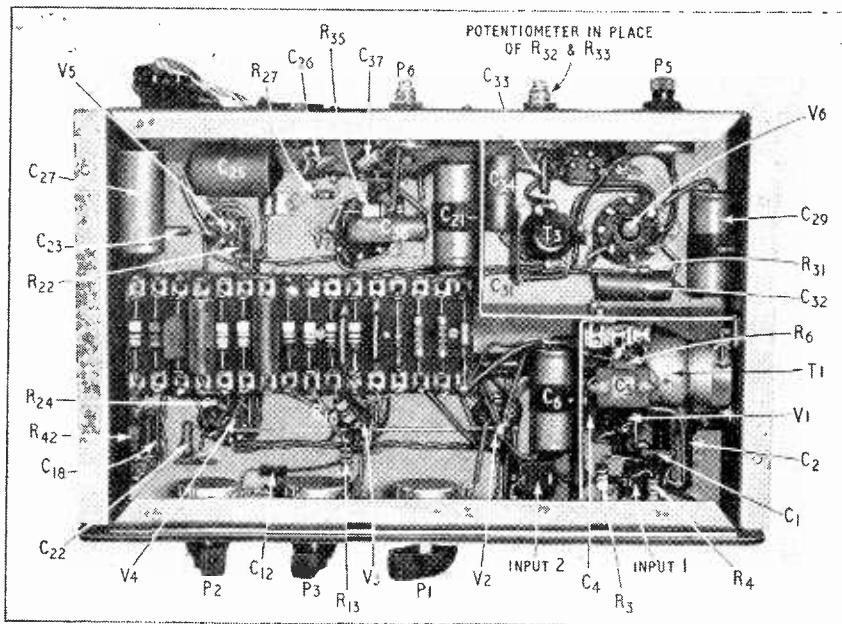
Underside of chassis, showing positions of the principal components. Only the output transformer, and, of course, the valves appear on the top of chassis. From left to right the components on the tag board are: R_{29}, R_{26}, R_{30}, C_{19}, R_{23}, R_{26}, C_{20}, R_{18}, R_{17}, R_{15}, C_{16}, R_{14}, C_{11}, R_{12}, R_{15}, R_{11} and R_{3}.

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.

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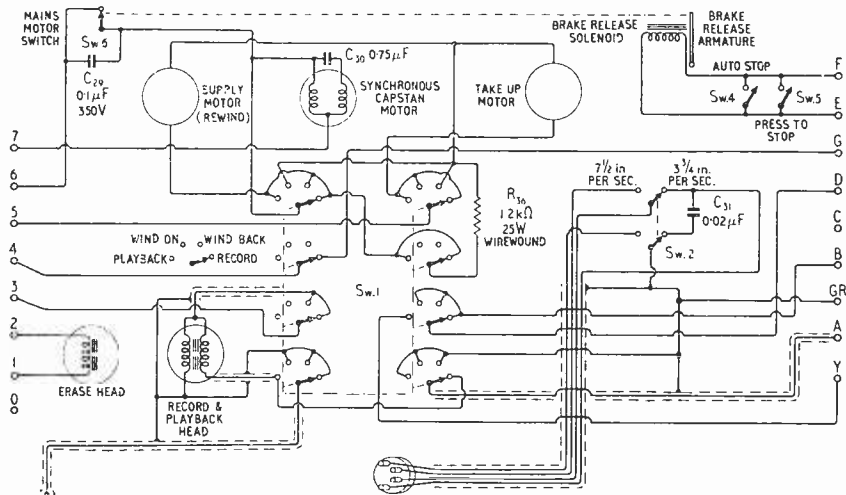 approximately in the middles of rotation. V3(a) is a voltage amplifier, direct coupled to V3(b) phase-splitter. Negative feedback is

applied to the cathode of V3(a) via R_{42} and R_{18}, 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 sinewave 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_{30}, 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_{17}, C_{18} 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

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_{29} 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_{29} be of high power-factor. P_3 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 unsual for a class AB₁ supply. The large values of C_{38} and C_{39}, however, tend to keep the voltage across C_{30} 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 1½-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_5, 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
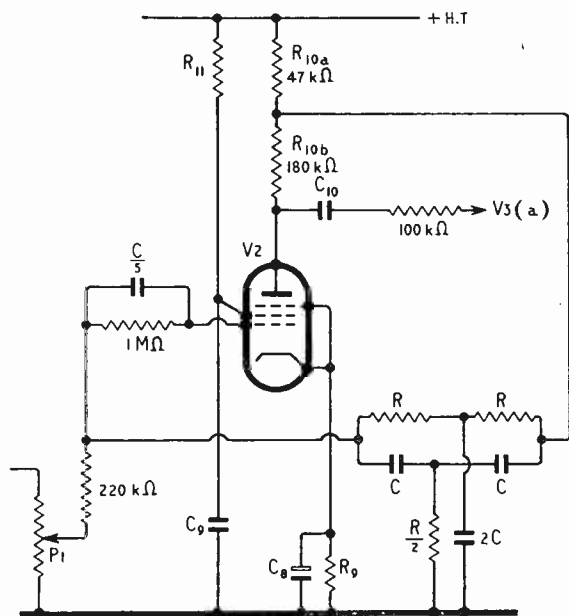

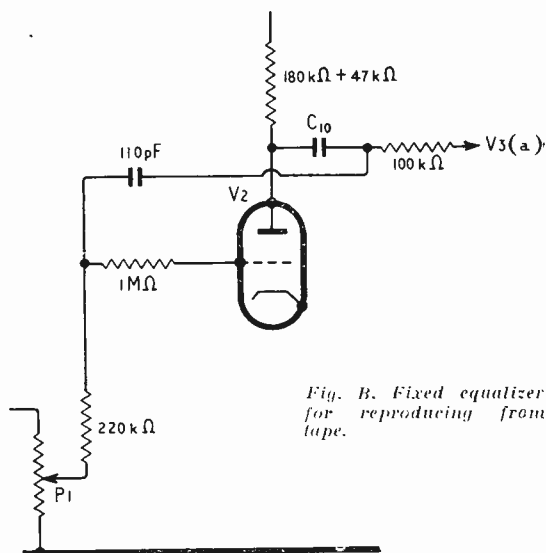Fig. A. *Alternative high-frequency pre-emphasis circuit for recording.*

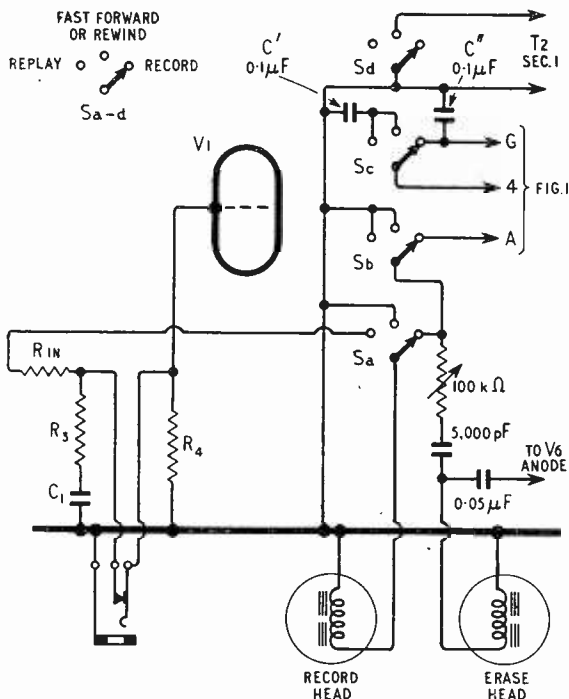Fig. B. *Fixed equalizer for reproducing from tape.*

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. All 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 $f = \dfrac{1}{2\pi RC}$, or more conveniently $\dfrac{159}{R(k\Omega) \times C(\mu F)}$. 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_{31} and C_{32} 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 $12 \times 9 \times 3\frac{1}{2}$ in and weighs 4 lb.
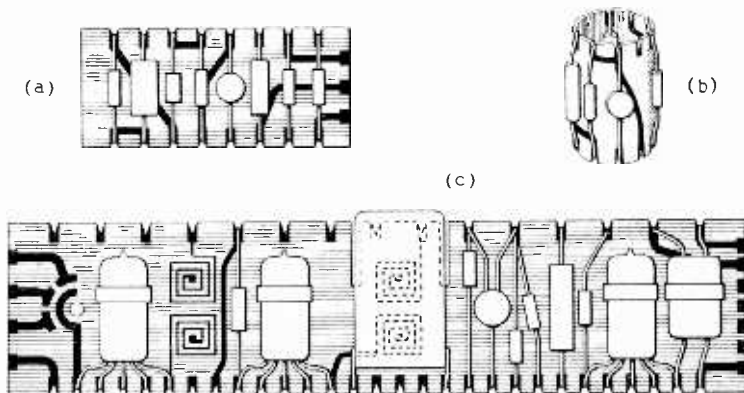

Development in Printed Circuitry

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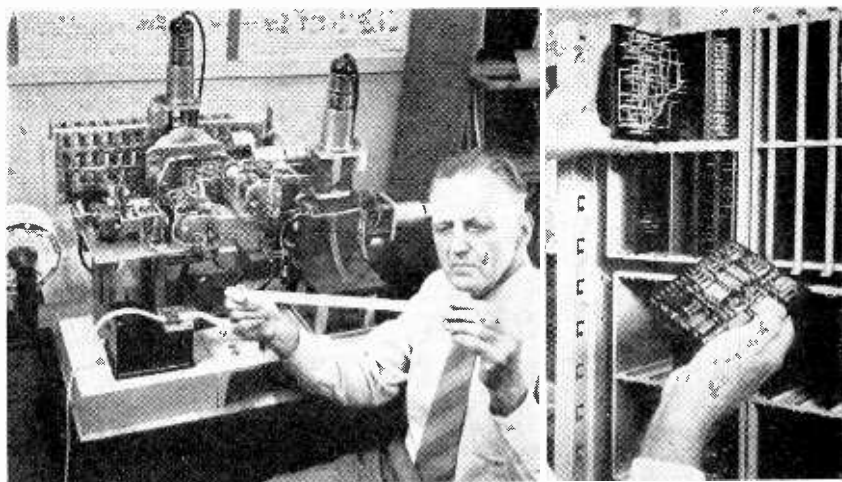
* *B.S.T.J.* Vol. 32, p. 523 (May 1953).

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

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	**Al**fa	Alfa	Able	Amsterdam
B	**Bra**vo	Bravo	Baker	Baltimore
C	**Char**lie	Coca	Charlie	Casablanca
D	**Del**ta	Delta	Dog	Danemark
E	**Ec**ho	Echo	Easy	Edison
F	**Fox**trot	Foxtrot	Fox	Florida
G	**Golf**	Golf	George	Gallipoli
H	**Ho**tel	Hotel	How	Havana
I	**In**dia	India	Item	Italia
J	**Ju**liet	Juliet	Jig	Jerusalem
K	**Ki**lo	Kilo	King	Kilogramme
L	**Li**ma	Lima	Love	Liverpool
M	**Mike**	Metro	Mike	Madagascar
N	No**vem**ber	Nectar	Nan	New York
O	**Os**car	Oscar	Oboe	Oslo
P	**Pa**pa	Papa	Peter	Paris
Q	Que**bec**	Quebec	Queen	Quebec
R	**Ro**meo	Romeo	Roger	Roma
S	**Si**erra	Sierra	Sugar	Santiago
T	**Tan**go	Tango	Tare	Tripoli
U	**Uni**form	Union	Uncle	Upsala
V	**Vic**tor	Victor	Victor	Valencia
W	**Whis**ky	Whisky	William	Washington
X	**X-ray**	Extra	X-ray	Xantippe
Y	**Yan**kee	Yankee	Yoke	Yokohama
Z	**Zu**lu	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
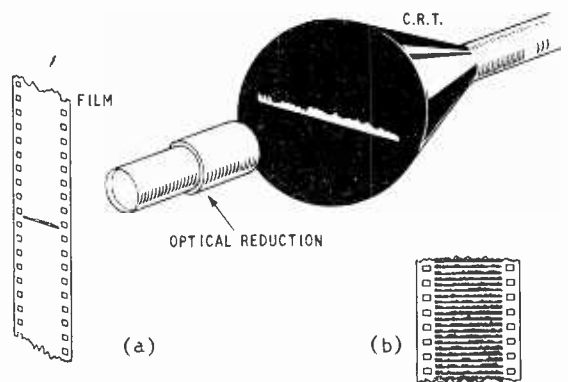

Fig. 1. (a) Essentials of the proposed recording system, with (b) showing how successive traces would appear on the film.

* 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
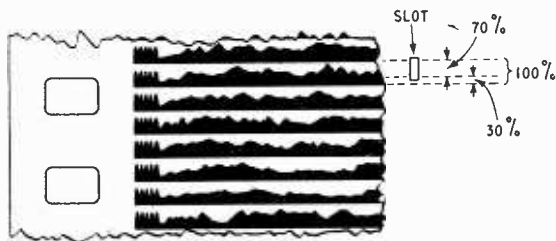

Fig. 2. Magnified section of the film showing the position of the recording slot (right) relative to the traces it produces.

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.

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

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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

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.*
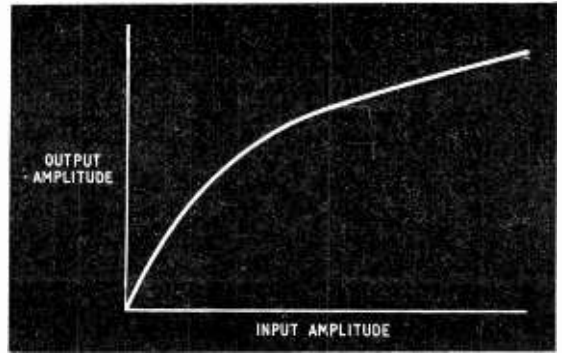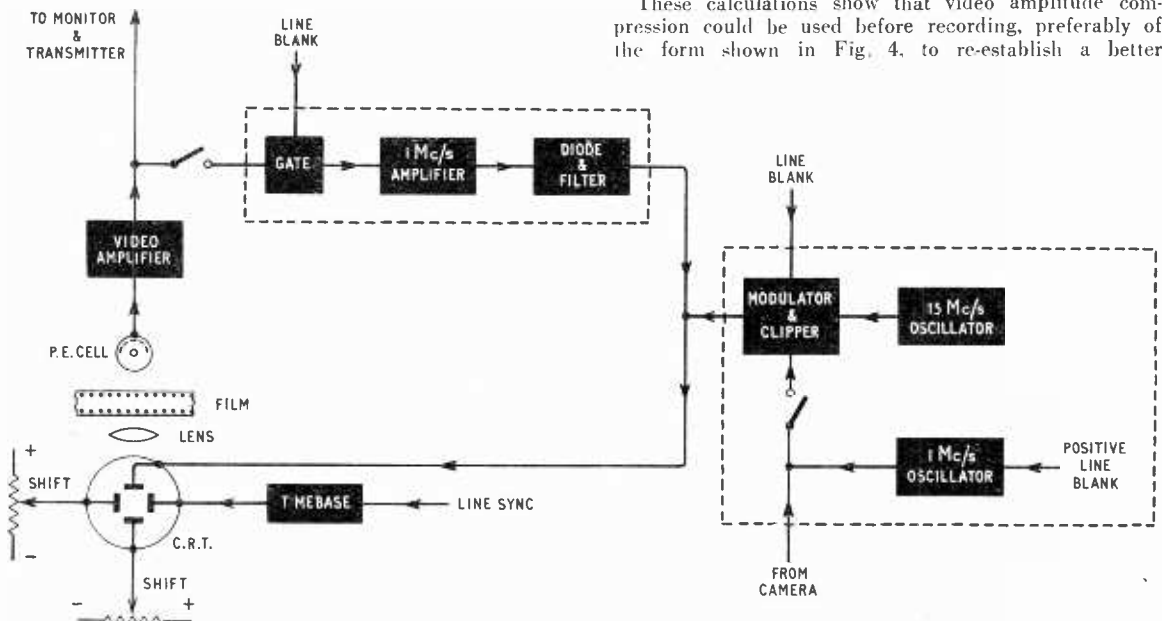

Fig. 4. *Recording characteristic with video amplitude compression.*

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.

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

TO MONITOR & TRANSMITTER

LINE BLANK

GATE — 1 Mc/s AMPLIFIER — DIODE & FILTER

VIDEO AMPLIFIER

P.E. CELL

FILM

LENS

SHIFT

C.R.T.

SHIFT

T/MEBASE — LINE SYNC

LINE BLANK

MODULATOR & CLIPPER — 15 Mc/s OSCILLATOR

1 Mc/s OSCILLATOR

POSITIVE LINE BLANK

FROM CAMERA

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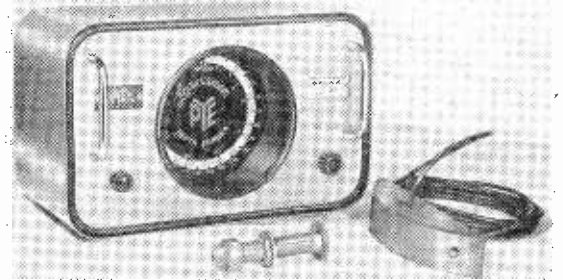
Pye "Leadsman" echo sounder with transducer and hull gland. The overall dimensions of the unit are approximately 13 3/4 in × 8 1/2 in × 7 3/4 in.

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.

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.
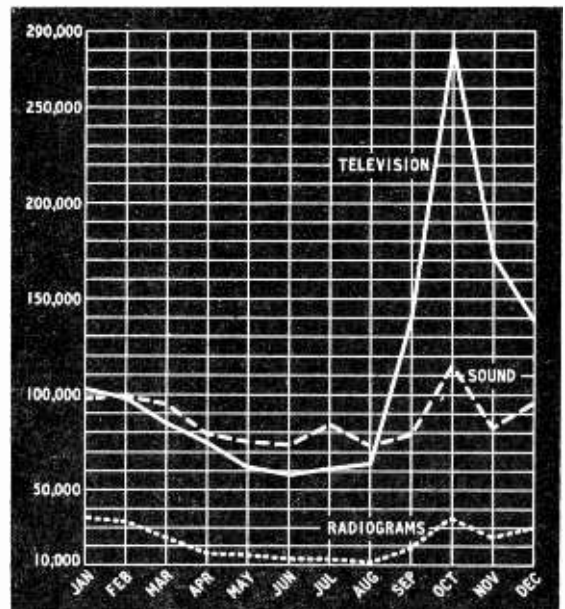
RECEIVER SALES. — A summary of the retail sales of domestic receivers during 1955, issued by the British Radio Equipment Manufacturers' Association, reveals that by comparison with 1954 the total sales of television receivers rose by 6% to 1,335,000. The sale of sound receivers fell by 11% to 1,048,000, 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; "$+$", "$\div$", "$\sqrt{}$", 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.

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

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

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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

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

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

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

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

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

** "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*
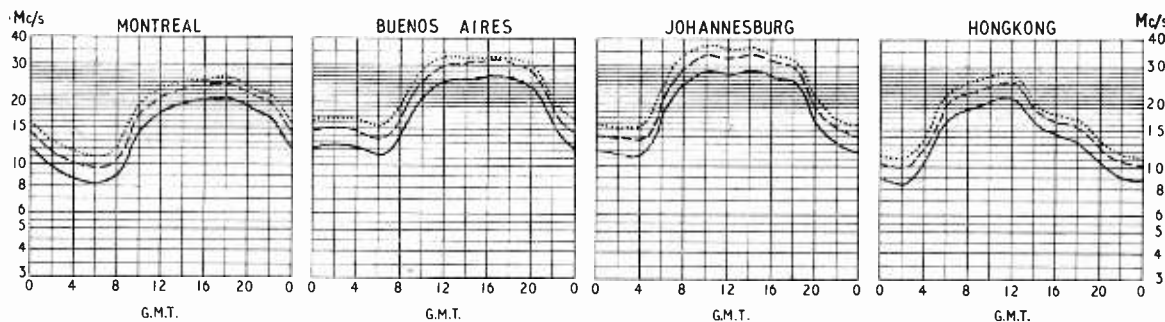
THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during March.
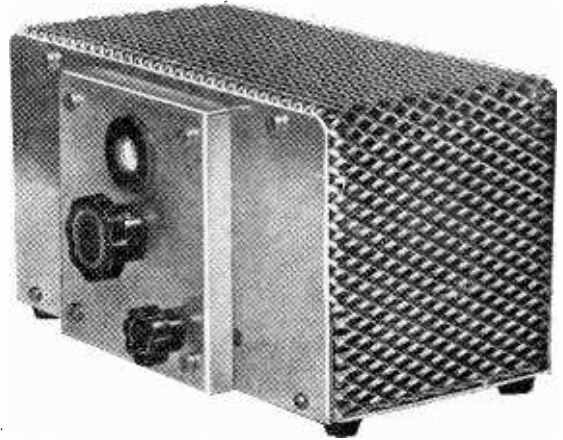
Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

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

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

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

Simplified Band III Convertor

DESIGN FOR USE IN AREAS OF HIGH SIGNAL STRENGTH

By O. E. DZIERZYNSKI

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

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.

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_0) 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
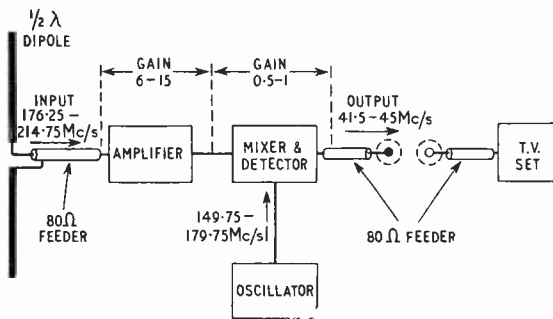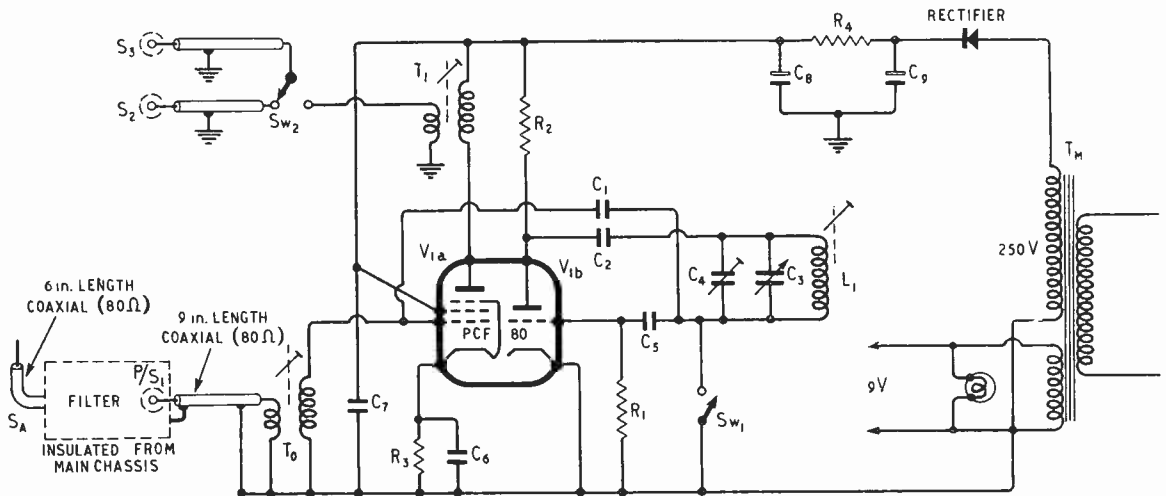
Fig. 1. Block schematic diagram of a conventional Band-III convertor.

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} 3-30 pF air-spaced con-
C_{12} centric trimmer (Mullard).

C_{13}, C_{14} 2-15 pF air-spaced trim-
C_{17} mer.

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).

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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_o 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_o. 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

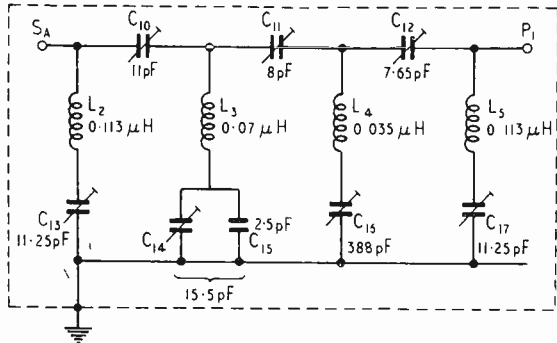| Pos.	Function	Details
L_1	Oscillator	1½ turns No. 18 s.w.g. En wire on ¼in dia (approx.) polystyrene former with turns spaced ¹/₁₆in. Core, dust iron.
T_o	Band-III input trans.	1½ turns No. 18 s.w.g. En wire ¼in dia polystyrene former with turns spaced ¹/₁₆in. Core: dust iron.
T_1	Band-I output trans.	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 × 1⅜ in high.
L_2-L_6	Filter coils 0.113 μH	3½ turns No. 20 s.w.g. spaced to fill ³/₁₆in 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 ⅛in 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.

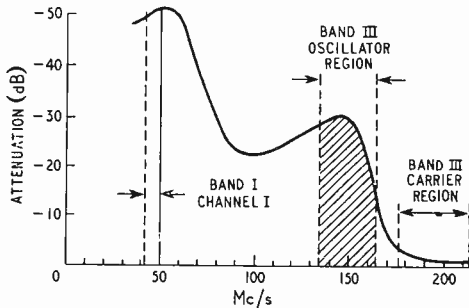Fig. 3. Circuit diagram of the filter unit.

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_1 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:—

$F_{min} = 174 - \text{Band-I channel (Mc/s)}$
$F_{max} = 216 - \text{Band-I channel (Mc/s)}$

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.

www.americanradiohistory.com
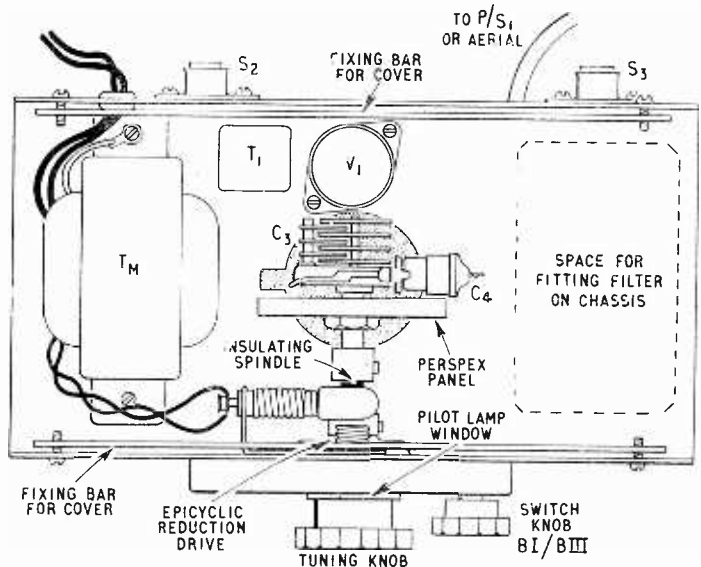
almost any value and the behaviour of the filter will be unpredictable and not quite as shown in Fig. 4. In order to compensate for impedance mismatch of this kind with a short aerial a piece of 80-ohm coaxial catch is interposed between the aerial and the filter. With a 14-in rod a 6-in length of cable 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 $3\frac{3}{8}$ in $\times$ 2in and is housed in a screening box measuring 4in $\times$ $3\frac{1}{2}$ in $\times$ $1\frac{7}{8}$ 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.

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.

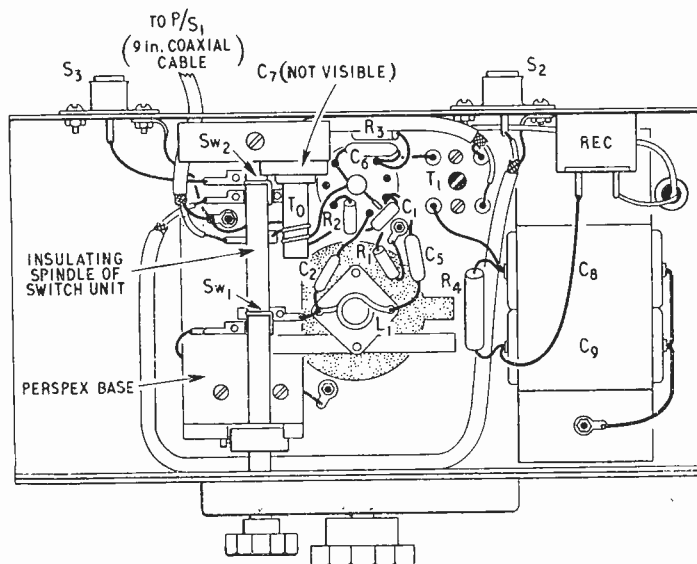Figs. 5 and 6 are largely self-explanatory but possibly a few points may need clarifying. The
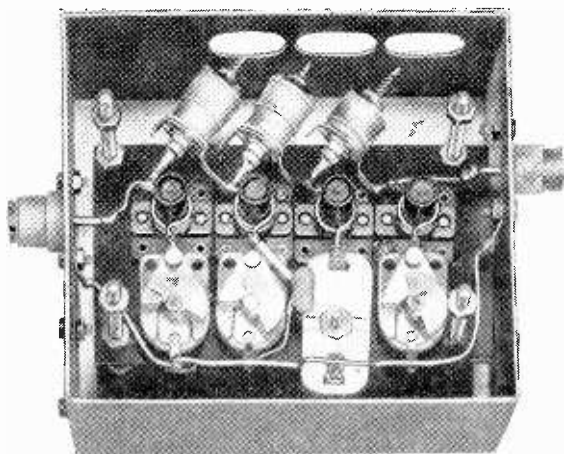
View showing the layout of parts comprising the filter unit.

shaded area below C_3 and C_1 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_1 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.

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.

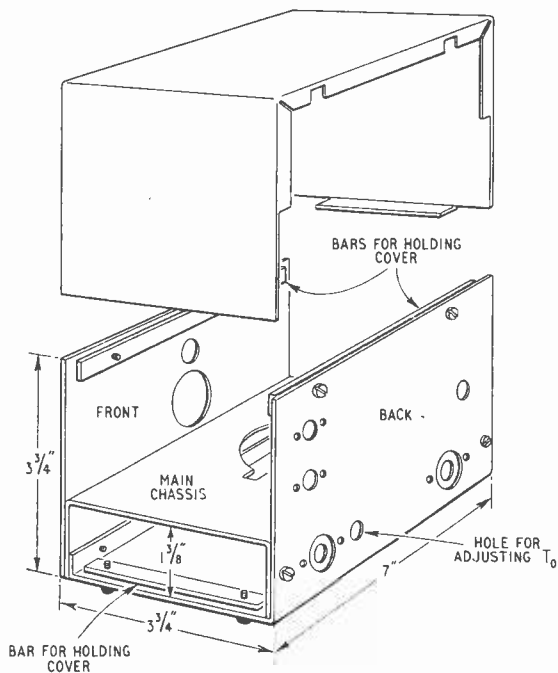*Fig. 6. Layout of parts on the under side of the chassis.*

BARS FOR HOLDING COVER

FRONT

BACK

MAIN CHASSIS

3¾"

1⅜"

3¾"

HOLE FOR ADJUSTING T₀

7"

BAR FOR HOLDING COVER

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

Fig. 8. Details of aerial change - over switch SW₂; SW₁ is built on to the same rod.

A○ ○B
C

Fig. 9. Details of the Perspex panel supporting the oscillator tuning capacitor C₃ and padder C₄.

THICKNESS OF ALUM. SHEET

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 ¼ in diameter rod is used it can be supported in ¼ in (hole diameter) panel bushes and ¼ in collars (with fixing screws) used to prevent

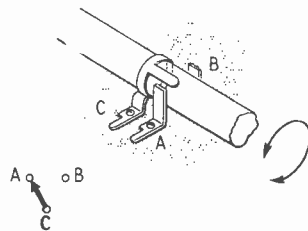end-play. The SW_1 section of this switch need have only one contact (A or B) as it is an on/off, not a change-over switch.

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_{14} inclusive) on a bridge to the values

SIGNAL GENERATOR
40–220 Mc/s

UP TO 200 mV OUTPUT

200 Ω

F

200 Ω

SHORT LEADS UP TO 2"

(a)

100 μA
1k Ω

1,000 pF

GD4

R.F. CHOKE
20 TURN No. 30 s.w.g. d.s.c
CLOSE WOUND ON ¼ in FORMER

METER SCALE (μA)

100

50

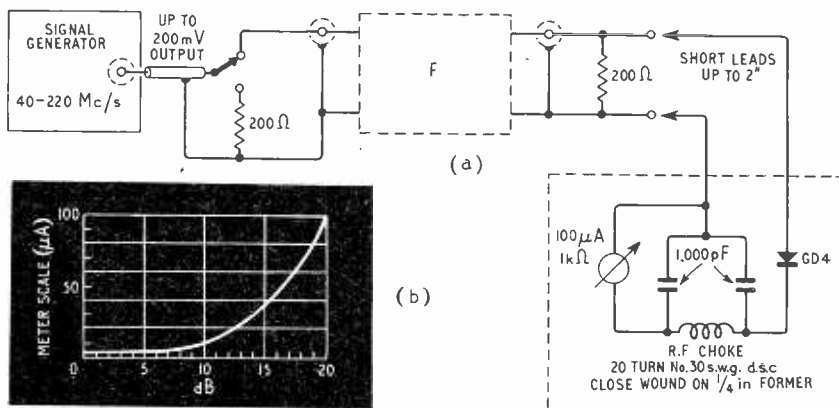0   5   10   15   20
dB

(b)

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

138

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.

<div align="right">P. J. WALKER.</div>

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.
<div align="right">E. DE BOER.</div>

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.,
<div align="right">A. H. ELLSON,</div>
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.
<div align="right">F. J. WYLIE,</div>
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.
<div align="right">ROBERT C. BELL.</div>

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.
<div align="right">E. J. YOUNSON.</div>

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

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_7 (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.*
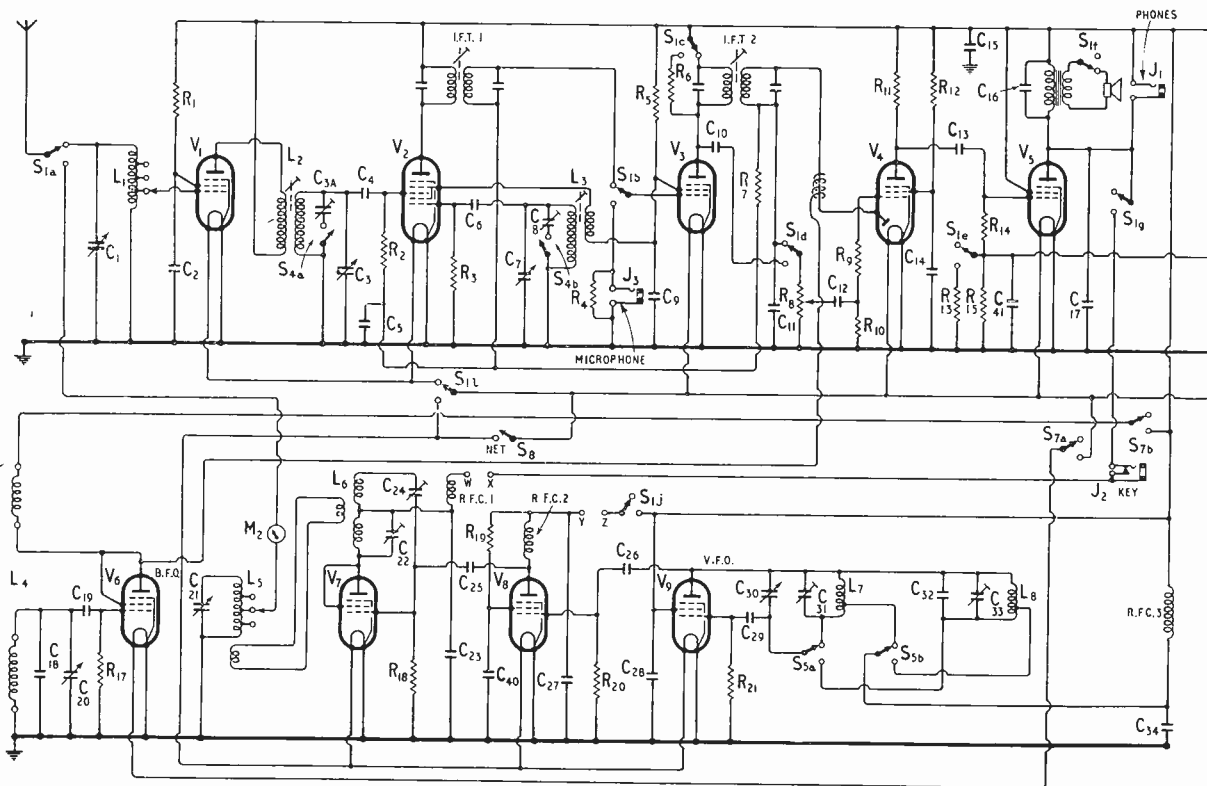
LIST OF COMPONENTS

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_9, 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_4, C_{3A}	250 pF ceramic padder (Cyldon)
C_4, C_6, C_{11}, C_{19}, C_{23}	100 pF 200 V wkg.
C_5	0.1 µF 200 V wkg.
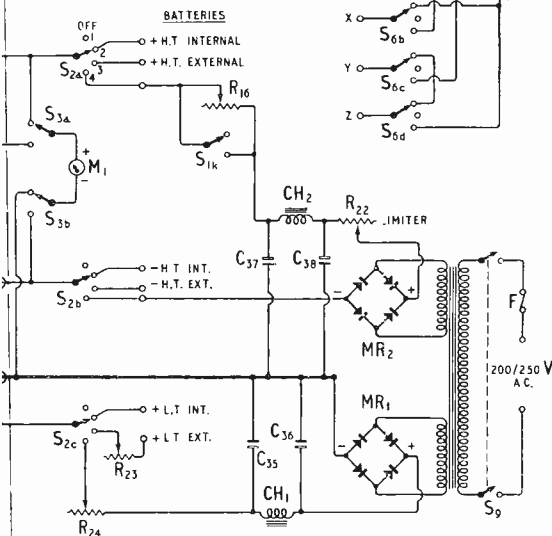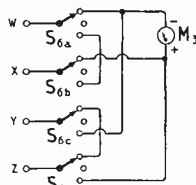
C_{12}, C_{16}, C_{17}	0.005 µF 200 V wkg.
C_{15}	2 µF 200 V wkg.
C_{18}	140 pF silver mica
C_{20}	15 pF air-spaced variable (Eddystone 580)
C_{24}	3/30 pF trimmer (Phillips)
C_{25}, C_{26}	0.001 µF silver mica
C_{27}, C_{28}, C_{34}, C_{40}	0.001 µF 200 V wkg.
C_{29}	300 pF silver mica
C_{41}	25 µF 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 1FT11) (1FT1, 1FT2)
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. 23 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 AD1)
1	H.T. battery 120 V (Ever Ready " Winner ")
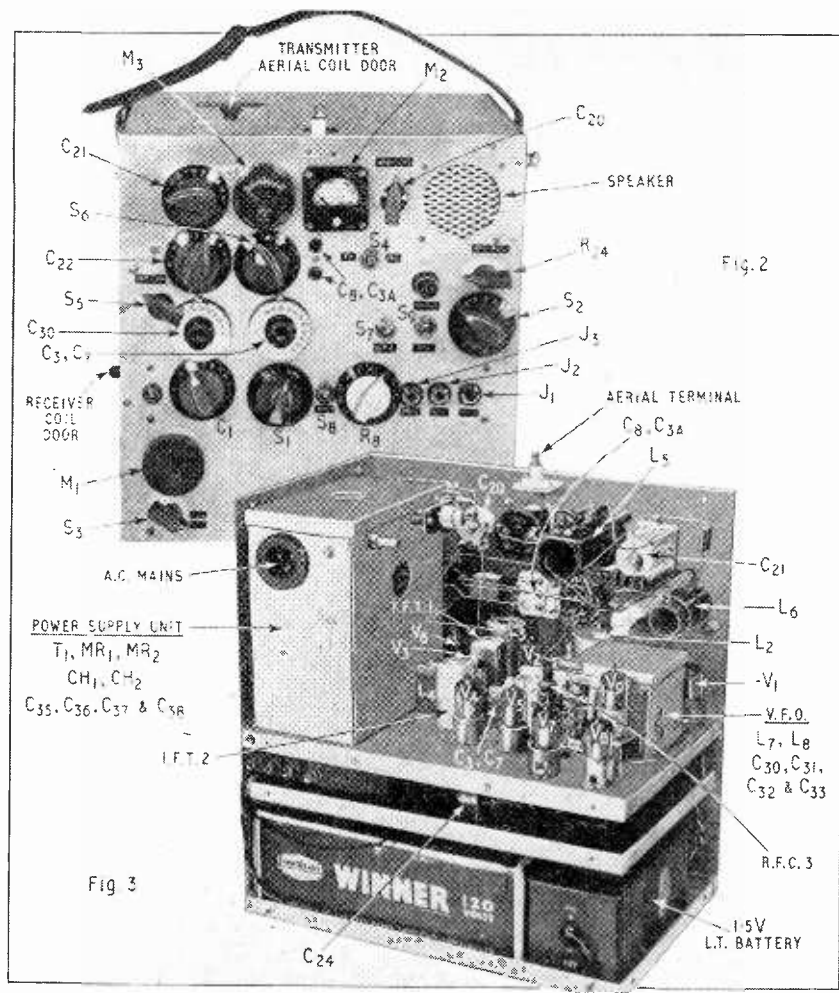
Fig. 2. Front panel of the unit showing the position of the various controls.

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

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_0) 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, on 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.

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

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.

144
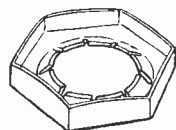
Ionosphere Review 1955

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

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* British Broadcasting Corporation.

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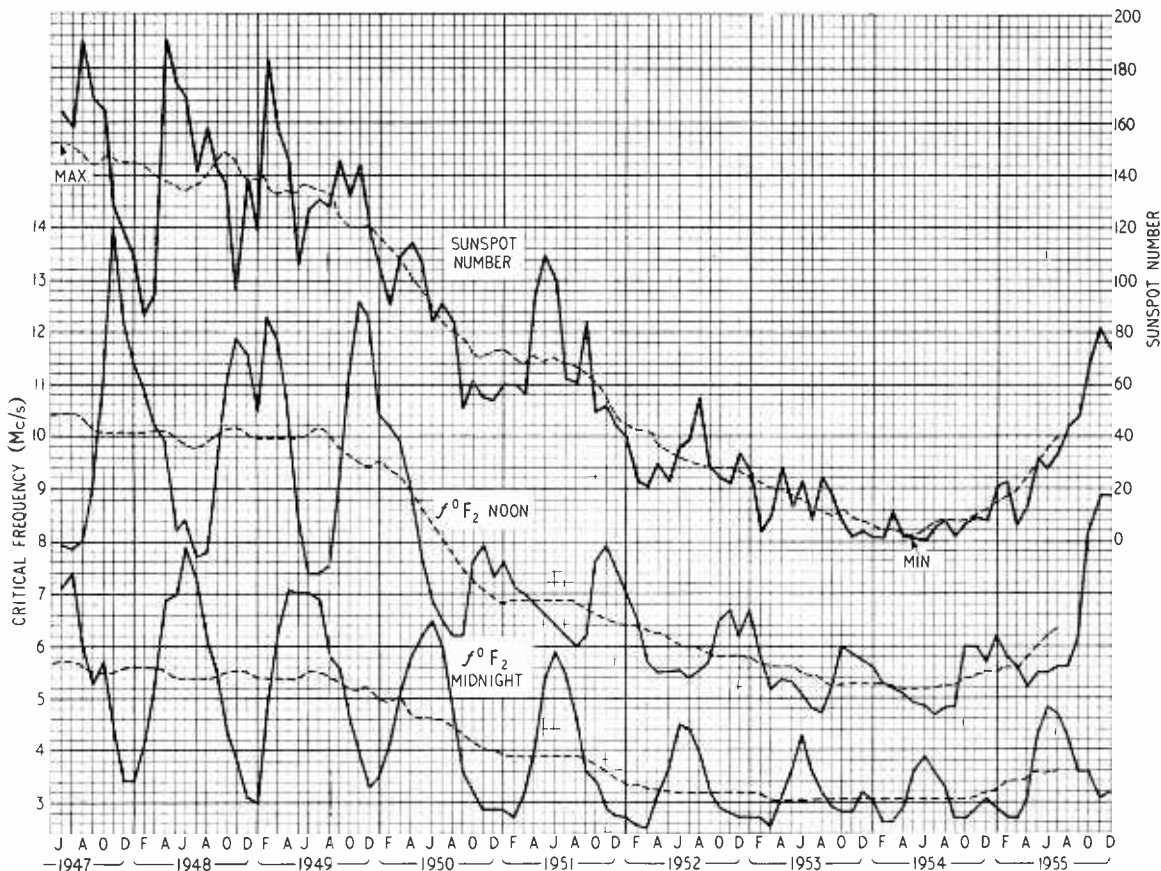
illustrate the dependence of conditions in the ionosphere upon the activity of the sun, which produces it. The maximum usable frequencies for short-wave communication are directly related to the F_2 layer critital frequency, and may thus be assumed to vary in a like manner to the variations shown.

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.

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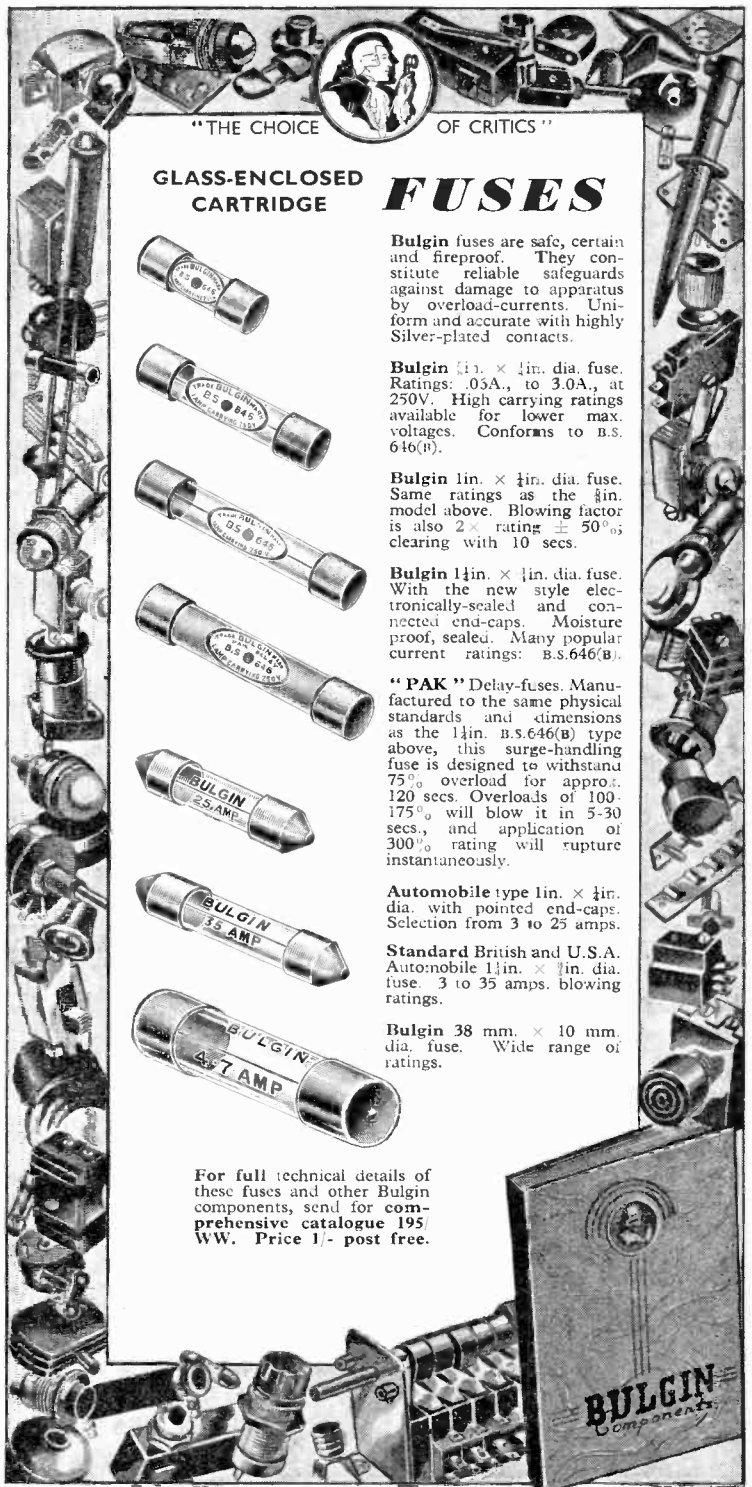
Then the little Hiawatha
Took a correspondence course.
Studied often, in his wigwam,
Kirchhoff's laws and lines of force.
Wouldn't stop for Minnie-Ha-Ha,
Tempting him with breathless sighs,
Had to learn to solve quadratics;
Had to learn to factorize.

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,
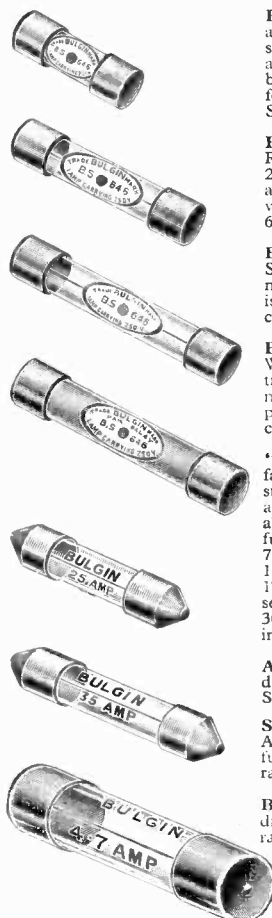Couldn't cut a crystal axis
With a broken tomahawk.

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)

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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
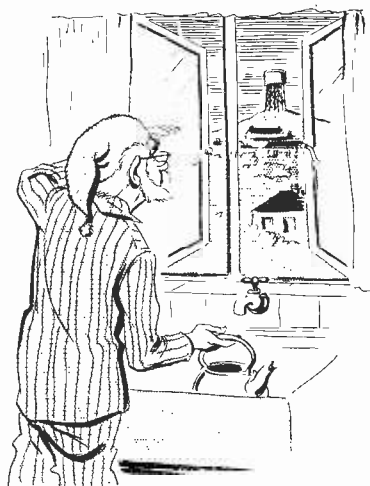
Watching and waiting.

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.

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.