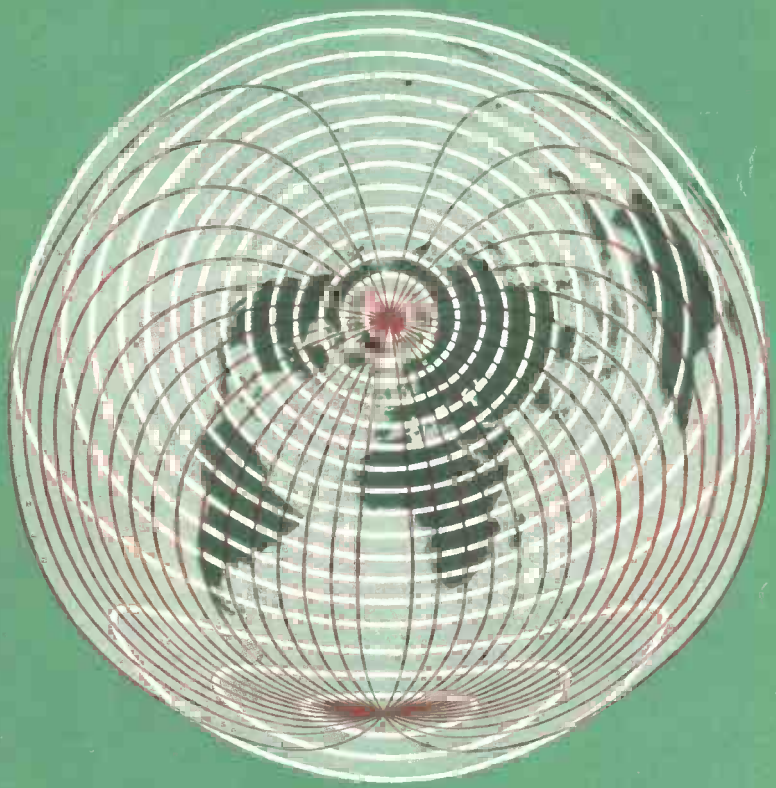
APRIL 1957

TWO SHILLINGS

Wireless World

ELECTRONICS
Radio · Television



FORTY-SEVENTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

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

APRIL 1957

In This Issue

VOLUME 63 No. 4

PRICE: TWO SHILLINGS

FORTY-SEVENTH YEAR OF PUBLICATION

Editorial, Advertising and Publishing Offices:
Dorset House, Stamford Street, London, S.E.1

Telephone:
WATerloo 3333 (60 lines)

Telegraphic Address:
"Ethaworld, Sedist, London".

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD. Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Iliffepres, Sedist, London." *Annual Subscription:* Home and Overseas, £1 12s. 6d. U.S.A. and Canada $5.00. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10 Corporation Street. *Telephone:* Coventry 5210. *GLASGOW:* 26B Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. OVERSEAS OFFICES: *U.S.A.:* 111 Broadway, New York, 6, N.Y. *Telephone:* Digby 9-1197. *CANADA:* 67, Yonge Street, Toronto, 1, Ontario. *Telephone:* Empire 6-0873

EDITORIAL COMMENT

Wireless World

APRIL
1957

Vol. 63 No. 4

TRUER THAN THE TRUTH

As is shown in the article "Seeing and Hearing" in this issue, the mere avoidance of distortion, hitherto one of the main objects of the communications engineer, is by no means the end of the story. As Dr. Colin Cherry, the author, points out, the classical and mechanistic approach to the problem often ignores the real purpose of a communication system, which is to transmit information from person to person. Human beings cannot be modified to fit them into a communications chain; obviously the alternative is to modify the characteristics of the chain to suit their psychological needs.

The idea that art (which may be crudely defined as faking) can improve on nature (represented by fidelity of the transmitted signal) is not new. Long before the days of "hi-fi" Rudolf Pfenniger produced "caricature" sound effects which certainly succeeded in evoking the desired reactions in the listener's mind much more effectively than the most perfectly reproduced natural sounds. A good caricature is often truer than the truth. Corresponding improvements are possible in the visual transmission of information. For example, F. H. Brittain recently showed at an I.E.E. discussion meeting that a desired piece of information could be much more efficiently conveyed by a sketch in a few bold lines than by a highly detailed photograph. The sketch could have been transmitted recognizably by the Baird 30-line television system with a bandwidth of a few kc/s; the photograph, with all its redundant information, would need many Mc/s.

ELECTRONICS UP TO DATE

Ordinary English words sometimes change their meanings drastically, but usually such changes take many years—even centuries. The technical terms with which *Wireless World* and its readers are concerned may change much more rapidly. It now seems that the meaning of the word "electronics" is undergoing one of those quick changes.

A year or two ago, everything was simple enough. Among the less pedantic practitioners of the art, electronics was defined roughly as "radio-like techniques and devices, especially valves, applied to non-communication purposes." In more academic circles the accepted definition was the one originally put forward by the American Institute of Electrical Engineers and recently given world-wide currency in revised form in the 1956 International Electrotechnical Vocabulary: "That branch of science and technology which deals with the conduction of electricity in a vacuum, a gas and in semi-conductors, and with the utilization of devices based on these phenomena." According to that definition radio technology should rationally have been regarded as merely a branch of electronics, but there was a widespread conspiracy —or tacit understanding—to keep the two apart.

The sharp distinction commonly drawn between "radio" and "electronics," irrational though it was, may have served a useful purpose in the days when electronic devices for non-communication purposes were novelties. Now, most components and many techniques are freely interchangeable between the communications and non-communication branches of electronics; many of the practitioners are equally at home in either.

Transistors in Television

POINTERS AT THE TELEVISION SOCIETY'S EXHIBITION

THE ultimate aim of a transistorized television set does not seem quite so remote, now that radio-frequency and power transistors are coming on to the market—though it will be some time before the necessary types for amplification at v.h.f. become available. Some evidence of progress in this direction was to be seen at the recent Television Society's exhibition held in London. G.E.C., for example, were showing an experimental television receiver in which both the line and frame timebase oscillators were transistorized and also the respective sync separators. Moreover, a power transistor was used for the frame output stage.

Fig. 1 shows the transistorized part of the circuit. V1 is the line sync separator and V2 the frame sync separator and clipper, both of these transistors being experimental p-n-p types. The line timebase, V3, is an n-p-n transistor arranged in a blocking oscillator circuit. It gives a positive-going sawtooth waveform of about 45 V peak-to-peak which is used to drive the thermionic-valve line output stage. The frame timebase, V4, is also a blocking oscillator circuit, and it drives the frame output stage V6 through a buffer amplifier V5—all these transistors being experimental p-n-p types. With a supply tension of 30 V, the total consumption of the transistorized section is approximately 160 mA.

Although no transistors are available in this country for amplification at v.h.f., at least some appear to be working satisfactorily as oscillators at these frequencies—as was evident from two pieces of experimental test gear at the Show. The Ferguson transistorized pattern generator illustrated in Fig. 2 gives either a plain video signal (of 7 V peak-to-peak maximum) or a video-modulated r.f. carrier (of 50 mV r.m.s.) at a frequency of 56.75 Mc/s (Channel 3). The r.f. carrier is produced in a section containing two transistors with alpha cut-off frequencies of at least 30 Mc/s, and is crystal-controlled to maintain frequency stability. The remaining 39 transistors are divided between 21 types with an $f_{c\alpha}$ of 500 kc/s and 18 types with an $f_{c\alpha}$ of 5 Mc/s. The actual pattern produced by the generator is a black-on-white graticule, plus the normal synchronizing waveform. It has a fixed number of horizontal bars, while the number of vertical bars can be varied.

As can be seen from Fig. 2 the construction takes full advantage of the smallness of the transistors by using a number of printed circuit panels, which can be removed individually for servicing. The first panel carries a master video oscillator and mains locking circuit, the second a frequency divider chain, the third the sync waveform generators, while the fourth produces the complete video signal and the fifth generates the modulated r.f. signal. Power is supplied by 13.5-V dry batteries and the total consumption is only 650 mW. The weight of the instrument, including batteries, is $4\frac{1}{2}$ lb.

The other transistorized test instrument on show was a wobbulator, giving an r.f. output of 0.1 V in the television i.f. range of 31-41 Mc/s. Developed by Philco, it uses the well-known surface-barrier transistor for the r.f. oscillator (actually a Hartley circuit). The frequency of the oscillator is swept through the required range by a triangular waveform, which varies the permeability of a ferrite rod core

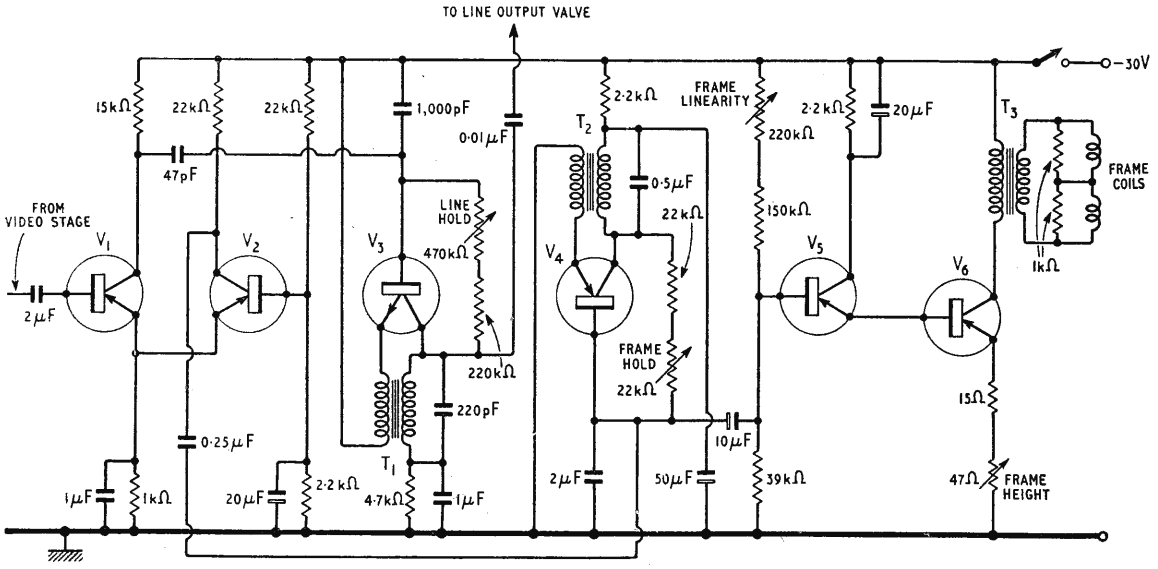


Fig. 1. Transistorized section of televison receiver shown by G.E.C. Note the use of an n-p-n transistor for V3

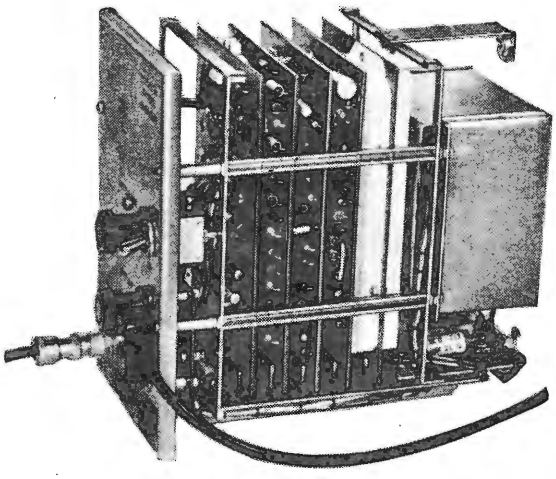


Fig. 2. Five printed-circuit boards are used in the Ferguson transistorized pattern generator, which measures only 7½in x 6¾in x 4¼in

in the oscillator coil. A multivibrator using two OC71 transistors provides the basic waveform for synchronizing the external oscilloscope and the triangular waveform generator (which also has two OC71s). The sweep waveform is then amplified in a push-pull stage using two OC72s, which feeds an energizing coil wound on the ferrite rod. This particular unit works from a 4.5-V torch battery, drawing a total current of 110 mA.

Another test instrument, but for testing the transistors themselves, was shown by Mullard. This enables measurements of α and I_{co} to be made and gives an indication of collector turnover voltage over wide ranges of collector current and voltage. Details have already been given in our February, 1957, issue, page 80.

A good many of the operations performed in television circuits are essentially switching operations, and Ediswan were demonstrating the typical behaviour of the transistor in this type of work (for which it was originally developed, of course). By means of a pulse generator, an oscilloscope and several transistors of different cut-off frequencies, it was shown that the ultimate transient response depends on $f_{c\alpha}$ and on the magnitude and direction of the current input. Storage of current carriers in the base region limits the speed at which a transistor switching circuit can be turned off, and if the transistor is driven into collector-current saturation in order to improve the rise time, this delay in turning off is prolonged. Best results were, of course, obtained with an r.f. transistor of high cut-off frequency.

A bibliography, covering published and some unpublished material, on printed circuits and allied techniques has been issued by the Television Society. It contains 468 references—classified and cross referenced—with an author index. The Society has also issued a second supplement to the bibliography of colour television published in 1954. It covers material published up to last August. Both bibliographies were prepared by Mrs. K. Bourton, Librarian at Ultra Electric, and cost 2s 6d each.

AUDIO FAIR

List of Exhibitors

WITH one or two exceptions all the exhibitors (see below) at the Audio Fair (April 12th-15th) will have demonstration rooms as well as stands in the main hall of the Waldorf Hotel, Aldwych, London, W.C.2. The Fair is open daily from 11 to 9.

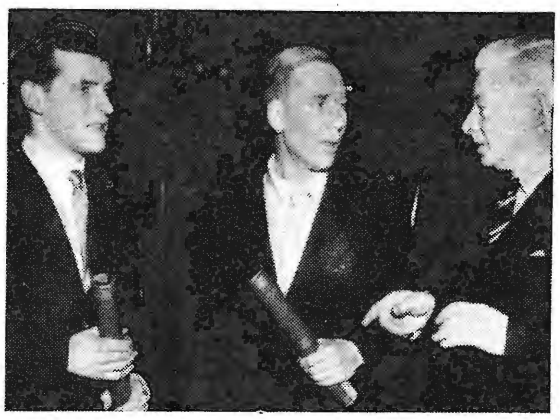
Tickets for individual days are available from the editorial office of *Wireless World*. Applications must be accompanied by a stamped addressed envelope.

Acoustical
Armstrong
Beam-Echo
Brenell Engineering
Champion
Chapman (Reproducers)
Collaro
Cosmocord
Decca
Dulci
Dynatron
E.M.I.
Electric Audio Reproducers
G.E.C.
Garrard
Goldring
Goodmans
Gramophone Record Review
Grampian
Grundig
H.M.V.
Hi-Fi News
Leak, H. J.
Lowther
Lustraphone
M.S.S.
Mullard
Pamphonic
Pilot
Philips
Plessey
Pye
R.C.A. Gt. Britain
R.G.D.
Reslosound
Rogers Development
Rola Celestion
Simon
Sound Sales
Specto
Sugden
Tannoy
The Gramophone
Trix Electrical
Thermionic Products
Truvox
Vitavox
Vortexion
Wharfedale
Whiteley
Wireless World
Wright and Weaire

Awards to Technical Writers

AS reported in last month's issue, the Radio Industry Council has awarded five 25-guinea technical writing premiums for 1956. The scheme, which is to be continued for the present year, aims at encouraging members of the industry and others to write more freely about their work; it is described in a leaflet obtainable from the Council. The 1956 premiums were presented at a luncheon in London on March 14th. In the photograph, F. S. Mockford (Chairman, Radio Communication and Electronic Engineering Association) is seen presenting premiums to F. H. Brittain (centre) and D. M. Leakey (left).

Working in collaboration, they wrote the article "Two-Channel Stereophonic Sound Systems," published in *Wireless World* for May and July, 1956. Both authors are in the General Electric Company's Research Laboratories at Wembley.



WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

Components Progress

A SIX-FOLD increase in the production of components during the past ten years is recorded in the 24th annual report of the Radio and Electronic Component Manufacturers' Federation. During the same period the volume of exports has increased over seven times and the value considerably more. The demand for components by the domestic receiver industry, which at one time during the period absorbed about 60%, has gradually decreased. It now takes only 40% of the output.

Although, as will be seen from the table, the domestic receiver field still absorbs more components than any other section of the industry, the value of those used in capital equipment is higher.

	Value (£M)	Quantity (M)
Domestic receivers	21.5	600
Capital equipment	25.0	450
Direct exports	16.0	275
Sound reproducing gear	6.0	100
Retail sales	10.5	75
Other	2.0	
	81.0	1,500

The 1956/57 report, which opens with a lengthy review of the country's industrial position in general and the radio industry in particular, provides a very full survey of trends—both technical and economic —in the components industry.

The Federation, which has so successfully organized its own exhibition during the past years, stresses that the question of exhibition policy is one for the whole industry—"there is no exhibition at present which is representative of the industry as a whole." Although during the current year there will be at least ten shows representing various interests in the radio and electronics field "not one major exhibition can justifiably be regarded as demonstrating the full magnitude, or as upholding the true prestige, of the industry."

Oscillator Radiation Limits

AN improved method of measuring oscillator radiation from television and v.h.f. sound receivers, evolved by the International Electrotechnical Commission, has been adopted by B.R.E.M.A. in place of the method put forward in 1954. At the same time the permissible limits of radiation in microvolts/metre have been reviewed and new recommendations have been made for frequencies between 30 and 250 Mc/s.

The total free-space radiation is measured at 3 metres by a comparatively simple procedure, using apparatus which can, for example, be set up on a flat roof. The method and the limits (which are also applicable to radiation at i.f. harmonic frequencies) will probably be incorporated in a revised version of BS905 due out later this year. Meanwhile, details can be obtained from B.R.E.M.A. at 59, Russell Square, London, W.C.1.

Servicing Technicians' Association?

WHEN the Radio Trades Examination Board was formed in 1942 the stated aim was "the promotion of a high standard of skill and efficiency in the technique and work of persons employed or otherwise engaged as radio mechanics, technicians and tradesmen in the radio and allied trades." Having established a sound basis for the certification of technicians and craftsmen in the domestic sound and television field, the Board has considered the desirability of extending its work into "the growing field of electronic application."

Suggestions have been made that the Board, which comprises representatives of the R.I.C., Brit.I.R.E., R.T.R.A., and Scottish Radio Retailers' Association, might encourage the formation of an association to provide, if required, the means of introducing candidates to prospective employers and to arrange meetings to enable successful candidates to keep abreast of new techniques in servicing and maintenance. The possibilities are, in fact, being examined.

International Recording Contest

TWO entries from England won awards in the recent Fifth International Recording Contest for the best amateur sound recording judged in Paris. G. Holmes Tolley, of Evesham, Worcs., won the first prize of 250 Swiss francs (presented by Radio Basle, Switzerland) in the Actuality Category with his recording of a Rumanian Folk Dance. The recording was made during the 1956 Annual Festival of Dancing at Stratford-on-Avon. The equipment used was an E.M.I. midget battery-operated tape recorder with a Lustraphone baton-type moving-coil microphone. The second award for a U.K. entry was in the same category and was won by Leslie Murray.

Over 400 entries were received, of which 115 were from France, with other entries from Denmark, Belgium, Germany, Spain, Austria, Chile, Holland and a few from Great Britain. Until last year's contest no entries at all had been received from amateur recordists in this country.

"Trader Year Book"

CONDENSED specifications of over 250 current commercial television receivers and all the 1956/7 sound receivers, lists of television and sound i.fs, diagrams of base connections of over 300 valves, and directories of trade names and addresses are among the features included in the 1957 edition of the "Wireless and Electrical Trader Year Book." The value of the Year Book, which is now established as the *vade mecum* of the radio engineer, technician and trader, has been considerably increased by separating the radio matter from the electrical information. It costs 12s 6d.

PERSONALITIES

As already announced **Professor Balthazar van der Pol,** D.Phys., retired at the end of the year from the position of director of the International Radio Consultative Committee (C.C.I.R.), which he had held since its formation in 1948. Dr. van der Pol, who was born in Utrecht in 1889, spent three years in this country during the first world war, studying under Fleming at London University, and J. J. Thomson at Cambridge. From 1922 until his appointment with the C.C.I.R. he was director of research at Philips, Eindhoven. In a tribute to his work in international fields, the *Journal* of the International Telecommunication Union emphasizes that "as a man of science he could conceive of no frontiers . . . as an international official he systematically overlooked the nationality of the technical experts he had occasion to meet and treated them exclusively as scientists and engineers with whom ideas and information could be exchanged." In 1952 he was awarded the Valdemar Poulsen gold medal by the Danish Academy of Technical Sciences for his theoretical and practical work on the propagation of radio waves.

Sir Robert Renwick, Bt., K.B.E., has resigned from the presidency of the Radio and Electronic Component Manufacturers' Federation to which he was appointed in 1947, and is succeeded by **Major L. H. Peter,** A.F.C., M.C., M.I.E.E. Sir Robert, who is a director of a number of companies, including Associated Electrical Industries, was controller of communications equipment at the Ministry of Aircraft Production during the war. He has been president of the Radar Association since 1955. Major Peter is chief development engineer of Westinghouse Brake & Signal Company.

F. Langford-Smith, B.Sc., B.E., well known as editor of "Radio Designers' Handbook," has left his native Australia, and has joined the English Electric Valve Company, Chelmsford, as editor in charge of its technical publications. He had been with Amalgamated Wireless (Australasia) since 1932 and was for some time engineer in charge of the company's valve laboratory. Mr. Langford-Smith, who graduated at Sydney University, was in this country from 1928 to 1932, initially with Metro-Vick, and subsequently as valve development engineer with Cosmos lamp works.

Dudley Saward, O.B.E., has been appointed managing director of Texas Instruments, Ltd., the recently formed U.K. subsidiary of the U.S. organization Texas Instruments, Inc. New works and offices are being erected for the British Company in Kempston Road, Bedford. Mr. Saward was chief radar officer to the Commander-in-Chief, R.A.F. Bomber Command, during part of the war, and was appointed O.B.E. for his part in the development and application of radar navigational and blind bombing devices. He was for some time after the war controller of navigation and telecommunications for British European Airways. He is 44.

Two new posts have been created in Marconi's aeronautical division. That of deputy chief air radio engineer (development) will be filled by **G. P. Parker,** A.M.I.E.E., and that of deputy chief air radio engineer (projects) by **J. H. Gill.** Mr. Parker will be responsible for the airborne and ground development group of the division, and Mr. Gill for airborne and ground installation projects. Both will be responsible to Dr. B. J. O'Kane, the company's chief air radio engineer.

R. D. Phillips, technical manager at 20th Century Electronics until 1952, when he went to Ferranti's on colour television tube research, has rejoined the company as senior engineer in charge of prototype development and production engineering of cathode-ray tubes.

R. J. Hayes, M.B.E., has joined Piezo, Ltd., of 26, St. Albans Road, Watford, Herts, manufacturers of quartz crystals. He has retired from the Board of Trade where he was for many years a senior executive in the Export Promotion Department.

W. O. P. Jones, B.Sc.(Eng.), A.M.I.E.E., recently appointed assistant superintendent of the Electronics Department of the Metropolitan-Vickers Electrical Company, has been manufacturing engineer in the department since 1953. He joined the company as a college apprentice in 1939.

O. H. Davie, M.I.E.E., who has been with Cossor for the past 18 years, has been appointed to the board of Cossor Instruments, Ltd., as technical director. He contributed to the development of the original Cossor double-beam oscilloscope.

OUR AUTHORS

Dr. Colin Cherry, reader in telecommunications at Imperial College, is engaged in research in experimental psychology in communications, and in an article on page 164 discusses the importance of this subject in telecommunication engineering. Dr. Cherry, who graduated at the Northampton Polytechnic in 1936 whilst a research student at the G.E.C. Research Laboratories, later joined the Laboratories' scientific staff and during the war was attached to T.R.E. for radar research. He joined the staff of Imperial College in 1947, and was appointed to his present position as Henry Mark Pease reader in telecommunications in 1949.

R. F. Hansford, joint author of the article on the choice of wavelengths for radar in this issue, studied communication engineering at the Portsmouth Municipal College and during the war was at the Admiralty Signal and Radar Establishment developing navigational radar gear. After the war he was in the research department of the Sperry Gyroscope Co., and while there was responsible for the design and installation of the pioneering harbour radar at Liverpool. In 1952 he joined Decca Radar, to take charge of its newly formed radar applications division. He is a founder member of the Institute of Navigation and was for a number of years its technical secretary. His co-author, **R. Collis,** was a meteorologist in the Royal Navy before joining Decca as a meteorological specialist.

Dr. H. R. L. Lamont, contributor of "Colour TV on Tape," is European Technical Representative for the Radio Corporation of America, which he joined in 1953. A graduate of Glasgow University, he was on the staff of the G.E.C. Research Laboratories at Wembley from 1939 to 1950, engaged in research on microwave tubes and circuits and on propagation of centimetre and millimetre waves. Prior to joining R.C.A. he was for three years at the Royal Technical College, Glasgow, as senior lecturer in electronics.

Captain F. J. Wylie was among the delegates to the recent Maritime V.H.F. Radiotelephone Conference at The Hague, and he reviews the findings in an article in this issue. He attended the Conference as director of the Radio Advisory Service (Chamber of Shipping and Liverpool Steam Ship Owners' Association), which he founded a year after his retirement from the Royal Navy in 1947. Throughout his naval career he was closely associated with wireless, having successively been fleet wireless officer (Mediterranean), officer-in-charge of wireless experimental department of H.M. Signal School, deputy director signal department, Admiralty, and director of radio equipment, Admiralty. Captain Wylie edited "The Use of Radar at Sea" published by the Institute of Navigation in 1952.

W. Ian Heath, who, with G. R. Woodville, gives design data for a 50-watt amplifier in this issue, joined the Research Laboratories of the G.E.C. in 1939, and until 1946 was concerned with valve circuitry. He is now working with F. H. Brittain in the acoustics section of the Laboratories. **G. R. Woodville** joined the technical staff of the M-O Valve Company in 1935, after service with several other firms in the industry. He has been principally concerned with circuit applications of valves.

B. G. Martindill, author of the article on variable attenuators, joined Wolsey Television, of which he is general manager and chief designer, in 1950. For the previous five years he had been in charge of meter production with Automatic Coil Winder and Electrical Equipment Company.

John R. Greenwood, who in an article in the last issue described a method of indicating sound and picture intensities on a single cathode-ray tube, graduated in electrical engineering in 1951 at Leeds University. After completing National Service in the signals branch of the R.A.F. he was with the Bristol Aeroplane Company for a short while, working on the development of electronic measuring instruments. In 1954 he joined the B.B.C. and after gaining practical experience in sound studio engineering transferred to the Engineering Training Department.

IN BRIEF

January's increase of 187,088 brought the total number of **television licences** in the United Kingdom to 6,757,185. The number of domestic sound licences at the end of the month was 7,405,273 and those for car radio 303,318. There were, therefore, 14,465,776 broadcast receiving licences current in the United Kingdom at the end of January.

Some thirty papers are being presented at the "**Electronics in Automation**" Convention to be held by the British Institution of Radio Engineers at Cambridge University from June 27th to July 1st. The six sections will cover office machinery and information processing, machine tool control, chemical and other processes, simulators, automation in the electronics industry, and automatic measurement and inspection. During the convention the third Clerk Maxwell Memorial Lecture will be delivered by Professor Sir Lawrence Bragg. He will speak on the diffraction of short electro-magnetic waves.

Scottish I.T.A.—Since March 1st test transmissions with an effective radiated power of 1 kW have been radiated from a pilot transmitter on the site of the I.T.A. station at Black Hill, Lanarks., between Airdrie and Bathgate. The station is operating in Channel 10 (vision 199.75 Mc/s, sound 196.25 Mc/s) on which the permanent station will begin operation on August 31st. The transmissions are vertically polarized.

For the ninth successive year the London and Home Counties Regional Advisory Council for higher technological education has prepared a **summary of applied research** in electrical engineering (including radio and electronics) in progress in university colleges and technical colleges in the region. The list, copies of which are available from the Council at Tavistock House South, Tavistock Square, London, W.C.1, is issued in the hope of stimulating industrial interest in the research being undertaken in the colleges.

Price Reduction.—Due to reductions in the world price of elemental selenium and to improved manufacturing methods employed by Standard Telephones and Cables, they have been able to reduce the selling price of SenTerCel spindle-mounted rectifiers by as much as 25 per cent.

A private exhibition of r.f. miniature cables and connectors is being held by Transradio, Ltd., at the Washington Hotel, Curzon Street, London, W.1, from April 8th to 11th.

Our publishers have issued the 6th edition of "**Television Explained**" which, within its 184 pages gives a non-mathematical presentation of technical information on domestic receiving equipment. W. E. Miller, the original author, was unable to undertake the extensive revision required, and E. A. W. Spreadbury, associate editor of *Wireless and Electrical Trader*, has undertaken the task. Several chapters have been rewritten, and a number of new chapters added to bring the book into line with modern television practice. The price is 12s 6d.

Facsimile Weather Charts.—Muirhead Mufax chart recorder, described in our April, 1954 issue, is being exhibited at the Science Museum, South Kensington, for the next few months. It can be seen in operation during the daily transmissions of weather charts from the Dunstable meteorological station at 12.10 and 16.50.

A new science film **Mirror in the Sky,** presented by Mullard, Ltd. and the Educational Foundation for Visual Aids gives an account of the work of Sir Edward Appleton on the ionosphere. It is intended both to excite the interest of the young with a view to encouraging them to take up a scientific career and as an instructional film for those already specializing in science.

British National Radio School, which moved to Bristol during the war, has returned to its original premises at 66, Addiscombe Road, Croydon, Surrey. (Tel.: Addiscombe 3341).

An evening **refresher course** for radio and television technicians is being arranged for the summer term (May 1st to July 3rd) at the Wesley Institute, Wesley Road, Stonebridge, London, N.W.10. (Fee 10s.)

FROM ABROAD

An international symposium on the **Physical Problems of Colour Television** will be held in Paris from July 2nd to 6th under the sponsorship of the International Union of Pure and Applied Physics, the Société Française des Radioeléctriciens, and the Société Française des Ingénieurs et Techniciens du Vide. The discussions will come under four main headings: properties and behaviour of the human eye in colour television; image analysis and restitution; assessment and measurement of picture quality; and coding procedures for transmission of colour signals. Particulars are obtainable from the secretary, Colloque International sur les Problèmes de la Télévision en Couleurs, Conservatoire National des Arts et Métiers, 292, rue Saint-Martin, Paris 3e.

We have received from Fairchild Publications, of New York, a copy of "**Electronic News,**" a weekly newspaper devoted exclusively to the electronics industry. Specimen copies of the 24-page paper, which covers technical and commercial matters throughout the world, are obtainable from the London branch of the publishers, 16, Berkeley Street, London, W.1.

Technical Co-operation.—At the invitation of the Finnish broadcasting organization an informal meeting was held in Helsinki in February between representatives of the International Broadcasting Organization (O.I.R.), which has its technical centre in Prague, and the European Broadcasting Union (E.B.U.), which has its technical centre in Brussels. The object of the meeting was to discuss the possibilities of extending the technical co-operation between the two organizations.

MEMORIAL STAMP for the centenary of the birth of Heinrich Hertz (February 22nd, 1857) issued in one denomination, 10 Pf., by the German Post Office. It will be on sale until the end of August.

BUSINESS NOTES

The **Hartley Baird** group of companies—which includes the manufacturers of Baird and Ambassador domestic receivers and tape recorders, Hartley Electromotives whose products include magnetic recorders, Duratube & Wire, Tenaplas, and three electrical appliance companies—has been acquired by Camp Bird, Ltd. They already control a number of other electrical and electronics companies, including E-V, Ltd., manufacturers of gramophone styli, and Hampton & Sons, radio and electrical retailers.

20th Century Electronics, Ltd., have signed a five-year agreement with Compagnie Générale de Télégraphie Sans Fil, under which the French company will use designs and patents of 20th Century. Similar licensing agreements have been signed with companies in the Netherlands, Belgium, Germany and Switzerland, the main interest being in multi-gun cathode-ray tubes and gieger tubes.

Decca Navigator Company, Ltd., has acquired the rights for the United Kingdom and certain other countries of the electronic self-steering device for ships—the Arkas Automatic Pilot.

A portable oscilloscope and recording oscillographs (including a portable model) made by **Siemens & Halske**, of Germany, are distributed in this country by W. Wykeham & Co., 17-19, Cockspur Street, London, S.W.1. A number of radio components, including small tubular tantalum electrolytic capacitors, made by the Siemens-Halske organization, are marketed in this country by R. H. Cole (Overseas), Ltd., 2, Caxton Street, Westminster, London, S.W.1.

A recent order for twenty **Marconi** radio compasses brings the total to over 600 which the company has installed in Vickers Viscount aircraft. These automatic direction finders (Type AD.7092) are generally installed in duplicate.

V.H.F. radio-telephone equipment has been installed by **Marconi's** at the Wath-on-Dearne shunting yard in the eastern region of British Railways. Each of the five diesel engines is fitted with a 3-5-watt set, and 5-watt transmitter/receivers are installed in the two signal boxes.

Marconi Marine announce that they supplied or received orders for radio equipment for 35 of the 39 trawlers built in United Kingdom yards during 1956 for British owners.

Decca airfield control radar (Type 424), which provides both talk-down facilities and airport supervision in one unit, has been ordered by Skyways, Ltd., for installation at Lympne Airport, Kent.

All the television equipment for the **I.T.A.** studios in Glasgow and a complete three-camera television O.B. unit are being supplied by **Pye.** The studio equipment includes four cameras and ancillary control equipment, three film scanners and twenty-one monitors.

Orders for over 40 radio-telephone transmitter-receivers (Type AM104) have been received from the Flintshire and Norwich County Councils by **Hudson Electronic Devices, Ltd.** The AM104 is an amplitude modulated 15-watt set.

With the opening of its new factory at Lawrence House, Breakspear Road, Ruislip, Middlesex, the **Electronic Production Company** has increased manufacturing capacity, its specialities being coil winding, eyeletting, sub-assemblies and the manufacture of interference suppressors.

Closed-circuit television equipment, including Nera large screen monitors (48-in by 36-in), is available on hire from **P.A.M., Ltd.**, Merrow Siding, Guildford, Surrey.

Panda Radio Company, of Castleton, Nr. Rochdale, have opened a London showroom and office at Autavia House, Redcliffe Gardens, Kensington, S.W.10. (Tel.: Flaxman 0906.) G. R. Hamilton-Walker (G3LND) is in charge.

The industrial division of **Amplivox, Ltd.,** is being enlarged and the company has appointed R. Steven, B.Sc., as manager. He was formerly sales manager of Painton & Co.

OVERSEAS TRADE

January Exports.—After breaking records in 1956 with exports worth more than £40M (a 20% increase on the previous year), overseas sales of British radio and electronic equipment in January were over £3.2M —nearly 10% more than in January last year.

Poznan Fair.—At the time of going to press eight radio and electronics firms had taken space in the British section of the International Trade Fair being held in Poznan, Poland, from June 9th to 23rd. They are Acoustical Mfg., Cinema Television, Kelvin-Hughes, Marconi's, Pye, Redifon, Siemens-Ediswan and Solartron. Other manufacturers may wish to avail themselves of the opportunity being given by the Board of Trade for literature to be available at the official enquiry stand. Literature, which should be in Polish, must be sent direct to United Kingdom Official Trade Enquiry Stand, British Section, Trade Fair, Poznan, Poland, to arrive about June 1st.

S.R.E. for India.—A combined speech reinforcement and bi-lingual interpretation system has been installed by Tannoy in the Upper and Lower Legislative Chambers of the Government of Mysore, in Bangalore, India. In all about 170 microphones and a similar number of low-intensity speakers are installed. Headphones are provided for the interpretation system. A main control panel, similar to those in the Houses of Parliament, Westminster, is provided.

A quarter-million pounds' worth of radio and television equipment—**from transistors to transmitters**—was shown by Pye at the recent Leipzig Fair.

A variety of equipment, including transmitters, receivers, direction finders and frequency measuring gear, is required for a **monitoring station** in Burma. Manufacturers interested in the enquiry can obtain a list of equipment required from the Special Register Information Service, B.o.T., Lacon House, Theobalds Road, London, W.C.1. (Ref. ESB/3902/57.)

Recording Equipment.—Miles Reproducer Co., Inc., of 812, Broadway, New York 3, who manufacture a portable recorder, microphones and amplifiers, are seeking U.K. supplies of components and accessories. A representative will be visiting this country in a few months, and interested firms are advised to write direct to J. M. Kuhlik at the above address.

Frequency-modulated v.h.f. **radio-telephone equipment** is being supplied by Automatic Telephone & Electric Company to the five transatlantic liners operated by the Holland-America line, and for installation at the Hook of Holland. It is understood that a chain of coastal v.h.f. stations is being planned by the Netherlands Government.

A complete **television station** for operation in Band III on Eastern European standards—625 lines with a vision bandwidth of 6 Mc/s—has been ordered from Marconi's by the Polish broadcasting authority. The station, which will be built at Katowice, will be equipped with two 7.5-kW vision transmitters, two 2-kW sound transmitters and two combining units each feeding the outputs of a vision and sound transmitter to half the 16-stack aerial. The vision e.r.p. will be of the order of 200 kW. Studio equipment, film scanners and test gear is also being supplied.

Design for a 50-WATT AMPLIFIER

THE NEW G.E.C. "88-50" USING KT88 OUTPUT VALVES

By W. IAN HEATH, B.Sc.(Eng.), and G. R. WOODVILLE†*

FOR many years the KT66 valve has been regarded by many as the hall-mark of a high-quality amplifier whether "home made" or commercially manufactured. With a total anode-plus-screen dissipation of 28 watts, when operated with cathode bias, its power output, in push-pull pairs, ranges from the 12 watts of the original "Williamson" amplifier, to 32 watts when used in an "ultra-linear" output stage.

The new KT88 is a pentode with a higher anode-plus-screen dissipation of 40 watts, and a higher mutual conductance of 11 mA/V. With this valve it is therefore possible to build amplifiers having higher power outputs suitable for public-address equipment and high-quality sound reproduction in general. Due to the lower anode impedance of the new valve, its higher power output is obtained without increasing the h.t. voltage requirements beyond the limits of normally available components. For example if plugged into a KT66 "ultra-linear" output stage giving 32 watts, a pair of the new KT88 valves will give 40 watts with a corresponding increase in drive voltage. Thirty watts output is obtainable with a h.t. line voltage of only 375 volts, instead of 425 volts for the KT66.

The maximum power obtainable from a pair of KT88s with cathode bias is slightly over 50 watts with a h.t. line voltage of 500 volts. This article gives details of the design and construction of a 50-watt power amplifier using KT88s. A new pre-amplifier suitable for use with this amplifier will be described later.

The two units have been designed to offer an improved performance and range of controls compared with previous designs, yet they include no complicated networks or unusual components, and are comparatively economical to construct. They will reproduce from radio tuner, any magnetic (or crystal) gramophone pickup, microphone, or direct from a magnetic tape replay head. A rotary switch selects the input circuit required and at the same time adjusts the sensitivity and frequency correction for tape or disc recordings. The pre-amplifier is separate from the power amplifier to which it is connected by a flexible cable; its controls are similar in function to those on the G.E.C. "912" amplifier, but the operation of the treble slope and "presence" controls has been improved, and a rumble filter is incorporated.

Power Amplifier.—The circuit of the power amplifier is shown in Fig. 1. It contains a pair of KT88s connected in an "ultra-linear" output stage, a push-pull low-impedance double-triode driver stage using a B329, and a high-gain B339 first stage incorporating phase splitting. Overall feedback of −22 dB is used, and the input sensitivity is about 0.5 V r.m.s. to give full output power. The 500-volt h.t. supply is provided by a U52, and the electrolytic smoothing condensers are protected by the use of a thermistor against excessive voltage during the warming-up period.

The "ultra-linear" connection for output tetrodes

* Research Laboratories of the General Electric Co., Ltd.
† The M.O. Valve Co., Ltd.

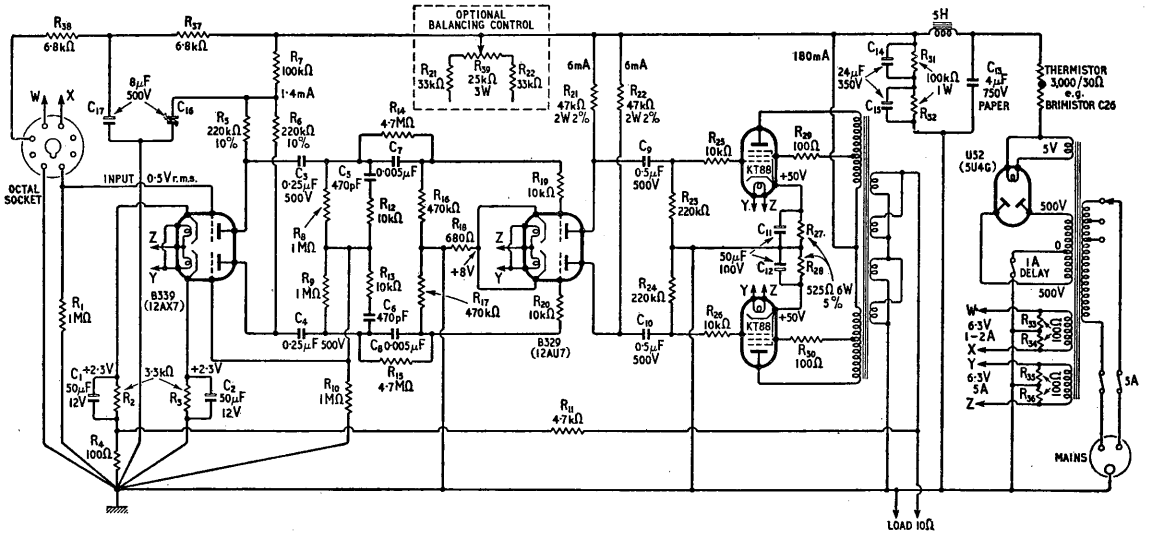


Fig. 1. Complete circuit diagram of main amplifier. Resistors are rated at ½ watt unless otherwise stated.

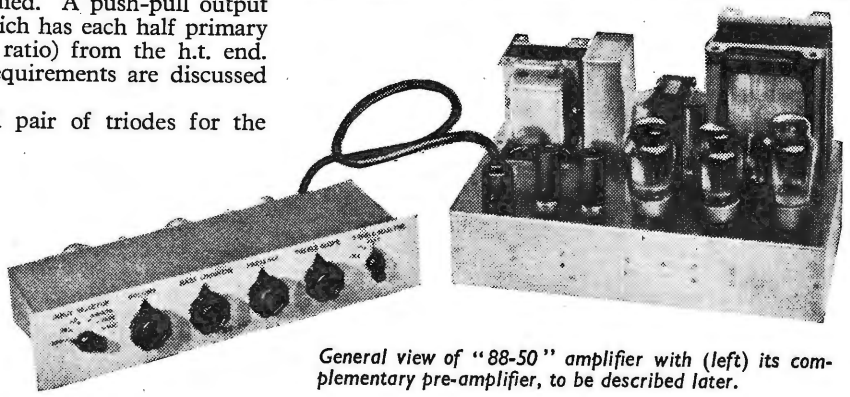
and pentodes has become popular during the past two years. As will be seen from Fig. 1, it resembles the triode connection except that the screen grids are tapped down the primary winding of the output transformer and the signal voltage on each screen is only 20 per cent to 40 per cent of the signal voltage in the corresponding anode‡. Its advantages are that it gives a maximum power output at least equal to that obtained from the pentode connection, with distortion similar to or less than that for the triode connection, which gives less than half the power output. For equal power output, the distortion from an "ultra-linear" output stage is about half that for a triode stage using the same valves. The "ultra-linear" connection also provides a low output impedance, roughly equal to the load, and a good damping factor is, therefore, easily obtainable when feedback is applied. A push-pull output transformer is required which has each half primary tapped 40 per cent (turns ratio) from the h.t. end. Leakage and inductance requirements are discussed later.

The use of a push-pull pair of triodes for the driver stage was chosen so that the output stage would be symmetrically driven, and that no unbalanced operation would occur even at the onset of grid current in the output valves during overload. The removal of the phase splitter to an earlier stage ensures that the time constants in the grid circuits of the output valves are the same. The B329 is used in this stage because it has a low anode impedance, about 10,000 ohms. With this low value of driver impedance the phase shift due to the input capacity of the output stage is relegated to frequencies above 50 kc/s, and this, combined with the symmetry of the circuit, greatly assists in ensuring freedom from h.f. instability when feedback is applied overall.

A high-gain first stage (B339) is used to provide good balance in the phase-splitting circuit, and also adequate overall sensitivity after feedback is applied: the phase-splitter circuit used is one in which the input to the grid of the second or inverter triode is automatically balanced against its stage gain. This circuit gives a push-pull output from the two anodes of the B339, and as the amplifier is truly push-pull from this stage through to the output transformer little h.t. smoothing is required, with a corresponding economy in components.

Balancing Circuits.—The push-pull output from the B339 stage is balanced to about 2 per cent, a high-gain stage being an advantage here. This balance is improved slightly by the use of an unbypassed common bias resistor in the cathode circuit of the B329 driven stage. This degree of balance is very satisfactory for many purposes, and with close-tolerance cathode bias resistors the KT88 valves used in designing the prototype amplifier have given a consistently symmetrical output voltage waveform when driven up to full power output when the peaks just show "flattening" due to the onset of grid current. However, it has been found on amplifiers of this type with unmatched output valves that minimum distortion is obtained when the push-pull drive is adjusted so that both output valves reach the onset of grid current simultaneously as the drive voltage is increased.

Where facilities are available, and it is desired to make this adjustment, alteration of the balance of the push-pull drive is obtainable by relative adjustment of the two anode loads of the B329, and accordingly a pre-set variable wire-wound potentiometer R_{39} is shown in Fig. 1 incorporated as part of the anode loads circuit. The waveform of the voltage across the secondary of the output transformer can be observed on a cathode-ray oscilloscope connected across a dummy load resistance, and R_{39} should be adjusted so that with a sinusoidal input voltage of suitable value the output waveform shows similar "flattening" on both positive and negative peaks. Although judged visually, this adjustment can be made with more than sufficient accuracy, provided the input waveform is free of second harmonic distortion. To avoid phase effects a frequency is chosen between 200 and 2,000 c/s.



General view of "88-50" amplifier with (left) its complementary pre-amplifier, to be described later.

Stabilizing Circuits.—When feedback is to be applied over an amplifier it is desirable that it is truly "negative" feedback over the whole frequency range that will be fed to the amplifier. At frequencies outside this range the feedback should be either "negative" or inoperative. If this is not so, the final frequency response of the amplifier will show peaks. Further increase of feedback, or in borderline cases certain types of input signal, will produce oscillation at these "peak" frequencies. Even if oscillation does not occur the amplifier will "ring" at these frequencies; that is, when an input signal containing the "peak" frequencies is interrupted the output from the amplifier will not cease as abruptly as the input, the "peak" frequencies persisting with a more gradually decaying amplitude. The "peak" frequencies usually occur at very low or very high frequencies, and are due to phase shifts in the intervalve coupling circuits and in the output transformer itself.

The low-frequency peak occurs only when feedback is applied, and is due to the combined phase shift of the intervalve coupling capacitors in conjunction with the associated grid leaks, together with the phase shift of the output transformer's primary inductance in conjunction with the load and valve impedances. The peak in amplification commonly occurs well below 20 c/s and often results in low-

‡ Either ratio is satisfactory, but with 40% screen tappings it is easier to design an output transformer giving freedom from instability at very high frequencies.

frequency instability ("motor-boating") when a pre-amplifier is connected to the same h.t. power supply. The effect is reduced if the several phase shifts are arranged to occur at differing frequencies, for example in the circuit of Fig. 1, large coupling capacitors are used so that phase shift due to them will occur at frequencies lower than that due to the output transformer.

Complete or nearly complete avoidance of a low-frequency peak can best be obtained by reducing the gain of the amplifier before feedback is applied at the frequency at which the peak is expected, without introducing additional phase shift at this frequency. If a flat frequency response is required down to this frequency, then the reduction in gain should approximately equal the feedback to be applied. This is achieved by inserting a small coupling condenser shunted by a high resistor, so that with the following grid leak the gain is reduced as the signal frequency is lowered until at the very low frequencies where a peak is expected the gain is reduced by a substantially resistive potential divider with very little phase shift. For a 20 dB (10:1) gain reduction the shunt resistance should be ten times the grid leak. The capacitor should be sufficiently small to have an impedance at the very low frequencies equal to or higher than the shunt resistance.

As the "88-50" amplifier is push-pull throughout such a circuit has to be incorporated on each side, and on one side, in Fig. 1, this consists of C_7 shunted by R_{14} and followed by grid leak R_{16} with C_8, R_{15} and R_{17} on the other. The valves chosen will give low-frequency stability with any output transformer capable of delivering the full power output down to 40 c/s. An advantage of the inclusion of this type of stabilizing circuit is that there is no tendency for the amplifier to "motor-boat" when the pre-amplifier is connected to the same h.t. line. The smoothing used in the pre-amplifier supply is therefore economically chosen solely to give sufficient ripple reduction.

At the high frequencies peaks may be detected in the response of most amplifiers when this is measured up to 100 kc/s or 200 kc/s before feedback is applied. These peaks are due to resonances in the output transformer, the most important of which is the series resonance of the primary leakage inductance with the primary winding capacitance. This is commonly the cause of the "first" peak, i.e., of lowest frequency. The response usually shows a general downward trend, and this is due to the total shunt capacities, including Miller effect, across each anode load in the amplifier. When feedback is applied the combined phase shifts due to shunt capacities and leakage inductance cause the peaks in the response to be exaggerated, and often rise above the mid-frequency level.

With the output transformers used in designing the prototype "88-50" amplifier the leakage inductances between the several windings were low, as described later, and the "first" high-frequency peak was detected about 100 kc/s. Accordingly a stabilizing circuit, similar in principle to that used at the low frequencies, is incorporated. This consists of a shunt capacitor connected across the anode impedance of the first valve, with a series resistance to limit its shunting effect to about 20 dB (10:1) and minimize phase shift at frequencies above 50 kc/s. In Fig. 1 this circuit consists of C_5 with R_{12} in series, and on the other side of the amplifier C_6 with R_{13} in series. These values are sufficient to give stability when the amplifier is loaded capacitively, and to reduce "ringing" on a square wave input (10 kc/s repetition rate) to only about 10 per cent overshoot on a resistive load, and even less on an inductive load.

The use of condensers for improving stability across any portion of the output transformer is not recommended in presence of the above stabilizing circuits, and was found merely to lower the resonant frequency, which was undesirable, and in some cases increased overshoot. The use of such condensers depends on individual transformer design, and is not suitable in this context. No reactances giving phase correction are included in the feedback network itself (R_{11} and R_4) because the correct choice of reactance is critically dependent on the type of load and output transformer used. For example overshoot, or actual instability, using a given transformer and dummy load resistance can be greatly reduced by shunting the feedback resistance R_{11} by a critically chosen value of capacitance, but this will be found to worsen stability on a reactive load such as a loudspeaker. This behaviour is common to all feedback amplifiers, and the stabilizing circuits here incorporated within the amplifier itself give satisfactory results with a wide variety of loads, and with the several transformers used in testing the prototype.

Greater stability could be obtained with inferior output transformers by altering the capacitances in the stabilizing circuits so that the level frequency response of the amplifier, before feedback is applied, is further restricted. The level frequency response at high and low frequencies will be restored when negative feedback is applied, but the amount of feedback (difference in gain with and without feedback) will be so reduced that the overall harmonic distortion at high and low frequencies will be considerably higher than at mid-frequencies. In addition the valve preceding the stabilizing circuits handles a higher signal voltage at high and low frequencies, and extra distortion may occur here as well as the distortion inherent in using a poorer output transformer.

The stabilizing circuits shown in Fig. 1 are incorporated in as early a stage as possible, so that only one valve precedes them within the feedback chain. The components' values have been found satisfactory for use with a typical "minimum" transformer, but are primarily intended for use with a transformer of the type described below. The reduction of feedback at 40 c/s and at 10 kc/s amounts to some 6 dB less than the −22 dB feedback at mid-frequencies.

Output Transformer.—The output transformer used for the first prototype amplifier was the type WO866, made by R. F. Gilson, Ltd. Although originally intended for operation with valves of lower power output, it gives a very good account of itself with the KT88 from 40 c/s to 20,000 c/s. Another transformer tried with excellent results was the Savage Type 4Nl. For its extra size and cost this would deliver the "full power" output down to a lower frequency than the WO866.

The requirements for an "ultra-linear" transformer to be used with feedback are adequate primary inductance and low leakage inductances between primary and secondary (as normally connected), between each half primary, and between each half primary (anode-tapping) and the associated

screen tapping. The primary winding capacitance must also be low enough to relegate the lowest high-frequency resonance to the region where a reasonable stabilizing circuit has reduced the gain of the amplifier without appreciable phase shift.

Both the transformers mentioned gave measurements of all five leakage inductances less than 6 mH, and a high-frequency resonance in circuit operation above 100 kc/s. The WO866 achieves this by the use of gain-oriented silicon iron, with moderate sectionalization of the windings, and the 4N1 achieves similar figures with a larger core of normal silicon iron by more sectionalization of the windings.

Construction.—The accompanying photograph shows the underside of the power amplifier chassis. The prototype was constructed on a chassis measuring 14in × 9in × 3in. The mains transformer was of ordinary silicon iron, but the choke and output transformer were of grain-oriented silicon iron and were therefore comparatively small. A slightly larger chassis would be needed if larger transformers were used, but the same layout must be used, and the transformers positioned as in the top view of the amplifier. Because of the high h.t. voltages it is advisable to mount the transformers "tags down"; the elongated holes required can easily be cut with a valve hole-cutter and file.

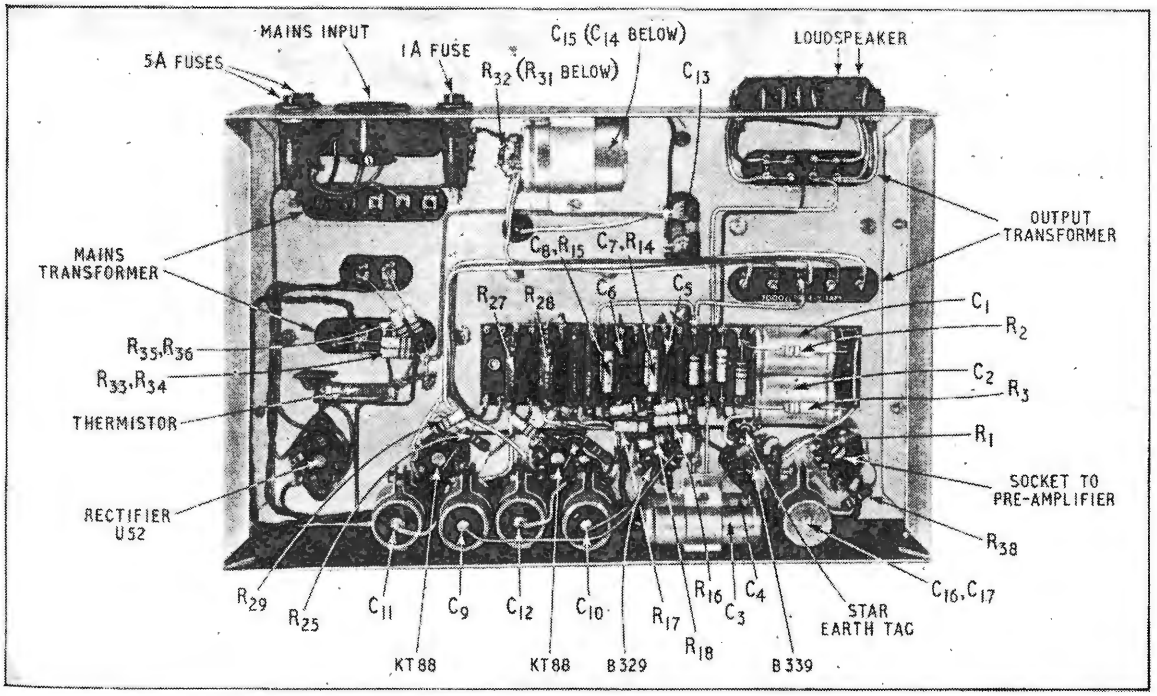
The heater wiring should be laid in first, with twisted twin wires laid along the bend of the chassis. The valveholders are oriented to avoid the heater wires crossing the grid wiring. The second heater supply to the octal pre-amplifier socket connection should also be laid in. Both supplies must have a centre-tap earthed to chassis, or an artificial centre-tap using two equal resistances, as shown. An earth point should be chosen next the first valve B339, and a "star" tag bolted down with a serrated washer to ensure good contact. This will be the one earth point to which all grid, anode, and intervalve coupling circuits must be connected by insulated wiring. The signal input (pin 8 on the octal socket) should be wired as directly as possible to the grid of the first valve; the earth (pin 1 on the octal) connected to the "star" earth tag, and the grid leak connected. The cathode bypass condenser with feedback resistance R_4 in series should be connected between the cathode pin and the "star" earth tag using the smallest total loop area of wiring possible, and keeping the cathode circuit as close to the grid input lead as possible. The cathode bypass condenser of the second half of the B339 should be wired in an equally compact fashion. The grid of this valve is fed from the phase-splitting network connected between the two anodes, and this should be wired as compactly as possible consistent with good mechanical location of the components.

The tagboard is used for all the smaller components, but the larger coupling condensers and the later cathode bypass condensers are mounted by standard clips on the side of the chassis. Except for C_{14} the clips "earth" the condenser cases, which thus provide screening. For ease of servicing almost no wiring is beneath the tagboard.

Wiring should be continued by working through the amplifier, keeping grid and anode wiring as short and as separated as possible, while "dead" wiring such as h.t. leads returning to a smoothing condenser, or cathode bias resistors which are bypassed, may be longer to "fit in." Stopper resistors R_{19}, R_{20}, R_{25}, R_{26}, R_{29}, and R_{30} are included to kill instability at radio frequencies, and must be wired closely on the valveholders with very short leads. "Stoppers" are unnecessary in the grids of the B339.

The earth connecting point associated with each

Underside of chassis showing layout of principal components.



valve should be insulated, and connected back to the insulated earth point of the preceding valve, and so to the original "star" earth tag. The earthed side of the secondary of the output transformer should also be returned to this tag as this is part of the feedback circuit. An exception may be made of the h.t. supply earth, and the heater supply centre tap earths, which can be connected to any convenient points in the chassis.

The mains transformer is as remote as possible from the input to discourage hum, and its orientation should be noted. The output transformer is of necessity nearer the input, and the "live" anode and screen wiring to it should be bound together and laid carefully away from the tagboard and other components.

Using the precautions outlined above the "strip" layout of this amplifier gives the greatest separation of input and output and the least potential "teething troubles."

Connecting the Feedback.—When completed and checked, a dummy resistance load should be connected, and first switched on with the feedback disconnected by an open circuit at R_{11}. If the voltages measured across the cathode bias resistors approximate to those shown in Fig. 1 (some voltmeters will give a lower reading) a test signal may then be connected to the input of about 100 mV, and a loudspeaker tapped across the dummy load. If an audio oscillator is not available, a gramophone pickup having a high output, such as a crystal type, can be connected to the input via a temporary volume control. An extra resistance of about 47 kΩ should be connected in series with R_{11}.

With the test signal audible, the feedback should be connected, and a note made of whether the output is increased or decreased. If the feedback increases the output the connections to the output transformer must be reversed. If the feedback decreases the output then the connections are correct, and the feedback may be permanently connected with the extra resistance removed. This method removes the risk of oscillation and possible damage to the output valves and transformer.

Performance.—The maximum power output of an R-C coupled amplifier such as that described here may be conservatively defined as the maximum obtainable without driving the output valves to grid current. This criterion is easily checked on a cathode-ray oscilloscope, the onset of grid current being observed as peak clipping, the input being reduced just to avoid this. The measurements described below use this method of determining maximum power output.

Fig. 2 shows the maximum power output, measured across various values of dummy load resistance on the secondary of the WO866 transformer. An output of 50 watts is obtained in the load with an equivalent anode-to-anode load of 5,000 ohms, which corresponds with this transformer to a load resistance of 10.7 ohms. These conditions were used for subsequent tests.

It should be noted that values of anode-to-anode load below 4,000 ohms give increased distortion and are not recommended. The WO866 transformer has a ratio which gives a primary load of 7,000 ohms for a 15-ohm secondary load, and satisfactory operation can be obtained when operating into one 15-ohm loudspeaker giving about 40 watts maximum output, or into two 15-ohm loudspeakers connected in parallel giving about 60 watts at somewhat greater distortion. At frequencies above and below 500 c/s the impedance of a loudspeaker, or loudspeaker assembly, is usually greater than the nominal value, and the effective load is therefore higher.

Fig. 3 shows the frequency response at a power output of about 1 watt into a load of 10.7 ohms. The level response with the absence of peaks over the whole frequency range from 10 c/s to 100 kc/s indicates that the stabilizing circuits are very satisfactory with an output transformer having the characteristics described earlier. In consequence the amplifier is completely free of any tendency to parasitic oscillation under drive. The tendency for the response to fall below 10 c/s is typical of a stabilized amplifier with feedback, and greatly assists l.f. stability when a pre-amplifier is connected to the same h.t. supply.

Fig. 4 shows that maximum power output is obtainable within 0.5 dB over the audio band from 30 c/s to over 20 kc/s. Below 30 c/s this is limited by flux saturation phenomena in the output transformer, rather than by peak clipping in the output valves. At these low frequencies the power at which saturation occurs depends on the unbalanced d.c. in the transformer primary. This was 2 mA in the amplifier under test with unpicked valves. The power output is maintained to well above 20 kc/s

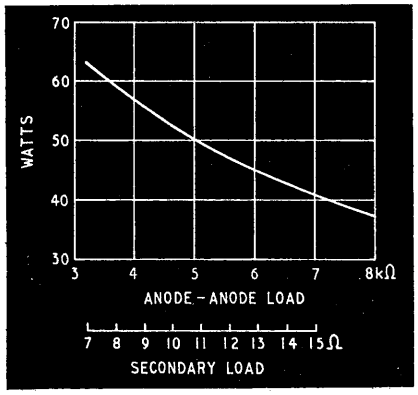


Fig. 2. Maximum power output of KT88 output stage delivered to load on secondary of transformer (Gilson WO866), at 500 c/s.

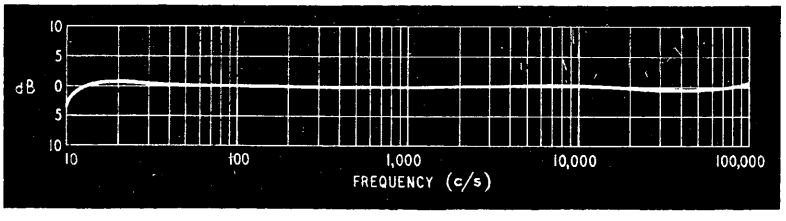


Fig. 3. Frequency response of power amplifier measured at 1 watt output.

because of the low leakage inductances and lack of resonances below 100 kc/s in the output transformer.

Fig. 4 also shows the distortion at maximum power, and this is less than 0.1% of the fundamental for both 2nd and 3rd harmonics at 500 c/s. The increases at 100 c/s and 5,000 c/s are due to the reduction of effective feedback at high and low frequencies because of the stabilizing circuits, but this is a small price to pay for the clean performance resulting from good stability. The harmonic distortion was measured up to 15 kc/s, and listening tests confirmed the merit of the results shown.

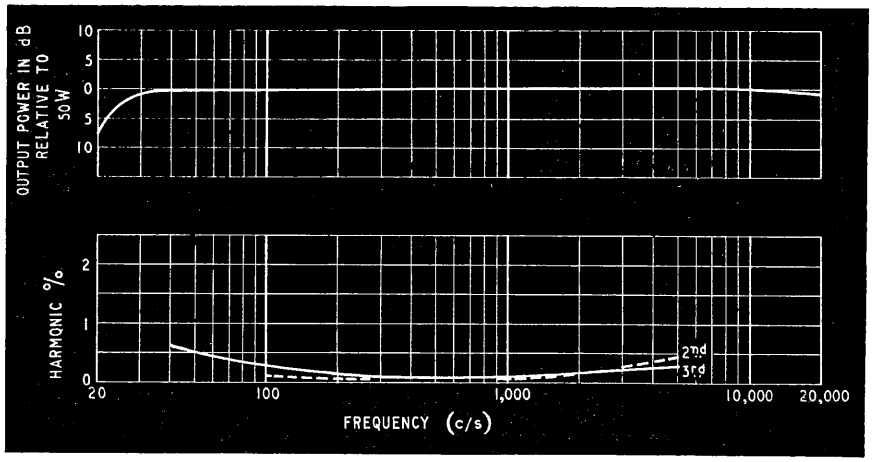


Fig. 4. Maximum available power at different frequencies, and distortion at maximum power output. Transformer : Gilson WO866. Load 10.7 ohms, equivalent to 5,000 ohms anode-anode.

The maximum power output is obtained with an input drive of 0.5 volts r.m.s., and the hum level is −73 dB with the input open circuited, or better than −90 dB with the input short circuited. The feedback is −22 dB at 500 c/s with the components shown and a 10.7-ohm secondary (24 volts output). For use with load impedances other than this the feedback resistance R_{11} (4.700 ohms) should be altered in proportion to the resulting output voltage.

The authors wish to record their thanks to their colleague D. M. Leakey for his considerable help and advice during the design of this amplifier.

Useful References

"Stabilizing Feedback Amplifiers," Thomas Roddam, *Wireless World*, March, 1951.

"UL Output Transformers," D. M. Leakey and R. B Gilson, *Wireless World*, Jan., 1956.

ITALIAN TELEVISION DEVELOPMENT

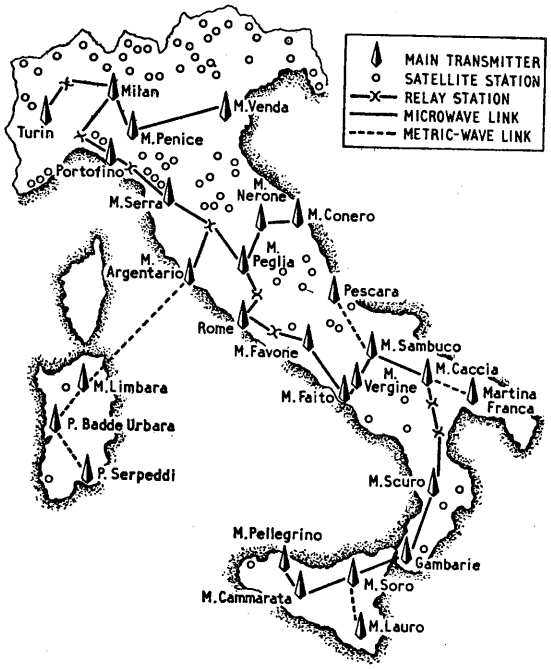
RAPID GROWTH OF THE NETWORK

WHEN the Italian broadcasting authority, Radiotelevizione Italiana, has completed its chain of 98 television stations in two or three months' time, Italy will have one station to every 1,220 square miles against the United States' one to 6,144.

At the end of December there were 24 main stations and 40 satellites, or relays, but by the end of June there will be three more main stations and a further 31 satellites, making 98 in all. When the chain is completed each station will serve an average of 480,000 people; in the United States the ratio of population to stations is 341,000 to one.

Despite the considerable growth of the network in the past twelve months the number of licensed receivers was only a little over 300,000 at the end of December —about 5,000 to each station then in use. In the country there is an average of 357,400 sets for each television station, and in the United States (where at the end of the year there were some 500 stations) about 84,600 per station.

As will be seen from the sketch map, radio links are provided between the main stations, but the satellites, which have transmitters rated at from 5 to 50 watts, rely on direct reception from a main transmitter for re-broadcasting. The majority of these satellites are unattended, are equipped with duplicate transmitters, and are automatically switched on and off by pre-set time switches. Many of them serve a comparatively small population in enclosed valleys.



Radio links are provided between the main stations.

HEARING AND

Importance of Experimental Psychology in Telecommunications

IT has been traditional for the telecommunication engineer to concern himself, almost wholly, with the design of *equipment;* equipment to be used for transmitting, receiving and reproducing signals accurately. Most of his research has been directed to the preservation of waveforms accurately, and to the reduction of harmonic distortion, noise levels and cross-talk. To accomplish this, the telecommunication engineer has trespassed beyond the classical bounds of "try-it-and-see" engineering, as evolved so magnificently in the 19th century by men of great practical experience, and has steadily drawn more and more from the fields of mathematics, of classical physics and, in recent years with the coming of semi-conductor devices, of quantum physics too.

I use the word "trespass" here advisedly, for a sense of trespass is aroused only initially. But, once accepted, the trespassers become friends and the bounds and unity of a science grow. I hope that what I have to say may convince those of you already unpersuaded, that the latest science to be drawn into contact with telecommunications, to the betterment of both, is experimental psychology—especially the study of sense perception.

New Philosophy Needed

The idea that telecommunication systems should be designed solely on a basis of waveform purity preservation is historical; it arises from the particular practical needs and the theoretical tools available, as these have existed in the past. Faithful signal reproduction is not the basic purpose of a telecommunication system at all. A telecommunication system, by itself, does not communicate. People communicate, one with another. I would suggest that we take the following as a guide to the ultimate purpose of any telecommunication system, inasmuch as we need such guides or philosophies as long-term goals in our research: *the purpose of a telecommunication system is to transmit those data, or "clues," sufficient to set up in the mind of the recipient those illusions which are desired by the sender, under given environmental conditions.*

For the popular and descriptive term "illusions" here we may substitute "beliefs." For beliefs are all you have; all that the sensory side of your brain deals with are "beliefs." When awake you are continually in some state or other of belief, and communication signals, such as the printed characters on this page, continually operate upon your sensory nervous system and change your state of belief. But more of such philosophical points later.

As in the past, it is partly the practical needs of the time which are forcing us to take this wider view of telecommunication. And we see an analogous changing attitude in our sister-sciences and techniques, especially automatic control. The practical needs may be exemplified by: the accelerated developments of automation (with its increasing supervisory tasks and sense-substitution devices); high-speed tracking as in flying jet aircraft (at such speeds and under such stress conditions that the pilot and aircraft become integrated into a unified bio-physical mechanism); and, within telecommunication pure, it is the urgency of increasing ether congestion, or finite message-capacity, which is forcing our attention more and more upon human perception and its mysteries—especially aural perception.

"Ether congestion" may suggest only work upon technical means of compressing the bandwidth of speech or music channels, or facsimile and television channels. Practical working systems have, of course, already been designed and made; for example, those of Gabor[1], or the "Vocoder"[2], or the parametric systems of Lawrence,[3] or the G.P.O.,[4] or the Haskens Laboratories in New York. But the details of the systems are of less interest in the present context than the way in which their development has opened our eyes wider and made us realize how little we know, as communication engineers, of how the brain carries out its tasks; of *how* and *why* these practical systems succeed in doing what they do. All these systems of channel compression have been evolved by an experimental philosophy, with a little guiding theory which has steadily grown to embrace some speculation or quasi-theory of the human receptor organs and nervous system. Theories of the ear are now so numerous and complex that Helmholz would well be more peaceful in his grave. Not only the ear mechanics but the aural nervous system must be brought in.

Briefly, these attempts to compress bandwidths, or otherwise to reduce the redundancy of speech and vision channels, have shown us that the way to real success is blocked until we understand much more about human listening and seeing; but, more important, this work has singled out and highlighted a number of absolutely fundamental prob-

[1] *J.I.E.E.*, Vol. 94, Part III, Nov., 1947.
[2] *J.I.E.E.*, Vol. 95, Part III, Sept., 1948.
[3] "The Synthesis of Speech from Signals Which Have a Low Information Rate," by W. Lawrence. In "Communication Theory," Ed. by Willis Jackson, Butterworths, 1953.
[4] "*Wireless World*," June, 1956, p. 291.

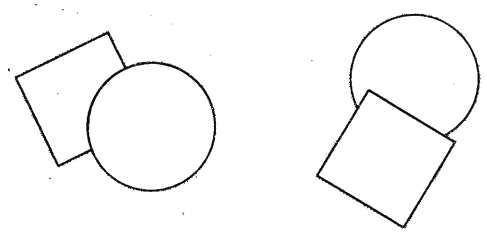


Fig. 1. "Gestalten." Looking at the two geometrical figures you "see," and respond to, a circle and a square. Yet neither figure is actually complete.

SEEING

By COLIN CHERRY,* D.Sc.

lems of human perception. These are a challenge to us, just as they are to the psychologist, but the particular way in which they have emerged in our own science has exposed a technique (that is, a body of apparatus and methods) which is being taken over by psychologists.

We have reached the stage now where first-class experimental psychologists are working with communication engineers, in complete mutual understanding and sympathy. On a long-term view this merger cannot fail to be a success, and I would stress that there will be great dividends to be had. Again on a long-term view not only will "band-compression" systems benefit but our approach and whole potential for tackling communication problems will be affected.

No Universal Criteria

It will be apparent to anyone who has heard various systems for compressing speech channel bandwidths that these systems have specialized uses. For instance, one system may be excellent for conveying the bare word or phrase content of spoken messages, for military and similar uses; another may convey good telephone speech, with emotional qualities, yet fail to satisfy the critically musical listener; one may operate well under one type of noise conditions, yet fail under others; other systems may be unintelligible to a novice yet clear as a bell to one who has been trained to their peculiar "accents."

One lesson we learn from channel compression studies is that universal criteria (for example, "waveform fidelity") cannot be applied. We must now include not only the listener, with his particular habits of listening—the stimulus/listener relationship—but the whole environmental conditions as well. Listening and viewing tests must be made and various criteria satisfied, such tests raising a whole field of difficulties because communication of, say, speech is not a single, simple activity but a whole hierarchy of activities. Speech can communicate *who* the speaker is, his emotional states, his phrases and the sets of meaningful associations they set up, and other distinct categories. Correspondingly we may need several criteria; we may do articulation and intelligibility tests using logotoms, "jabberwocky," or single meaningful words, or whole sentences; we may go higher and speak problems to be interpreted and solved by the listener; we may emulate Stanislavsky, the great Russian theatre-master, who made his pupils speak the one word "*tonight*" in one of fifty emotions to be identified by the listener. All these various categories of communication, and criteria of success, are distinct and each is relevant under different conditions of environment and different practical requirements of the channel. There is no universal standard; we must ask the *purpose* and *conditions* of the channel.

In my section at Imperial College, within the Department of Electrical Engineering, our research is mainly concerned with human perception, especially aural, and I am frequently asked how I justify this incursion into experimental psychology.

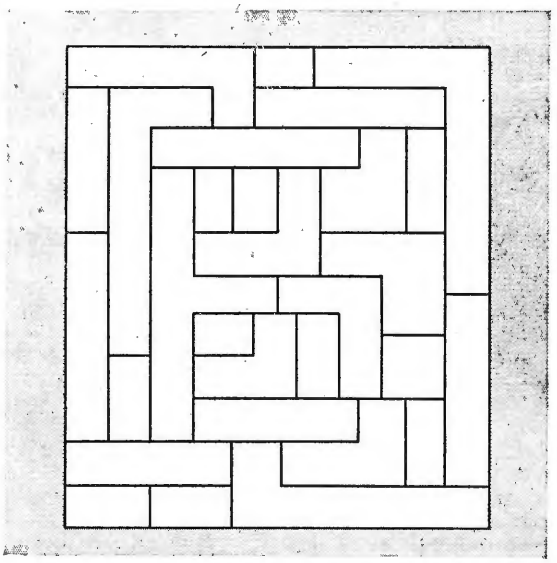


Fig. 2. A certain well-known sign is here buried in "noise." You may not spot it. But when you are told what it is, it "jumps out at you." *(Answer on page 168.)*

I hope now to have answered this question and I should like to proceed by saying something of the nature of human perception and of the fundamental problems which are of vital interest to the future of telecommunications.

We perceive only a minute fraction of all the sights and sounds around us; the rest pass us by. Only this fraction affects us and changes our state of belief; the rest leave us cold. Listening to a string quartet, one can perceive the whole music; or the 'cello alone; or the viola. This discriminatory faculty of the brain is a basic psychological concept. It is the perception of whole forms, or what are called, borrowing from the German, *gestalten* (see Fig. 1). What occupies my senses at any instant falls together into a whole pattern and excludes the rest. It forms the integrated patterned stimulus to which I respond. (In some situations the response is dependent on prior knowledge, as can be seen from Fig. 2.) How does the brain perform this selective operation? By what mechanism and logical basis?

One very special case which is directly relevant to telecommunication I have often called the "cocktail party problem." When in a noisy, crowded room I have little difficulty in singling out one speaker and listening attentively; yet my ears receive the conglomerated sound from 20 voices. The brain discriminates in a way utterly unlike the tuning or filtering action of a radio receiver and has no difficulty with its cross-talk problems. The *gestalt* is formed of one person's voice or another, as we choose. Regarded as a selective filter the brain can

* Imperial College, London. This article is based on an informal lecture given recently to the I.E.E. and has also been published in The Record of The Standard Radio Engineering Society.

act only statistically, making continual inductive inferences from the mass of acoustic data received, dependent upon its past experience, immediate and distant. That is to say, habits are called into play and these habits, of speech, of sight, of touch, are far more extensive, deeper and influential upon our beliefs and actions than most people realize. Our brains have astronomical stores of probabilities, of phonetic sequences, word and phrase sequences, of all the aural and visual patterns which make up each individual's model of the "outside" world. And we are slaves to this store of habits.

Many experiments illustrate this. Spelling errors are commonly unnoticed in proof-reading; again, we can guess 75 per cent of the words of common speech; seeing a man standing in front of a chair or table we nevertheless perceive the chair or table whole, not broken. The brain most readily accepts the familiar, and rejects the bizarre. Our "realities" and our nightmares differ only in their probabilities. The sane man has his world and the dipsomaniac his.

The American psychologist S. S. Stevens has said that "discrimination is the most fundamental act performable." Since information theory is based upon the concept of discrimination or selection of one sign from another in a set or alphabet, it would seem to have direct relevance to the psychology of perception. Indeed it has. Numerous measurements have been made of the rates at which discriminatory acts can be performed, that is, of the rates at which information can be taken in—using the words "information-rate" in their technical, exact sense, measurable in bits per second.* The interesting point is the small proportion of the total information received which is actually used. When listening to speech about 50,000 bits/sec impinge upon the ear; when reading a book the retina receives millions; yet perceptually we take in and respond to information at the rate of a few tens of bits/sec. Information theory enables us now to put precise figures to the results of psychological experiments upon the discriminatory activity of the brain, whereas previously the results were only descriptive.

The brain, then, as part of a communication channel, has a very low capacity, but requires an enormous supply of information in order that it can carry out its inductive inferences with low chance of error. But it is not only the *quantity* of information reaching the ears and eyes which matters but the particular form or representation provided by the stimulus. There is a "matching" problem, and better understanding of the perceptions will assist us to match the better.

Mental Pigeon-Holing

This brings me to another fundamental psychological point in telecommunication; the brain not only discriminates between patterns, as *gestalten*, but must first form these *gestalten*. This faculty is commonly illustrated by our ability to recognize noisy or distorted speech. Most people would say that when a speaker speaks he utters words; noisy and distorted perhaps, but nevertheless words, strung into phrases. But this is not the logic of the case. Speech is a stream of sound, not segmented into words; everybody, saying "the same thing," sets forth a somewhat different stream of sound. There is no pure standard speech; all speech is, in this sense, distorted from a norm. But, just as no one has met "the average man," we have never heard words in their purity. "Words" exist only as pigeon-holes in the mind of the *listener* whose brain sorts out the sounds received and classifies them into these pigeon-holes. All *gestalten* are pigeon-holes in this sense; the sense data we receive are classified this way. But the various processes we call "learning" correspond to the creation of new pigeon-holes, for subsequent sorting acts or discrimination.

I should not like it to be thought, with this emphasis on the value of studying brain actions, that I am advocating the direct imitation of these processes in telecommunication or other electronic equipment. No, for the brain has its astronomical store of prior data which we cannot possibly hope to imitate. Rather, it is better to emphasize that with better understanding of perception and brain processes we may approach telecommunication in a new way and achieve better "matching" to the human terminal, by providing his senses with the data his brain requires, in specific noise or other environmental conditions. We may perhaps abstract those clues from the stream of speech which set up the illusion of "the words" and achieve channel capacity compression, or better discrimination against noise or cross-talk.

Adaptability of the Brain

But another point arises now, as a warning. Since we can recognize speech in all accents, in various noises or degrees of distortion, this may suggest that certain invariant parameters exist universally and that all we need to do is to define these, abstract them automatically and synthesize the "standard" speech at the receiver. Indeed, this is roughly what Lawrence's speech compression system does. He abstracts, automatically, data concerning vocal actions, voice cavity resonances, etc., and transmits these. But we must guard against generalizing too far, because there is no *a priori* reason for assuming that the brain is stimulated always by identical sets of data, or invariants, in all circumstances. The stimulating data and mode of perception may change as criteria are changed. For instance, once a stream of sound has been identified *as* speech, the mode of perception may alter, for then we form immediate associations with our own vocal tracts. Speaking and hearing speech, are very unified.

We must guard against the too mechanistic view of the brain as a "black box" with a fixed mechanism inside, operated by definite and settled parameters. Rather, its mechanism (or our model of it) may change from instant to instant depending upon degree of success, upon what has already been perceived, or other criteria—recognition of the sounds as speech sounds, identification of the language, identity of the speaker, of his emotional state, of his words and phrases, and of their semantic content . . . a multi-layered process, the various layers being mutually dependent. We should think of the brain-mechanism as being self-adjusting, self-optimizing, flexible, not constructed unalterably like an alarm clock. Again, the whole human organism is an integrated structure, and we cannot divorce the operation of any one of the senses from that of the

(*Continued on page* 167)

* For explanation see "Information Theory," *Wireless World*, Sept., 1952.

whole organism. What we can smell depends partly upon what we see. Seeing and hearing, too, are associated; for instance, a loudspeaker nearby or behind you, at an open-air function, or a cinema, will deceive you into believing that you hear the platform speaker, or cinema actor, making the utterance—the sound directions, physical and perceptual, are made to differ by the formation of this life-like *gestalt*.

My own researches have dealt far more with hearing than with seeing, and I should like particularly to refer to some of the fundamental facts about aural perception, whose understanding will, in my opinion, profoundly affect telecommunication in the future.

The basic problem, to me, is the one I have already called "the cocktail party" problem—how can the brain separate one voice from two or more falling concurrently upon his ears; how does the brain deal with its cross-talk problem? There are two particular aspects to this—with one-ear listening and with two-ear listening. Let us take the last-mentioned first.

We have two ears and yet we hear only one world. Normally, a binaural fusion takes place, but in a very subtle and valuable way. For the brain makes great use of the slight *difference* between the stimuli at the two ears; by virtue of this difference a listener may pull apart, in his subjective space, two simultaneous speakers so that *you*, Sir, appear to stand over there, and *you*, Madam, over there. This vital faculty is far from being fully understood and is almost wholly unexploited in telecommunications, as yet, even in so-called stereophonic systems.

Identifying Sound Directions

This "pulling apart" of two speakers, by the use of our two ears, greatly helps to solve the "cocktail party" problem. This faculty rests, *only in part*, upon the fact that two utterances, coming from different directions, stimulate the listener's two ears with slightly different time intervals and intensities. These inter-aural differences alone are insufficient to identify precise directions; all they can do is locate the sources as lying in the right or left hemisphere, with certain probabilities. True directions are identified by using further evidence, in particular from what is termed the associated kinesthetic sense whilst turning the head, the use of previously learned properties of room acoustics and, possibly, the use of wave-front orientation of the sounds impinging on the ears. It is a most complex faculty and only partially understood. To most people, the hearing of other people's speech is such a familiar experience that they cannot readily understand that there are such problems; how the sounds even get *outside* our heads, for instance (the so-called "projection problem"). Another example is familiar to musicians; two flutes playing together are heard outside the head, but the beat tone is heard inside.

It is no use saying here: Why, of course! The flutes "are" outside the head, but the beat is produced inside. If we wear headphones the sound invariably lies inside the head, but as the phones are drawn away from the ears the sound remains there; after some distance the sound comes out of the head and passes *behind*, never forwards.

One very simple experiment we have found to be most illuminating. In this, a listener sits on a revolving chair between two loudspeakers playing quite different long spoken messages; he is required to listen to one of these, and we observe his method. Invariably he turns until his two ears are in line with the two speakers—a symmetrical position. The sound from each speaker reaches the nearest ear first and, after about half a millisecond delay, the opposite ear. Simple algebra shows that one spoken message could be separated from the conglomerated sounds at the ears by subtraction of the two ears' stimuli. Two ears give us this advantage over one.

Much more elaborate and lengthy experiments have shown us that the binaural process is not one of simple subtraction but one involving cross-correlation analysis* of the signals at the separate ears. I cannot discuss details sufficiently briefly here, but suffice it to say that this correlation analysis appears basic to the brain operation of spatially locating a sound and, in conjunction with other processes, of discriminating one voice from another as in the "cocktail party problem."

Influence of Habits

Now you may have noticed one major difficulty, not yet discussed. Before a listener can separate two speakers, pulling them apart in subjective space, he must have the concept of *one* speaker *or* the other. Why should not two simultaneous speakers sound merely like some new experience—say like a single speaker, in a strange foreign tongue? How are the individual voice *gestalten* formed?

This is a fascinating problem; it essentially involves brain processes of a far higher order, partly at cortical and conscious level, and is independent of one-ear or two-ear considerations. Like other sensory-recognition, or *gestalt* formation, faculties, it depends upon our accumulated past experiences—in this case, past experiences of very, very many voices, in all accents and tones. From all this, we have accumulated a mental store, of astronomical scale, of phonetic and linguistic data—statistical data, that is—of sound and syllable probabilities, of sequence probabilities—a mass of data which represents "reality" to each of us. With this prior data, the brain may carry out continual inductive inferences about sounds falling on the ears. These inferences or guesses represent our own speech and hearing *habits*, which are so deeply ingrained into all of us.

A simple experiment illustrates the deep nature of these habits. If someone reads to me steadily out of a book, I have no difficulty in tracking on and speaking almost in synchronism with him, without seeing the book. His utterances readily stimulate my speech habits, and I am perceiving *and* uttering together, as a unified *gestalt*. On the other hand, if an English reader does this while an American listener responds, he responds in American, using words like *gotten, airplane, railroad*, these being his own cultural speech habits.

This question of past experience, of familiarity or strangeness of sounds, and of how the brain makes use of this prior data, greatly needs more study. It is basic to the understanding of how we recognize distorted speech, or speech buried in noise, or with cross-talk. If we understood more, we should be in a happier position to design communication

* For explanation of correlation techniques see "Recovering Hidden Signals," *Wireless World*, March, 1955.

systems which could supply the listener with what his brain needs and so provide a better "match." Of course, individuals differ greatly in their past experiences, and have somewhat differing habits, whereas telephones and radio sets are for general use. Nevertheless, this can be treated as a statistical problem, and it is readily shown how closely we humans adhere to statistical laws in speech and language!

I have so far referred mainly to speech and hearing. Now a word or two about sight. This is of prime interest to television and facsimile and, once again, our attention is forced upon human perception when we come to consider the question of bandwidth compression.

As I look around me I think I see a room and see it whole. Yet the fovea of my eye, or angle of sharp vision, is only 1°. Moreover, my eye travels not smoothly but in a series of rapid jerks, called saccades, resting on each point of fixation for about a quarter of a second. From all this spasmodic, disjointed sense data, I construct my image of this room. Again it is a question of stored experience; walls are straight, ceilings flat. I receive some small stimuli and conjure up the rest.

The ready perception of truly familiar patterns is illustrated by flashing up some well-known sign on a screen for a very short duration—far too short for the eye to make any saccadic exploration of its form. If words are projected, misspelt, you will see them to be correct, just as you can overlook a printer's error.

The eye moves along the lines of print whilst reading a book in this same jerky manner, pausing only at 2, 4 or say 6 points per line, depending upon the textual difficulty. For "difficulty" read "probability" here and we may be nearer the mark. We need to know far more about the control exerted by the text, in terms of probabilities, upon the eye movements. Again, and this in relation to television, we need to know far more about the way in which the eye scans scenes. In detail, we need to know what are the "bricks" which habitually build up scenes in our minds; we certainly perceive sharp edges and corners, but what other geometric forms exert control and what elements of patterns are unperceived because of prior knowledge, being inferred or conjured up?

All scenes, just like all utterances, are highly redundant in information, and this redundancy helps us to overlook errors in real life. In compressed television or telephony, we aim to reduce this redundancy and it is axiomatic that in so doing we raise the probability of error. But the "matching" problem is this, that we need to reduce those redundant elements of signals which are insignificant to perception; the errors then made are without serious consequence. And to do this we need to know vastly more about human aural and visual perception.

Answer to the Fig. 2 puzzle: the buried sign is the letter "E."

Inexpensive High-Quality Amplifier

(*Continued from page 113 of the previous issue*)

Measured Performance and Some Comparative Listening Tests

By *P. J. BAXANDALL, B.Sc.(Eng.)*

In view of the simplicity of the design, and the large margins left with respect to d.c. operating conditions and feedback stability, it is unlikely that any troubles will be experienced if the construction has been done carefully—the required performance should be obtained straightaway. A few d.c. voltages should preferably be checked, however, and should fall within the following limits:—

(a) Centre-tap of output transformer primary to earth:	280 to 320 V
(b) V1a cathode to earth:	1.2 to 1.8 V
(c) Decoupled h.t. supply to V1:	265 to 305 V
(d) V1b cathode to earth:	50 to 90 V
(e) Output valve cathodes to earth (The two cathode voltages should preferably not differ by more than 0.75 V.)	6.0 to 8.5 V
(f) Output valve screens to earth:	180 to 230 V

The total h.t. current should be within the limits 60 to 80 mA.

If an audio-frequency oscillator, valve voltmeter and c.r.o. are available, it is worth checking that an output of 5 watts can be delivered into a 15-ohm load resistor (8.66 V r.m.s.) over the frequency range 35 c/s to 10 kc/s, without visible signs of distortion.

It is necessary, of course, to ensure that the output transformer is connected so that the feedback is negative. If the transformer has been wound as intended, negative feedback will result when V3 anode is connected to the primary section on the outside of the winding. Should a mistake have been made, violent oscillation will make this very evident, and the amplifier should be switched off immediately!

Performance Measurements on Prototype.—Numerous measurements have been made with the circuit, using the Gilson prototype output transformer, and some of the results are presented in Figs. 6, 7, 8 and the oscillograms. With reference to Fig. 8, it may be added that higher-order harmonics are of very much smaller amplitude than

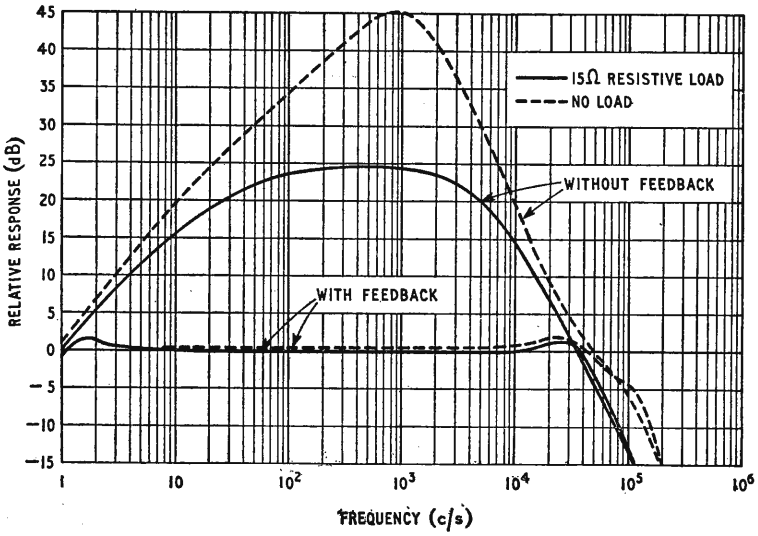


Fig. 6. Measured frequency-response curves for Fig. 1 circuit. (The output voltage was kept constant at approximately 0.1 V r.m.s. during these measurements.)

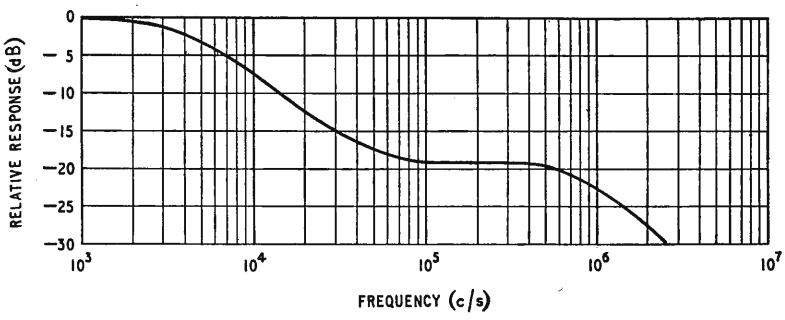


Fig. 7. Measured frequency response between V1a grid and V1b cathode, with overall feedback disconnected.

the 2nd and 3rd harmonics, and that they fall off very rapidly in amplitude with increasing order, as would be expected in a class A amplifier. The second-harmonic distortion is generated mainly in the input stage.

Some figures deduced from the measurements are as follows:—

(a) At 500 c/s there is just over 24 dB of feedback.

(b) The effective internal resistance of the amplifier, measured at the 15-ohm output terminals at 500 c/s, is approximately 0.7 ohm; this corresponds to a damping factor of just over 20 or to a damping ratio of approximately 0.96.

(c) The hum output is approximately 80 dB down on 5 watts, and corresponds therefore to 0.05 microwatt.

(d) The total mains power consumption is approximately 50 watts.

Listening Tests.—Some of the physical performance figures for this amplifier are inferior to those which apply to the highest grade amplifiers available today; this is inevitable, of course, in such a highly economical design. The really important question, however, is whether the results obtainable are in any way *audibly* inferior to those which can be obtained with amplifiers of the highest grade, and to find the answer to this question some careful listening tests have been made.

These tests were carried out both in the author's own home, where the living room has dimensions 21ft 6in × 13ft 6in, and also in the considerably smaller living room of a friend, Mr. S. W. Noble; in the latter case, however, there was the advantage of a loudspeaker (Acoustical Manufacturing Company's corner ribbon) whose performance, particularly at very high frequencies, is rather better than that of the author's loudspeaker. The equipment associated with the corner ribbon speaker consists of main and pre-amplifiers by the Acoustical Manufacturing Co., fed from either their f.m. tuner or an Ortofon pickup with diamond stylus. The equipment used with the author's loudspeaker is of generally similar quality.

In all tests the 5-watt amplifier was arranged as in Fig. 9, so that it could be instantly switched in or out of circuit, the 1-kΩ potentiometer having been carefully set, with the aid of an oscillator, so that the same voltage was delivered to the

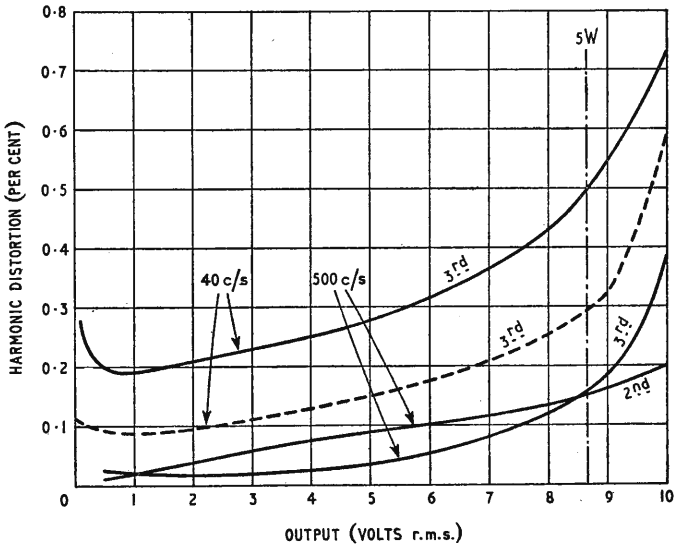


Fig. 8. Variation of second- and third-harmonic distortion with output voltage, on 15-ohm resistive load. Other harmonics are of much smaller magnitude. The dotted curve was obtained with a Partridge type P4077 transformer with grain-oriented silicon steel laminations.

loudspeaker for either position of the changeover switch.

To obtain information on the signal levels actually being fed to the loudspeaker during the tests, a simple peak programme meter was used. This is really a peak-reading valve voltmeter, in which the diode rectifier circuit has a charging time-constant of well under 0.1 millisecond and a discharging time-constant of 5 seconds. The circuit thus responds to transients of the shortest duration and the needle falls back slowly enough for the peak value to be satisfactorily indicated and read. The dial is calibrated in watts, using a sine-wave source and assuming the meter to be connected across a 15-ohm resistive load. For example, with 8.66 V r.m.s. applied to the meter, the reading obtained is marked "5 watts," since $(8.66)^2/15=5$; and so on for various other input levels. With this method of calibration, an amplifier rated at 5 watts in the usual manner (i.e., capable of giving a mean output power of 5 watts into a 15-ohm resistive load on sine-wave input) should be just capable of giving a meter reading of 5 watts on programme input without overloading.

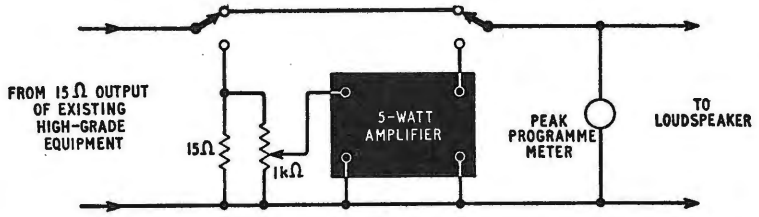
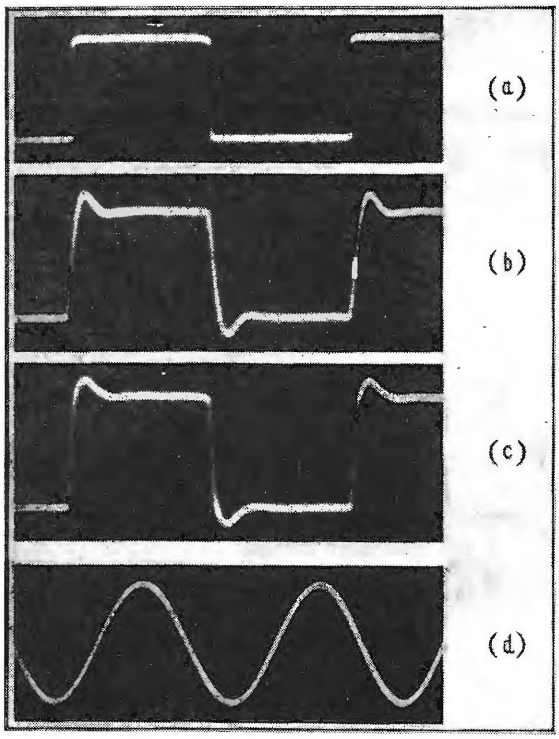


Fig. 9. Switching arrangements for comparative listening tests.

Most of the tests were made using long-playing records, which were all good examples of modern recording technique and which covered a wide range of different kinds of music. The listeners were all sound-reproduction enthusiasts with a keen interest in music as such. The author, in most of the tests, left the choice of volume control setting to other people, on the grounds that he had, so to speak, a vested interest in proving that high peak power levels were unnecessary. The procedure, then, was to ask a listener to set the volume control, with the author's amplifier switched out, to his chosen setting, observe the peak readings reached on that recording, and then replay the recording, or selected sections of it, with the author's amplifier switched in. Quick changeovers were also made, on numerous occasions, during particular passages of music. The results of the tests may be summarized as follows:—



(a) 5-kc/s square-wave input signal, and (b) and (c) corresponding output waveforms with 15-ohm resistive and no load respectively. (d) Waveform across 15-ohm resistive load at a mean output power of 5 watts, for 35-c/s sine-wave input.

(a) Provided peak readings beyond the 7-watt mark were not reached, no deterioration at all in quality could be detected by any listener when the author's amplifier was switched in. The same conclusion was reached when the amount of feedback in the amplifier was reduced by 6 dB, this being done by switching in a suitable potential divider into the feedback path, another section of the switch inserting a suitable attenuator in the grid circuit so that the gain of the amplifier was unaffected by operating the switch. The amplifier would thus appear to have an adequate margin to spare as far as audible distortion is concerned.

(b) Readings in excess of 5 watts were almost never reached, the only occasions when they were being momentarily during two or three extreme *fortissimo* passages of large orchestral works as reproduced in the living room of the above-mentioned friend, with the volume control set by this friend. On one occasion, during Beethoven's "Eroica" symphony (Columbia 33CX 1346), a reading of 8 watts was reached. On switching in the author's amplifier for this climax, there was a noticeable roughness for a fraction of a second, but apart from this there was no detectable loss in quality. Another record used in the tests, which produced peak readings up to 7 watts, was Holtz's suite "The Planets" (Nixa NLP 903).

(c) Much lower peak levels were reached, as might be expected, during music of a less dynamic variety. There was general agreement that most light orchestral music could be reproduced at what appeared to be a fairly realistic level without exceeding peak readings of about 2 watts, and that many people preferred to listen at an even lower level. During reproduction, in the author's living room, of a very good piano record (Sonata No. 3 in B Minor, by Chopin, on H.M.V. ALP 1243), peaks of just over 3 watts were reached, the reproduction giving the impression of being about full scale.

(d) On organ music an exceedingly great volume of sound could be produced, in the author's living room, with the volume control set so that extreme peaks went up to 5 watts; as, for example, during the conclusion of Bach's Fantasia in G Minor on

Decca LXT 5029 ("Bach Organ Recital")—a very good organ recording. The most striking thing, on watching the programme meter during this recording, with the volume control set as above, is that, for the great majority of the time, even during quite loud passages, the needle does not go above the 1 watt mark.

The amplifier has been found to be capable of handling heavy organ pedal passages, at its full output level, without an audible increase in distortion compared with a higher-grade amplifier.

(e) On talks, news bulletins, etc., at a fairly average sort of listening level, the peaks were much less than 0.1 watt.

Thus it may be concluded that this amplifier has sufficient available power for most normal domestic applications, and that its distortion is negligible as judged aurally. By using a larger amplifier, very little, if any, advantages would in actual fact be gained, but some readers, addicted to listening at very high volume levels, will no doubt prefer a larger amplifier, if only to give them the feeling of being more comfortably free from the risk of overloading it.

It may be mentioned that the author's loudspeaker, whilst probably a little more sensitive than the Acoustical corner ribbon speaker already referred to, is not of exceptionally high efficiency as high-quality loudspeakers go. With loudspeakers such as the G.E.C. metal cone speaker, whose sensitivity is low, some people would, no doubt, complain of a shortage of available power using this amplifier. A loudspeaker unit which has, on the other hand, quite a high efficiency, and which, in the author's opinion, has much to recommend it when economy must be considered, is the Goodmans Axiom 102. When properly loaded acoustically, this unit seems to be capable of remarkably good reproduction, as demonstrated, for example, in the Junior Corner Horn made by Rogers Developments, Ltd.

Electrostatic Loudspeakers.—The opportunity of trying this amplifier with a full-range electrostatic loudspeaker has not yet presented itself, but it is thought that a few comments regarding the feasibility of using it with such a loudspeaker might be welcomed. These loudspeakers, in the form made during the earlier stages of commercial exploitation, will contain matching transformers to suit them to use with amplifiers primarily designed for feeding 15-ohm moving-coil loudspeakers. The variation of impedance with frequency is, however, very different with an electrostatic loudspeaker, compared with a moving-coil one, and difficulties are likely to be experienced with some amplifiers in the form of high-frequency oscillation caused by the capacitive nature of the load presented by the electrostatic loudspeaker. Assuming the loudspeaker to be matched so that its impedance is 15 ohms at 5 kc/s, this means that it will look approximately like a capacitor of about 2 μF at high frequencies—except in so far as this may be modified by the presence of leakage inductance and resistance in the loudspeaker transformer or by the introduction of other separate stabilizing elements by the loudspeaker manufacturer.

Taking the worst likely case, i.e., that the loudspeaker looks like a pure 2-μF capacitor at high frequencies, it is necessary, with the present amplifier, to include some resistance in series with the 2-μF load in order to secure a satisfactory margin of high-frequency stability. A value of 3 ohms is suitable, and gives a large stability margin whilst having a negligible effect on the frequency response up to 15 kc/s. To prevent the introduction of such a resistor from producing an appreciable increase in non-linearity distortion in the loudspeaker transformer core at low frequencies, the best practice would be to shunt it with an air-cored inductor whose value is very uncritical but which should be in the region of 0.5 mH.

It should be emphasized that the above precaution *may* be unnecessary—it may turn out to have been taken by the loudspeaker manufacturer.

APPENDIX

Peak Programme Meter

The circuit is shown in Fig. A. The simplest calibration procedure is as follows:—

(a) Set switch to "Off" and adjust "Set Zero" control to give exactly 1 mA through meter.

(b) Set switch to "Cal," thus applying an input of approximately 6.3 V r.m.s. from the heater supply, and adjust "Sensitivity" control to give exactly 0.5 mA through meter.

(c) Set switch to "Use" and apply sine-wave input voltages of various known values corresponding to mean

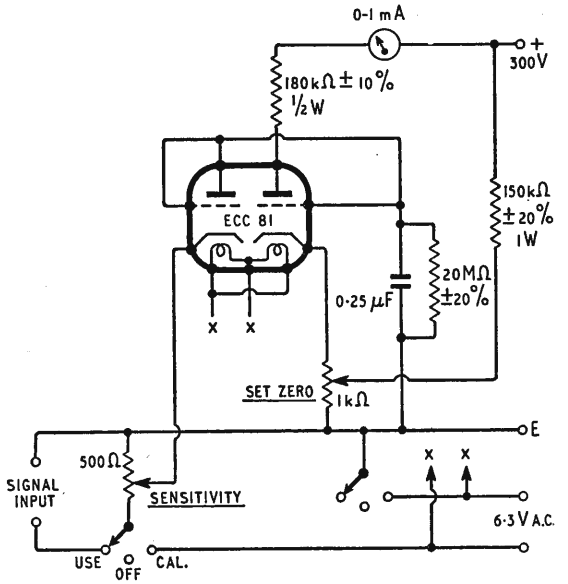


Fig. A. Circuit of simple peak programme meter used in listening tests. Alternative valve types are 12AT7, Osram B309 or Services type CV455.

TABLE

Mean Power (Watts)	Voltage across 15-Ω (r.m.s.)	Meter Current (mA)
0.1	1.22	0.91
0.2	1.73	0.86
0.5	2.74	0.78
1.0	3.88	0.69
2.0	5.48	0.56
2.65	6.30	0.50
3.0	6.72	0.46
4.0	7.75	0.39
5.0	8.66	0.33
6.0	9.48	0.28
7.0	10.2	0.24
8.0	11.0	0.20
9.0	11.6	0.17
10.0	12.2	0.14

power levels of 1, 2, 3, etc., watts in a 15-ohm load, and mark the scale off in watts correspondingly. The voltages required are given in the table, which also gives the currents obtained through the meter in the author's version of the circuit. Readers unable to supply known a.c. voltages for calibration purposes can adopt the author's calibration as given in the table; sufficient accuracy for ordinary purposes should be obtained in this way, but individual calibration is really preferable since the scale shape is dependent to some extent on individual valve characteristics.

Ideally the meter movement should be so damped that it just does not overshoot when a sudden change of current occurs. Ordinary meters vary a good deal in this respect; the one used by the author is made by Pullin, Ltd., and has the right degree of damping for the purpose. It is used upside down, so that an increase in signal level gives a pointer movement to the right. This particular meter has a case 2⅜in diameter.

A shortcoming of this simple programme meter is that it employs a half-wave rather than a full-wave rectifier. This is unimportant provided the signal waveforms are symmetrical, and it seems that most music waveforms are fairly symmetrical with the exception of those involving the male voice. It may easily be demonstrated, using a ribbon microphone, that different readings are obtained on male speech, to the extent of 3 dB or more, according to which side of the microphone faces the person speaking[4].

[4] "Amplitude Modulation Up to Date," by O. J. Russell, *Wireless World*, March 1943.

BOOKS RECEIVED

An Automatic System for Synchronizing Sound on Quarter-Inch Magnetic Tape with Action on 35-mm Cinematograph Film, by L. H. Griffiths, M.A., B.Sc., A.M.I.E.E., and N. W. Woodward, B.Sc.(Eng.), Grad.I.E.E. B.B.C. Engineering Monograph No. 10 describes equipment in which a 50 c/s reference signal on the tape is compared with the mains supply frequency and the phase error is corrected by supplying the capstan motor through a "selsyn differential" operating as a continuously variable phase-shifting transformer. Pp. 14; Figs. 8. Price 5s. B.B.C. Publications, 35, Marylebone High Street, London, W.1.

A Simple and Versatile R.F. Measuring Circuit, by J. Miedzinski, B.Sc., and S. F. Pearce, B.Sc., A.Inst.P. Electrical Research Association Technical Report M/T120 describes "constant input," "constant output" and "constant attenuation" methods of measuring the impedance-frequency characteristics of filter components. Pp. 11; Figs. 6. Price 10s 6d.

The Properties and Design of Iron-cored Suppression Chokes, by J. Miedzinski, B.Sc. Electrical Research Association Technical Report M/T121. A comprehensive treatise including a series of design charts. Pp. 29; Figs. 11. Price 24s. The Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Graphical Symbols for Telecommunications. Supplement No. 4 to B.S.530:1948. Miscellaneous recommendations and symbols including transistors. Pp. 22. Price 3s 6d.

Supplement No. 5. Functional symbols for switching diagrams with particular application to electronic circuits. Pp. 14. Price 2s 6d.

Safety Requirements for Radio or other Electronic Apparatus for Acoustical or Visual Reproduction. B.S.415:1957. Includes specifications for standard "test finger" and testing of cathode ray tube implosion guards. Pp. 31; Figs. 3. Price 6s. British Standards Institution, 2, Park Street, London, W.1.

A.C. Synchro Systems for Civil Aircraft. Survey of torque, control and resolver synchros and their uses, and of British and American wiring conventions. Pp. 27; Figs. 27. Price 10s. Radio Communication and Electronic Engineering Association, 11, Green Street, London, W.1.

Mathematical Tables Vol. 1. The Use and Construction of Mathematical Tables, by L. Fox, M.A., D.Phil. General introduction to a series of tables for use in computational problems to be prepared by the Mathematics Division of the National Physical Laboratory, D.S.I.R., with a bibliography of the subject. Pp. 59+IV. Price 17s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

Theorie und Technik der Pulsmodulation, by E. Hölzler, Dr.Ing., and H. Holzwarth, Dr.Ing. Treatise on pulse generation and modulation by amplitude, width, spacing and other methods. The problems of noise and an outline of practical pulse communication systems are also included. Pp. 505+XIV; Figs. 417. Price DM57. Springer-Verlag, Reichpietschufer 20, Berlin, W 35.

Tubes for Computers (Philips Technical Library). Introduction to switching circuits with specific circuit designs for use with selected Philips valves. Pp. 52. Figs. 59. Price 9s 6d.

U.H.F. Tubes for Communication and Measuring Equipment (Philips Technical Library). Selected valves, including disc seal types, and circuits for use at 300 Mc/s and above. Pp. 70; Figs. 76. Price 9s 6d.

Tube Selection Guide, 1956-57, by Th. J. Kroes (Philips Technical Library). Classification of Philips valves and their equivalents including transmitting valves with their maximum operating frequencies, arranged according to function and availability (current, replacement or obsolete). Pp. 124; Figs. 32. Price 9s 6d.

The Cathode Ray Oscilloscope, by J. Czech (Philips Technical Library). Comprehensive practical treatise on the design, construction and use of the c.r.o. as a measuring instrument with practical examples of investigations on television receivers and on the behaviour of the luminous flux from incandescent and fluorescent lamps. Pp. 338; Figs. 407. Price 57s 6d.

All the above Philips Technical Library books are obtainable through the Cleaver-Hume Press, Ltd., 31, Wrights Lane, London, W.8.

T.V. Conversion for I.T.A., by C. E. Lotcho. Detailed practical guide to the conversion of the leading makes of Band I British television receivers for use on Band III. Lists are included of intermediate frequencies and of models which are aligned to the upper sideband. Pp. 240; Figs. 170. Price 25s. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2.

Transistor Techniques (Gernsback Library). Collection of articles from *Radio-Electronics* designed to give familiarity with the properties and uses of transistors in simple practical applications. Price 12s through The Modern Book Company, 19-23, Praed Street, London, W.2.

The Electronic Musical Instrument Manual, by Alan Douglas. Revised and enlarged third edition. Pp. 247; Figs. 216. Price 35s. Sir Isaac Pitman and Sons, Ltd., Parker Street, London, W.C.2.

Television Techniques, by Hoyland Bettinger and Sol Cornberg. Guide to the writing and production of television programmes. Pp. 266; Figs. 32+XVI. Price 21s. Frederick Muller, Ltd., 110, Fleet Street, London, E.C.4.

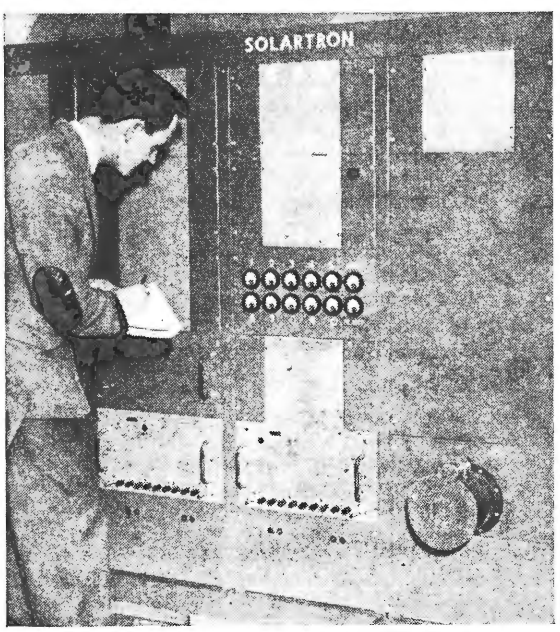
Reading by Electronics

AUTOMATIC CHARACTER RECOGNITION USING LOGICAL GATE CIRCUITS

VERY few of the automatic reading machines invented during the past 25 years or so have got past the experimental stage. The main difficulty seems to be in making them flexible enough to cope with different character styles, imperfections in printing, spots of dirt on the paper and so on, at the same time as achieving an absolute reliability of recognition. Some of the earlier schemes were intended as aids to the blind, but in recent years the emphasis has shifted to the requirements of the modern business office.

Here automatic readers are needed for rapid translation of printed figures from typewriters, cash registers, time clocks, ticket printing machines and so on into the medium of punched cards (or perhaps punched tape or magnetic tape) for feeding into existing business machines. Normally this job is done by human labour, and it takes a long time as well as costing a lot of money. It produces a "bottleneck" in the mechanized processing of information which is a particular disadvantage when, say, a rapid analysis is required of yesterday's sales figures. Moreover, this bottleneck becomes even more obvious now that high speed electronic computers are being introduced into the business field.

Most electronic reading systems work on the same general principle. The printed characters are fed in turn past a scanning system, either electronic or electro-mechanical, which converts each one into an electrical pattern corresponding to the disposition of light and dark on the paper. This electrical pattern is then compared with reference patterns, representing the complete range of possible characters, stored inside the machine. When a correspondence is detected a signal indicating the appropriate character (perhaps in binary or some other code) appears at the output. In one American machine, for example, the comparison of patterns is done by cross-correlation techniques. Circuits working on probabilities have also been suggested.



The Solartron machine is about the same size as a small digital computer and costs in the region of £20,000-£50,000. Here, monitoring meters are being read.

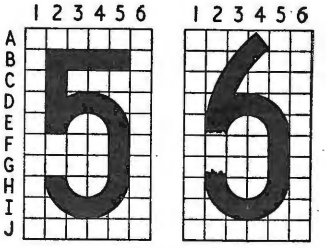
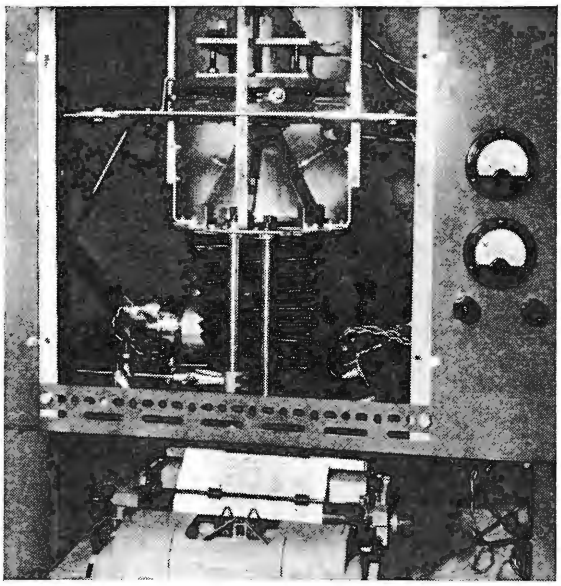


Fig. 1. Basic method of analysing a character into small black or white "picture elements" suitable for binary electronic circuits.

One recent trend is towards the use of logical circuits of the kind found in digital computers—notably the so-called "AND" and "OR" gates. Fig. 1 illustrates the general idea behind this approach. Supposing the characters are analysed into "picture elements" as shown, it is possible to identify a character by the fact that certain elements are either predominantly black or predominantly white. There are only two conditions, corresponding to "on" and "off" in electrical form, and this is what makes it possible to use the logical two-state gating circuits. In dealing with the left-hand figure, the circuits might detect the break in the circle (squares F2 and G2) and therefore decide that it could belong to either a "3" or a "5." In this respect it could also belong to a broken "6," as shown on the right. But the circuits would also find that there is black in B2 and B5 as well as in B3 and B4, so therefore the character in question is "5" and not "6."

The electronic circuits in these "logical" machines, then, have to work on statements of identification something like this: "If black is either in B5 *and* F2 *or* D3 *and* J5, *and* is in F6 *and* H5, but is not in E4 *or* G3, then the character is '4.'" The *ands* and *ors*, of course, are instrumented by gate circuits performing these functions, and it is the interconnections of the gates which provide the reference patterns against which the incoming characters are tested. This kind of principle is actually used in a machine recently developed by Solartron which can recognize numerals at the high rate of 120 per second. It has to be "programmed" for different type-founts, but allows for all the variations of pattern caused by bad or misregistered type, smudging, dirt on the paper and so on which one expects to find on ordinary business documents.

A block diagram of the Solartron machine is shown



Flying-spot scanner of the Solartron machine.

in Fig. 2. A paper feed mechanism moves the characters in turn past a flying-spot scanner, and the variations in reflected light resulting from the scanning process are picked up by a photo-multplier tube. The signals from this are amplified and then passed through limiting circuits which clip the top and bottom of the waveform. This establishes definite black and white levels which are independent of the heaviness of the printing, the condition of the paper and so on.

The actual scanning is done in ten vertical lines, and each line can be considered as being divided into 10 picture elements. Thus there are 100 picture elements altogether, each of which will be either predominantly black or predominantly white. The scanning speed is synchronized by the clock pulse generator (of 500-kc/s p.r.f.). The output of this is frequency divided down to give a line scan period corresponding to 10 picture-element periods (the "units generator") which is used to synchronize the vertical deflection. Another frequency divider (the "tens generator") then gives a signal for synchronizing the horizontal deflection.

There are actually two scanning cycles for each printed character. The first is used for automatic registration of the scanning raster on to the centre of the character, while the second is the actual reading period. This accounts for the "register/read gate" which, under the control of the timing generators, causes the photo-multiplier output to be switched either to the registration system or to the 100-element matrix store. The distribution of the black and white picture elements to corresponding positions in this matrix store is done by a 100-way gating system under the control of the "units" and "tens" generators. The actual storage is done by the "on" and "off" conditions of 100 two-state circuits arranged in matrix form with ten X inputs and ten

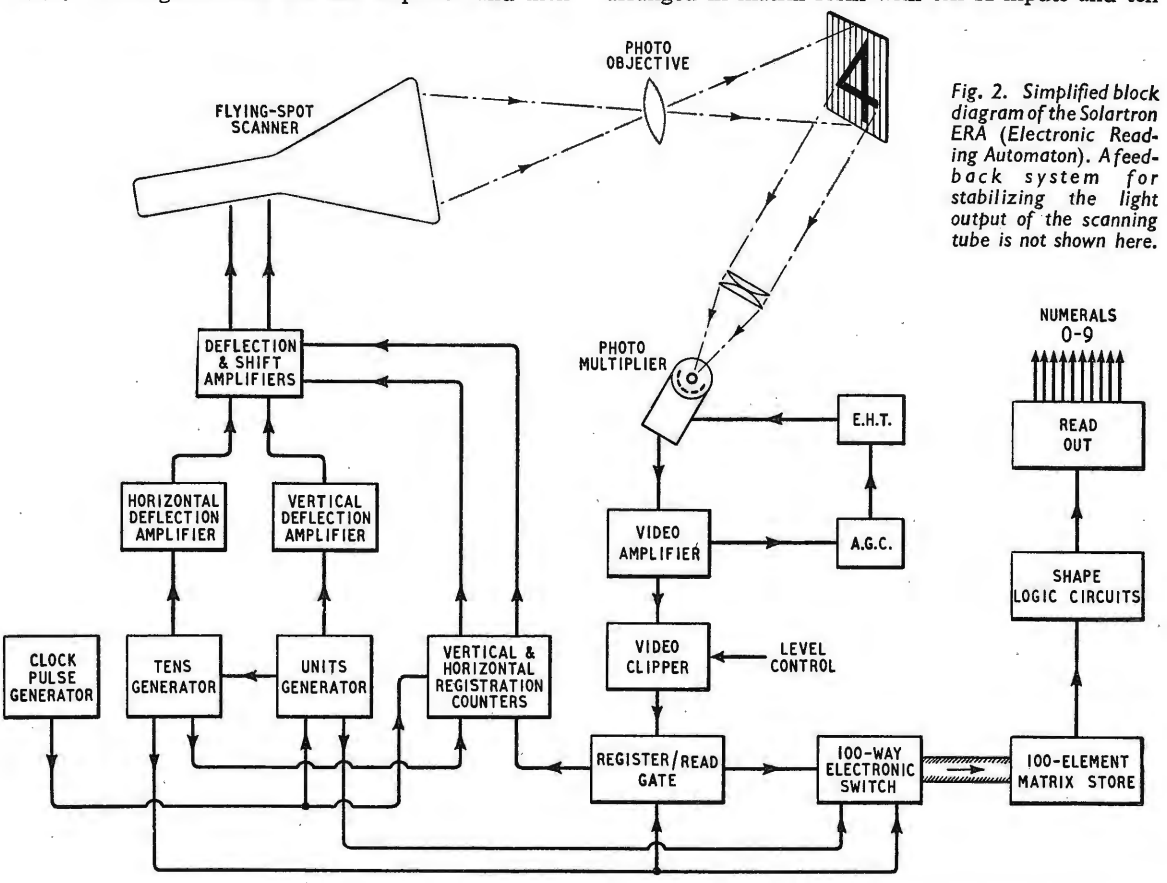


Fig. 2. Simplified block diagram of the Solartron ERA (Electronic Reading Automaton). A feedback system for stabilizing the light output of the scanning tube is not shown here.

Y inputs, but capacitors are likely to be used for this purpose in the future.

From the store the "on-off" pattern representing the read character is applied to the logical recognizing circuits, which work on the kind of principles mentioned above. The actual arrangements of gates are extremely complicated, but in general terms the initial identification processes are performed by groups of "OR" gates which, by their nature, allow for certain possibilities and variations in the patterns. The really conclusive and final decisions are then made by groups of "AND" gates, which are fed from the outputs of the "OR" gates. An "AND" gate is essentially a coincidence detector and only gives an output when the required set of electrical conditions is applied to its inputs simultaneously. Germanium diodes are used for these "OR" and "AND" circuits, and the interconnections between the gates (i.e., the reference patterns determining which paths the input information shall take) are set up, or "programmed," by printed-circuit boards.

At the end of the recognition process for each character a signal appears on one of the ten output wires (representing the numerals 0, 1, 2 . . . to 9) and this can be used for operating, say, a card punch or the keyboard of an automatic typewriter. The output signals can also be fed directly into a digital computer after conversion into binary-coded decimal digits taking the form of serial pulse trains.

The registration or centring process mentioned earlier is achieved by detecting the position of the top, bottom, left and right extremes of the character in the initial "register" scan, then applying appropriate X and Y shift voltages to the scanning tube during the "read" scan. For horizontal registration, a counter is used to count the number of vertical scan lines from the left to the first and last picture elements which have any black content. Half of the difference between these two counts (i.e., the centre of the misregistered character) then gives a measure of the shift from centre to be applied to the existing scan. For vertical registration a similar process is used, working with numbers of elements instead of lines. Any progressive tendency in character misalignment is corrected by a servo system on the paper feed mechanism.

MARITIME V.H.F. RADIO

A Step Nearer World-Wide Agreement

By CAPTAIN F. J. WYLIE R.N. (Retd.)*

TO those who have no direct or personal interest in them, one international radio conference is, no doubt, very much like another. So it seems desirable to emphasize the unusual nature and potential of the Agreement which was concluded at the Maritime V.H.F. Radiotelephone Conference at The Hague in January. It is not every day that a door is opened on to a new field of international telecommunication, but this is in fact what was done at The Hague for maritime v.h.f. The written Agreement was signed only by its originators, the Baltic and North Sea countries, but it is hoped that other maritime countries will accept it as a basis for universal co-operation, so that the seal of the International Telecommunication Union may be set upon it at its next Administrative Radio Conference in 1959. The U.S., Canadian and Italian representatives who were present at The Hague were in general accord.

The main purpose of the recent conference was to turn the informal Gothenburg agreement of 1955† and the technical recommendations made by the C.C.I.R. (International Radio Consultative Committee) at Warsaw in 1956 into a working arrangement, which would avoid a delay of nearly three years in establishing international maritime v.h.f. services. Many of the maritime countries of the world had already voiced their agreement with the principles of the Gothenburg plan.

In effect, the task of the conference was so to construct the frequency plan and the regulations for its use, that ships equipped with v.h.f. sets of economical design could depend on obtaining good service in any part of the world. This problem may sound precisely similar to that long since accomplished for wireless telegraphy in the 500 kc/s band and for telephony on 2 Mc/s. Apart from intership working, these m.f. services are, however, provided entirely on the basis of public correspondence through coast stations which in most countries are operated by the Administration. On the other hand, the v.h.f. services have to include facilities for direct communication with quite a variety of port and dock services. The operational nature of these lines of communication necessitates planning with one eye on system versatility and the other on the size and cost of the ships' equipment.

The port operational service required some definition so that it should not carry traffic which should properly be sent on public correspondence channels. It was agreed that its use should be restricted to messages related to the movement and the safety of ships and, in emergency, to the safety of persons. It was appreciated that in the vicinity of a port a ship's movement may be affected by administrative matters, such as customs or on medical grounds.

The frequency allocation table given overleaf is, of course, the foundation of the whole structure and it needs some explanation. It is based on 50 kc/s channel separation and each of the 26 usable channels is designated by a number and nominated for either single- or two-frequency working; interleaving of the

* Radio Advisory Service of the Chamber of Shipping and the Liverpool Steam Ship Owners' Association.

† See *Wireless World*, April, 1956.

two methods was avoided as far as possible. For port operations it was considered necessary to allow for both methods of working. Because of the varying demands and planning considerations in different localities the principle of allocating a few exclusive channels to each service and to specify the sequence in which they should be taken into use was adopted.

FREQUENCY ALLOCATION TABLE

Channel	Ship Frequencies (Mc/s)		Inter-ship	Port Operations		Public Correspondence
	Transmit	Receive	Single-Freq.	Single-Freq.	Two-Freq.	Single-Freq.
1	156.05*	160.65			10	8
2	156.10	160.70			8	10
3	156.15*	160.75			9	9
4	156.20	160.80			11	7
5	156.25	160.85			6	12
6	156.30	156.30	**1**			
7	156.35	160.95			7	11
8	156.40	156.40	**2**			
9	156.45	156.45	5	5		
10	156.50	156.50	3			
11	156.55	156.55		3		
12	156.60	156.60		**1**		
13	156.65	156.65	4	4		
14	156.70	156.70		**2**		
15	156.75	Guard-band (156.725—156.775Mc/s).				
16	156.80	156.80	Calling and safety			
17	156.85	Guard-band (156.825—156.875Mc/s)				
18	156.90	161.50			3	
19	156.95	161.55			4	
20	157.00	161.60			**1**	
21	157.05	156.05* or 161.65			5	
22	157.10	161.70			**2**	
23	157.15	156.15* or 161.75				5
24	157.20**	161.80				4
25	157.25	161.85				**3**
26	157.30	161.90				**1**
27	157.35	161.95				**2**
28	157.40	162.00				6

* In the special semi-duplex public correspondence used in France and Belgium and possibly elsewhere, these frequencies are for "ship receive."
** When required this channel will be used as a two-frequency calling channel and also for selective calling.

If no sequences were laid down, it would be impossible to decide what channels should be included in ships' equipments to give them the services they need. The sequences are applicable to each *station*, ship or coast, not merely to each country. Further, as an additional safeguard in the ships' interest, Administrations are enjoined to provide a reasonable service to ships with equipment covering only the channels indicated in heavier type in the table. The public correspondence service has one more "essential" channel, as three seems to be the minimum number on which an effective one-channel, continuous coverage coastal service can be arranged.

All the normal two-frequency channels use a spacing of 4.6 Mc/s between transmit and receive frequencies, but it will be noticed that channels 1, 3, 21 and 23 may also be used for special public correspondence services in certain countries, in such a way that the spacing is only 1 Mc/s; this enables simpler and cheaper equipment to be used, but the ship must employ press-to-talk (simplex) operation. The 4.6 Mc/s separation is a departure from precedent and is based on reports from U.S.A. of interference caused to ships using duplex operation (with 4.5 Mc/s separation) when in the vicinity of television transmitters using the same separation between sound and vision channels. The interference is due to intermodulation products.

Apart from this the technical requirements in the Agreement follow the Warsaw recommendations, the principal of which are:—

Frequency modulation with pre-emphasis of 6 bB per octave;
Channel separation 50 kc/s;
Maximum deviation ± 15 kc/s;
Frequency tolerance $\pm 0.002\%$.
Maximum output power 20 watts except in special circumstances.

The supplementary radio regulations which were recommended, require a ship equipment for working in the international bands to be able to use channels 6 and 16. The *minimum* equipment permissible will, therefore, be a 2-channel set but the majority of ships which will fit v.h.f. are likely to need at least the single-frequency port operations service in addition. It is difficult at this stage to forecast the shape of things to come and, partly because of this, the minimum *useful* single-frequency equipment seems likely to need perhaps 6 channels. The ship owners who intend to make economical but *comprehensive* use of the services which may be available fairly widely in a few years time, are likely to add up the "essential" channels, add two or more for fair measure and, therefore, look for a 12- or 14-channel set.

It has to be remembered that when v.h.f. has become a commonplace in ship communications the use of portable equipment brought on board by pilots, for use during port entry and departure, will have ceased to have any attractions. This implies, however, that ship equipment must provide sufficient channels for all the essential services. The total needed may well be more than those suggested, but multi-channel sets with accommodation for additional channels should be obtainable with very little increase in cost. An alternative would be to use "unit" equipment which could be added to, economically.

No doubt many attractive alternatives will be offered by manufacturers in the near future. Ships, however, will not fit equipment until services are available, so the next move seems to be with the port authorities to provide operations and information services, and the Administrations or radio operating companies to provide public correspondence facilities. The services envisaged in The Hague Agreement are largely to carry "ships' business" traffic. No doubt a certain amount of passenger traffic will be taken but the Agreement recognizes the need for the v.h.f. set to be controlled from the bridge. Major passenger public correspondence was not included in the Agreement; this important matter is for discussion elsewhere. The great thing is that the door to progress is now open; the Agreement comes into force on 1st October this year.

"LIMITERS AND DISCRIMINATORS FOR F.M. RECEIVERS"

The continuation of Part 3 of this series, by G. G. Johnstone, is unavoidably held over until the May issue. It will deal with practical design considerations for radio detectors and will also assess the relative merits of the Foster-Seeley and other detector circuits

LETTERS TO THE EDITOR

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

"*Limiters and Discriminators for F.M. Receivers*"

MR. G. G. Johnstone has raised an interesting issue in his article in the January, 1957, issue. He agrees that the use of wide-band limiter and discriminator circuits is advantageous in suppressing small amounts of f.m. interference, but says of a narrow-band detector: "in the region where *a* is greater than unity, a reduction in discriminator bandwidth causes the amplitude of the spikes to be reduced and the signal-to-noise ratio is better than for a wide-band discriminator."

He may like to know that we made no very subtle choice between the relative nuisance values of co-channel and ignition interference, but rather failed to consider the point he has raised.

It is a very difficult matter to predict the response of a narrow-band detector to wide rapid changes in frequency. Some of us made static analyses of the type indicated in his Fig. 4, but found that although the method gives results that are qualitatively right the dynamics of the tuned circuits are such that experimental results differ considerably from the static analysis. However, I agree that for impulses that are slightly larger than the signal the narrow-band detector should be expected to give better results than the wide-band, particularly when the impulses simultaneously exceed the signal by small amounts and occur at a moment of high deviation. On the other hand, for impulses considerably larger than the signal, high spikes do not ordinarily result, and the two receiver types should give about the same results. Thus I feel that the narrow-band circuit would have advantages over the wide-band for only a small range in which ignition noise exceeds signal strength by a small margin and at high deviation; for all other cases the wide band should be equal or better.

Actually this feeling of mine is an over-simplification, since the maximum spike height depends upon signal/noise ratio, upon instantaneous phase, and upon the instantaneous frequency deviation present at the time the disturbance occurs. It would seem that the results calculated for some statistical distribution of all these factors would be by no means so simple as Mr. Johnstone and I have assumed. My own guess is that under these conditions the wide-band circuits may show up more favourably than would at first seem likely.

Mr. Johnstone's suggestion should also be of interest in the suppression of the effects of random noise. When a wideband detector operates on the combination of an f.m. signal and random noise the observed results are similar to those with ignition noise. For large values of S/N the output is clean, having at worst some "clicks." When the r.m.s. noise approaches within a few decibels of the signal, random "pops" of identical form are observed. The number of these pops per second increases rapidly as the value of S/N approaches 1. This experimental result is readily explained by considering the amplitude-modulated character of restricted-band noise, but I am not aware of any numerical statistical analysis of "pop" probability, an analysis that is difficult but should be worth carrying through.

In U.S. practice most receivers use narrow-band detectors. Many of them are inexpensively built and do not have flat i.f. responses, but may fall off by 5 or even 10 dB at the edges of the band. Further, many fail to limit properly on noise. When a fully modulated signal of small amplitude is impressed on such a receiver the response falls below limiter control and noise on the peaks. As a result these receivers tend to distort badly on peaks not only because of spike clipping but for more earthy reasons as well. Receivers using wideband detectors are usually more carefully made in these routine ways, and it is not easy to say whether their observed superiority over narrow-band receivers in suppressing random noise is due to routine care or to their inherent properties. More experimental work is needed.

L. B. ARGUIMBAU

McIntosh Laboratory,
Binghampton, N.Y., U.S.A.

Audio Output Power

IT is to be hoped that P. J. Baxandall's amplifier design, published in your March issue, will herald a return to sanity in the field of domestic sound reproduction. His contention that an output of 5 watts is adequate in the home will be supported by many.

Large numbers of existing 10-15-watt amplifier designs are used with speakers which, even with acoustic loading, can handle little more than 5 watts. For these, the use of a lower-power amplifier would merely mean operation near the limit of the gain control setting, probably for the first time.

Percy Wilson recalls, in the same issue of *Wireless World*, that G. A. Briggs surprised many in the Festival Hall by the low readings given by his output power indicators. If my memory serves, the 5-watt mark was not often passed and during full orchestral reproduction peaks of 40-50 watts were indicated only occasionally. Further, I well remember that a demonstration was at that time given of reproduction from an 8-in acoustically loaded speaker which, without noticeable distortion but admittedly with some loss of realism compared with the multi-speaker system in use immediately beforehand, managed to produce a very fair sound intensity at a point well back in the hall. Had the music contained the largest peaks this speaker might well have overloaded at the existing gain control setting; I merely wish to suggest that power close to 5 watts was giving effects at the ear not vastly different from that produced by live music under identical conditions.

If modest power can give good results in the Festival Hall, surely a comparable figure should provide all the reserve required for peak reproduction in the average living room?

R.A.E., Farnborough. W. E. DEAN.

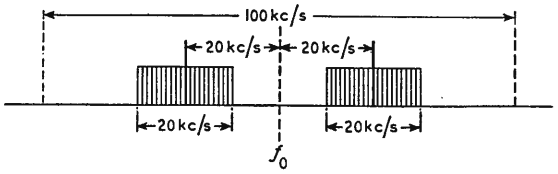
Stereophonic Broadcasting

I AGREE with G. H. Russell (Jan. issue) that v.h.f. transmission offers an unprecedented opportunity for giving sound broadcasting a new lease of life, but I do not think that extension of h.f. response in a single channel is the best way of using the available bandwidth.

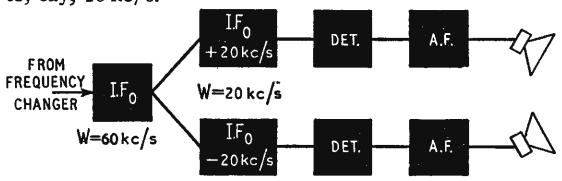
The human auditory mechanism is very intricate and is normally based on the transduction of separate stimuli at each cochlea into electrical waveforms, then into nerve pulses which are projected at both sides of the cortex. It is upon the relationship between these *two* different sources that our mind primarily depends for an appreciation of the spatial qualities of sound, and when this relationship is properly established our hearing is "contented"—much more so than by the "hi-fi" frequencies. As J. Moir has reminded us (Nov., 1956, issue, p. 543) "the frequency range that is produced seems

much less important than the sense of size and spatial distribution produced by the system."

It is often assumed that stereophonic broadcasting must be prohibitively expensive because two transmitters and separate sets at the receiving end would be required. This may have been true for medium-wave broadcasting conditions, but at v.h.f. a twin-channel a.m. stereophonic transmission could be accommodated in each 100-kc/s channel as indicated by the accompanying spectrum.



A single receiver of input bandwidth W = 60 kc/s and a branched i.f. amplifier and audio channels would suffice for each transmission if limited in audio response to, say, 10 kc/s.



The service area would be limited by the distance at which variations of signal level due to anomalous propagation could be neglected, unless means could be devised for maintaining adequate relative levels at the receiver, but this should present no insuperable difficulty.

Ghent, Belgium. H. A. V.

High-Quality Demonstrations

E. R. ASLIN (February issue) suggests that the pedal notes of an electronic organ can be used to test the bass response of a reproducer.

Although my original letter in the October issue dealt mainly with the problems encountered at high audio frequencies I pointed out in it that every electronic instrument uses, as the final sound source, a loudspeaker of uncertain age whose characteristics are usually unknown. Therefore, although bass tones of reasonable purity may be generated in an electronic organ we cannot know (without hearing it directly) how much fundamental tone is being emitted by the instrument's own loudspeaker. At high volume, some frequency doubling in the lowest octave is almost certain, and when the sound passes through a reproducing chain we can only conjecture how far each of the two loudspeakers contributes to this.

If the recorded signal were taken direct from the tone generating system we could be sure that all the tones generated were recorded without significant distortion. This might indeed be practicable for organ solos, but would be more difficult for concerted pieces, in which all the instrumentalists must hear their own music and that of their colleagues.

Sawbridgeworth. H. GLOVER.

Beat Interference

YOUR article on the beat effect on reception from North Hessary Tor (March issue) is good enough for science fiction. But, before the inhabitants of Cawsand become afraid to go out in the dark, would it be possible to test for an unstable air-flow from the south-west? This is not so much within the province of meteorology as of aerodynamics and abnormal propagation. The prevailing wind striking the coast could produce a waving airstream with eddies breaking away from it: this air, being of different humidity, could bend the waves and produce the effect of a huge swinging reflector. However inefficient, a very large reflecting or refracting surface might produce the observed effect where the direct signal was highly attenuated. This hypothesis might be tested by sending pulses across the suspected atmospheric region from east-south-east to west-north-west of Cawsand. If that should be the explanation, the only treatment I can see would be distribution by one of the alternative methods (by wire, for example). The unstable air condition might have been placed on the coast, over the estuary, or between Plymouth and North Hessary Tor, if the interference had not been identified as coming from the sea; if there is some possible stationary reflector in that direction, the effect might still be anywhere within that region, or all over it. Glider pilots observe large eddies with horizontal axes: would it be possible for such an eddy, carrying air from the surface of the sea wound into it like the jam in a swiss roll, to produce a radio mirage in the direction opposite to that of the transmitters?

Forgive this fireside hypothesizing: it is so much easier than going out and investigating the problem properly!

London, S.E.18. N. F. SHEPPARD.

The Fletcher-Munson Curves

P. WILSON states (March issue) that the Fletcher-Munson hearing curves[1] are not reliable in the case of complex tones. But who says they are intended to be? For pure tones under the given conditions all the evidence points to the accuracy of the curves, but pure tones do not exist in practice. When a pure tone stimulus is at a low level, it excites a few nerve endings within a limited region of the basilar membrane. As the frequency is changed, the point of stimulation moves along the membrane. If the sound has more than one frequency component, it excites more than one region of the basilar membrane. The loudness of the combination of tones is obtained by summing up the loudness values which would result from each of the tones acting alone. If, however, the regions of excitation overlap the problem is more complex and a simple summation alone will not give an accurate answer[1, 2]. The effect of a complex tone is to produce an apparently louder sound from the same energy, thus the Fletcher-Munson curves flatten out.

It is also known that the loudness of a sound does not instantaneously reach a maximum. Therefore the apparent effect is much influenced by the rate of growth of the sound[3]. The apparent loudness is also influenced by the degree of consonance or dissonance of the sound, the latter always producing the effect of an increase in loudness[4, 5].

It will be observed from the references below that these investigations are by no means new, and Fletcher and Munson themselves were amongst the first to recognize the inadequacy of pure tone measurements for the assessment of musical sounds.

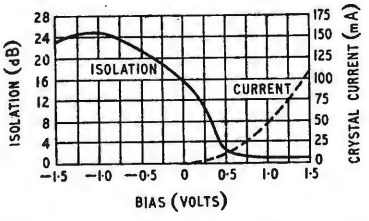
Nottingham. ALAN DOUGLAS.

[1] H. Fletcher and W. A. Munson: Loudness; Its Definition, Measurement and Calculation. *J.A.S.A.*, **5** (1933) 82.
[2] D. H. Howes: The Loudness of Multicomponent Tones. *Am. J. Physics*, **63** (1950) 1.
[3] G. von Békésy: Zur Theorie des Horens. *Physik Zeit*, **30** (1929) 115.
[4] R. C. Mates and R. L. Miller: Phase Effects in Monaural Perception, *J.A.S.A.*, **19** (1947) 180.
[5] G. von Békésy: Uber akustische Rauhigkeit. *Z. Tech. Physik*, **16** (1935) 276.

"Ionosphere Review, 1956": A Correction.—Owing to an unfortunate sub-editing error the words "sunspot number" appeared in line 15, left-hand column, page 146, in the March (1957) issue in place of "critical frequencies and m.u.fs."

Technical Notebook

Semi-conductors in Waveguides for switching purposes are not so well known as ferrites (see December, 1956, issue, p. 595). It seems, however, that they may have certain advantages—one being the relatively insignificant power required for switching, even at high repetition rates. The development of a high-speed semi-conductor switch for the 3-cm band is mentioned by M. A. Armistead, E. G. Spencer and R. D. Hatcher in the December, 1956, issue of *Proc.I.R.E.* It consists of an *n*-type germanium diode mounted in the centre of the waveguide, and the r.f. impedance for switching is altered by varying the bias voltage as shown in the graph. The curves are for r.f. powers of 1 mW or less, and the switching isolation is somewhat less for higher powers. The greatest isolation is actually obtained when the resistive and reactive com-



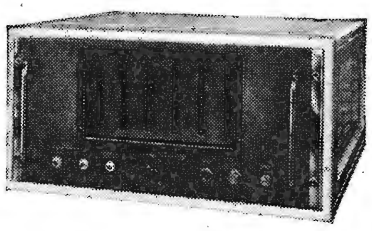
ponents of the diode r.f. impedance are near zero. Then 80 per cent of the energy is reflected, 0.3 per cent is transmitted and the remainder is absorbed in the diode.

"Thermionicized," as distinct from "transistorized" might be applied to transistor equipments which have been fitted with thermionic valves. Recently some r.f. valves for use with h.t. supplies of only a few volts (for example a 12-V accumulator) have been introduced in this country by Brimar. Where r.f. transistors are not available, these valves can be used in the r.f. stages of transistor receivers without the necessity for an additional high-voltage supply. One of these valves is a tetrode employing the space-charge grid principle first described by Langmuir in 1913. By providing the grid next to the cathode with a positive accelerating potential (the usual control grid lying between this and the anode) useful current outputs at low voltages can be obtained. Secondary emission from the anode, which produced the dynatron kink in early tetrodes, is avoided here by the use of special materials and processing.

V.H.F. Transistor, with an oscillating frequency claimed to be more than 250 Mc/s, is now available in quantity on the American market. It is made by Texas Instruments, using an improved production technique in which a process of diffusing impurities into the crystal to give an extremely narrow base layer is combined with the normal method of growing the crystal. The device makes possible transistorization of television and v.h.f. receivers, as well as increased speed in transistor switching circuits. Even higher frequencies than this have been reached in the experimental transistors made by the diffusion process by Bell Telephones. Here, diffused layers of less than one micron in thickness have made possible alpha cut-off frequencies in the region of 400-600 Mc/s. Obviously we may soon have to revise our original ideas about the transistor not being able to supersede the valve in all applications!

Control Knob Design for easy identification by touch so that mistakes in operation of equipment are reduced. Experiments on different shapes are described by D. P. Hunt and D. R. Craig in a D.S.I.R. unpublished report (**PB**11690).

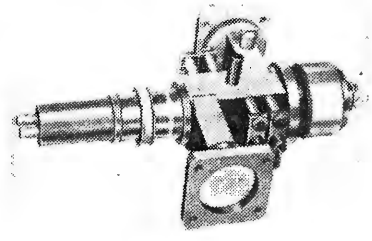
Digital Indication is becoming popular for electronic measuring instruments, as well as in the industrial sphere, because of the ease and rapidity with which readings can be made and the reduction of possible ambiguities. It is particularly



applicable in the field of time and frequency measurement, and the illustration shows a typical modern instrument (made by Racal) which can be used for both. When operated as an electronic chronometer, the start and stop pulses representing the time interval to be measured are used to gate a crystal-controlled 1-Mc/s oscillator. The cycles, each representing a 1-μsec interval, are then counted over this period by a series of scale-of-ten circuits, and the result is indicated directly in microseconds on the six illuminated numerical scales. If the instrument is used for frequency measurement the internal oscillator is not required, and the scale-of-ten circuits simply count the cycles of the frequency over a known time interval. To extend the range of measurement above the 1 second possible on the scales, an additional mechanical register is necessary.

"Supermandur." An improved grade of the "soft" magnetic alloy Permandur has been developed by Bell Telephone Laboratories. It is called "Supermandur" and, although of similar composition to Permandur (49 per cent iron cobalt, $2\frac{1}{2}$ vanadium), is made from materials of high chemical purity in a controlled atmosphere furnace, and is subsequently heat-treated in a magnetic field. Saturation is at 24,000 gauss and maximum permeability is 66,000 at 20,000 gauss; hysteresis loss is 6 watts/lb at 100,000 lines/in^2 and 400 c/s. With "Supermandur" a 30 per cent reduction is possible in the size and weight of power transformers, compared with grain-oriented silicon steel. The material is ductile and laminations as thin as 0.0003in can be rolled. The hysteresis loop is rectangular, with a range of flux of 45,500 gauss from remanence in one state to saturation in the opposite direction. The steepness of the loop sides gives an increase of gain in magnetic amplifiers of 80 per cent over grain-oriented silicon steel.

Ceramic Valve Envelopes are now coming into wider use, especially for power valves. They give greater mechanical strength, smaller size for a given power dissipation, enable the



valves to work at higher ambient temperatures and permit more effective de-gassing during manufacture so that greater emission current can be obtained. A recent example is a 2-kW continuous-power klystron made by Varian Associates of Palo Alto, California. Working in the range 7,125-8,500 Mc/s, it has a per-

formance characteristic that permits amplification of modulated signals at power gains as high as 50 dB. Other advantages claimed by the makers are long life, ruggedness and low microphonics. The klystron is tunable ± 25 Mc/s from the centre frequency.

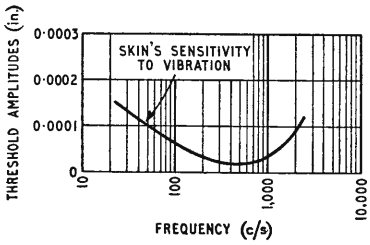
Transistor Batteries.—The cost of running battery-operated transistor equipment is becoming of some interest now that transistorized portable receivers, amplifiers and record players are arriving on the scene. As a guide, one battery manufacturer (Ever Ready) has compiled the table below giving an idea of costs and also service lives for various sizes of batteries. The figures are based on fixed resistance tests carried out for 4 hours per day, 7 days per week, to a final voltage of 1 volt per cell on load.

Drain (mA)		Test R (Ω)	Life (hrs)	Pence/ hour
6V	10	600	450	0.08
	25	240	150	0.24
	50	120	55	0.65
9V	2	4500	110	0.3
	4	2250	44	0.75
	8	1125	14	2.36
9V	7	1285	135	0.27
	10	900	90	0.40
	25	360	24	1.50
9V	5	1800	450	0.09
	10	900	190	0.22
	20	450	80	0.53
6V	20	300	875	0.13
	50	120	350	0.32
	100	60	150	0.74
9V	10	900	450	0.10
	25	360	150	0.30
	50	180	55	0.82

Fixed resistance tests do not, of course, reproduce exactly the conditions of use, but at least they give a useful general guide.

Accelerated Valve Ageing for reducing the time required for life-testing valves. The effect of cycling and other expedients is considered by N. J. Reitz, R. P. Anderson, R. D. Guild and C. F. Douglas in a D.S.I.R. report (PB116411).

Tactile "Telephony" is under investigation, not only for deaf people but as a means of communicating with aircraft pilots during the critical take-off and landing periods when their other senses are fully occupied to the point of saturation. The basic idea is to apply stimuli to the five fingers of the subject by means of sensitive vibrating diaphragms, using a signalling code of different frequencies. In an aircraft, for example, these diaphragms —adapted for transmitting as well as receiving—could be incorporated in the control column. The graph shows the skin's sensitivity to vibration at different frequencies. According to J. Hirsch, writing in *I.R.E. Transactions* PGME-7 for December



1956, tactual discrimination between frequencies is quite good. With practice, it is possible to recognize the difference between, say, 400 c/s and 420 c/s. It is interesting to note that the vibration curve looks rather like an auditory threshold curve, but is displaced towards the lower frequencies. An experimental device is being developed by the Commonwealth Engineering Company of Dayton, Ohio, for sending directional information to pilots through tactual signals applied to the thumb.

Smoother Response for low frequency horn-loaded loudspeakers is offered by a method discussed by W. E. Glenn in the December, 1956, issue of the *I.R.E. Transactions on Audio*. The horn is suitably plugged with sound-absorbing material. This material, by its resistive and reactive effects, compensates for acoustic mismatch and consequent reflections due to finite horn size. Another possibility is that, by using more than one plug, sharper h.f. cut-offs can be obtained. This avoids partial propagation outside the designed frequency range for the horn.

Transistor Wrist Receiver using three transistors and tuning over 1-1.6Mc/s with a sensitivity of 50 μV. A D.S.I.R. unpublished report by the U.S. Signal Corps Engineering Laboratories (PB111461).

Unpublished Reports mentioned above come from various sources but can be obtained from the Technical Information and Documents Unit of the Department of Scientific and Industrial Research, 15, Regent Street, London, S.W.1.

COMMERCIAL LITERATURE

Low Leakage Electrolytic Condensers with values ranging from 0.5 to 50 μF are described in a leaflet from T.C.C., North Acton, London, W.3. An insulation resistance of 100 MΩ/μF is attained after only three minutes of applied working voltage and this rises rapidly to 10,000 MΩ/μF if the condenser is left in circuit. These high resistances are maintained even after a six months' idling period.

T.V. Tube Construction in stages following the initial glasswork is shown in a copiously illustrated booklet from Mullard, Torrington Place, London, W.C.1. Physical and electrical tests include a test to show performance under possible conditions of low mains voltage.

Data on Brimar Valves including special-quality and CV types, transistors, thyratrons and hermetic seals are given in a booklet from Standard Telephones and Cables, Footscray, Sidcup, Kent.

Full Range of Microphones from the German Labor Company, to be marketed in England by G-A Distributors, 29, Whitehall, London, S.W.1, are described in a leaflet. Included is a microphone with a very directional response for use under noisy conditions, and a probe microphone for acoustic measurements. Earphones, microphone transformers, power amplifiers (up to 80 watts at less than 5% distortion), valve-voltmeters and other test instruments are also included.

Standard Oscillator and Signal Generator are described in leaflets from Airmec, High Wycombe, Bucks. The oscillator is variable from 100 kc/s to 1 Mc/s with a stability which improves with use up to one part in 10^7. A temperature controlled 100 kc/s crystal is used. The signal generator covers 30 kc/s to 30 Mc/s and includes crystal calibrator. The output is stabilized to ±1 dB with harmonic distortion less than 1%. Continuously variable attenuation up to 120 dB is provided. The normal maximum output is 1 volt from a 75-ohm source, when the 1,000 c/s internal modulation is used.

Wide Variety of Industrial Electronic Equipment is illustrated in a booklet from Lancashire Dynamo Electronic Products, St. Stephens House, Victoria Embankment, London, S.W.1. These include electronically adjusting speed drives up to 10 h.p., voltage (to within 0.1%) and frequency regulators, a smoke alarm indicator and other photoelectric apparatus, welding equipment and various safety relays.

Flexible Terminal Strips are useful with curved surfaces or irregular spaces. A new product in moulded Wybac P.V.C. has a flashover voltage between terminals of 9 kV, the insulation resistance being greater than 10^{12} ohms. The blocks can also be cut with a knife. Leaflet from Precision Components, 13, Byng Road, Barnet, Herts.

Complete "Avantic" Sound Reproducing System includes record player, tape reproducer, a.m./f.m. radio feeder unit and cabinet. The loudspeaker system comprises a 12in bass unit and two 2½in treble units. The amplifier gives a maximum power of 27 watts with 0.1% total harmonic distortion. The pre-amplifier has a maximum sensitivity of 2 mV (45 dB signal to noise ratio) with a choice of eight inputs. It incorporates a fixed "rumble" filter cutting off at 40 c/s. The usual bass and treble controls are included, and there is choice of two treble steep-cut filters and a variable loudness control. Booklet from Beam-Echo, Witham, Essex. The units may be bought separately.

V.H.F. Variable Attenuators

LADDER-RESISTIVE ELEMENTS OF CARBON COATED INSULATING MATERIAL

By B. G. MARTINDILL*

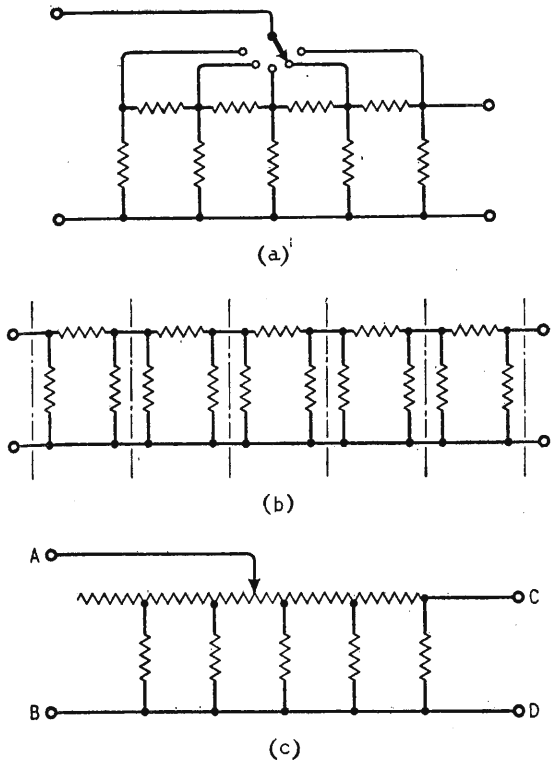


Fig. 1. Three forms of simple attenuators; (a) typical step type, (b) broken down into individual sections and (c) continuously variable ladder network.

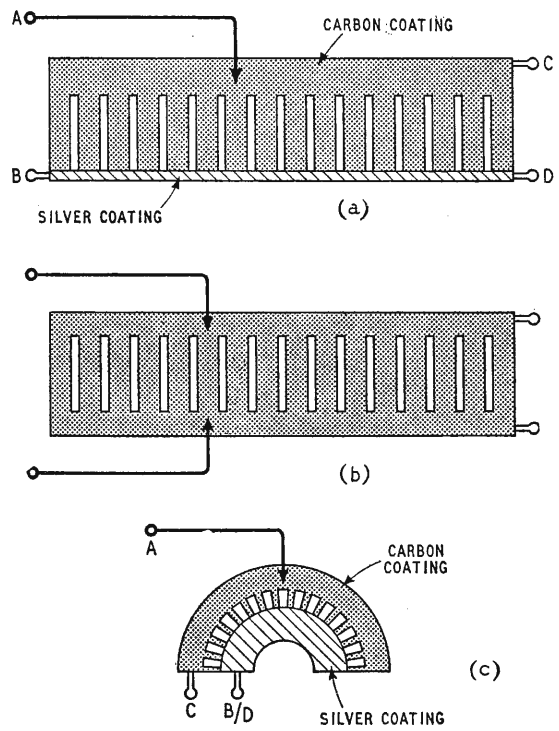


Fig. 2. Attenuators made from thin stamped out carbon-coated insulating material; (a) ladder network with single wiper, (b) balanced attenuator with ganged wipers and (c) semi-circular plate with rotating wiper.

IN designing variable attenuators for use at v.h.f. difficulty is experienced in maintaining the correct image impedance regardless of frequency. The ideal network would be one that is purely resistive and at the same time continuously variable and there are various ways that may be considered as reasonably approaching these requirements, but nearly all give rise to complicated mechanical arrangements which would prove costly to manufacture.

One of the simplest forms of attenuator of the unbalanced type is the T or π section, but to make these continuously variable would necessitate a ganged arrangement whereby the three resistive elements could be adjusted simultaneously. A further complication is that, to produce a linear calibration curve, it is necessary for the resistive elements to follow a logarithmic law.

Variable attenuators of the step type are in common use and usually comprise a number of T or π sections joined together in series, arrangements being made to tap into each section by a switch or other suitable means. (See Fig. 1(a).) Fig. 1(b) shows a step or ladder attenuator broken down into individual π sections, from which it will clearly be seen that the shunt resistors, with the exception of those at either end, are in parallel and may therefore be replaced by a single resistor of half the value.

If the number of π sections is made large then the incremental steps will be small, and if instead of a step arrangement a sliding contact is made to traverse the top of the ladder, as illustrated in Fig. 1(c), then we have a continuously variable attenuator with an almost linear characteristic. A simple and known form of this is an ordinary wire-wound potentiometer to which suitable shunt resistors are connected at regular intervals so that a ladder arrangement results. This form of ladder attenuator would not be of any use at anything except the very low frequencies owing to the high inductive reactance introduced by the wire-wound section.

A successful design which overcomes this difficulty (and is the subject of a patent application) is to manufacture the complete ladder attenuator as a press stamping from a thin insulating base which is covered with a thin carbon coating in a

* Wolsey Television Ltd.

similar manner to that normally used to produce carbon tracks for potentiometers. Such a method offers several advantages, chief of which is its low cost and ease of production in large quantities with identical characteristics.

Some of the possible variations are shown in Fig. 2, in which (a) is an unbalanced straight ladder section having fifteen identical sections. The lower portion is silver coated to provide the "earthy" side, the upper portion being the track over which the sliding contact operates, the shunt resistors being produced by punching out the slots. Fig. 2(b) is a similar network but is balanced. Balanced types would, of course, require ganged wipers.

Fig. 2(c) is another unbalanced type but of semi-circular construction on which it is possible to use a rotating wiper. Fig. 2(b) could be bent round a circular former to give a balanced rotary type.

When the carbon coating is uniform, and its specific resistance is known, the design of the unit becomes a simple process of calculating length and width of each section so as to give the required resistance value, and a press tool can then be made to stamp out the track to these dimensions.

Limits in physical size, in degree of accuracy and in total amount of attenuation are extremely wide, the ultimate accuracy being dependent upon the uniformity of the resistance of the carbon coating, and the closest possible limits in the stamping operation.

The types of track illustrated are symmetrical, the image impedance being the same when measured from either end; this could very easily be made to match unequal generator and load impedances by making the end π section asymmetrical; this section would, of course, have to remain in circuit at all times and would dictate the minimum value of attenuation possible.

Though illustrated as linear arrangements there would be very little difficulty in designing these networks to follow any known law. In addition, several attenuators could be arranged in cascade, for example, by using three attenuators in cascade, each one comprising ten equal π sections, the first having a total attenuation of 1 dB, the second 10 dB and the third 100 dB, a constantly variable attenuation of up to 111 dB would be possible with an accuracy of better than 0.1 dB over this range.

Experiments carried out on frequencies up to 200 Mc/s show that the image impedance may be maintained to a very close tolerance. Careful design of the unit as a whole is essential to ensure that any stray capacitive effects between the track and any associated component or their mountings is kept to an absolute minimum.

No details are yet available on the operation of these units at frequencies higher than 200 Mc/s, but it is felt that careful design, with the possible introduction of electrostatic screening between the shunt resistance sections if found necessary (which could be easily achieved by screens located through the slots punched in the track to form these resistances), satisfactory operation at much higher frequencies could be realized.

These notes illustrate some of the more obvious ways in which such a network could be used and the author feels sure that the reader will visualize many other possible applications.

SCHOOL TELEVISION : APPROVED RECEIVERS

THIS year will see the introduction of school television in this country if plans now being made come to fruition. About 18 months ago the School Broadcasting Council announced that an experimental service of school television will be provided in the autumn. These transmissions will be radiated from all B.B.C. stations. Since then, the I.T.A. has announced that the first of a series of experimental transmissions for schools will begin on May 13th from London and Lichfield.

In order to give local education authorities reliable information on the suitability of receivers for classroom use, a series of tests was held toward the end of last year at a school in Hertfordshire. All manufacturers of television receivers were invited to submit equipment, and fifteen makers submitted twenty-four models. The tests were conducted in the presence of an appointed panel consisting of representatives of various educational authorities. The ten-page report of this viewing panel, recently issued by the Association of Education Committees (10, Queen Anne Street, London, W.1), includes as appendices notes on arrangements of classroom seating and a list of 16 receivers approved as suitable for classroom use (see table).

All three types of receiver—direct viewing, rear and front projection—were tested by the panel, but no front projection receiver was considered suitable. Two rear projection sets, each giving a 30-inch diagonal picture, are approved. With only one exception all the direct viewing receivers have 21-inch tubes. It is not recommended that smaller tubes should be used, and the panel expresses the hope that receivers with larger tubes will become available.

In the section of the report dealing with the *pros* and *cons* of direct viewing and projection receivers it is stated that "the direct viewing receiver, though it gives a smaller picture, has some distinct advantages. The picture is brighter. The definition is better. There is less need to reduce the level of general room lighting. The picture does not deteriorate appreciably as one increases the angle to the screen. . . . On the other hand, care has to be taken to avoid reflections on the screen."

The majority of the receivers approved are standard production chassis housed in special cabinets with a viewing hood to reduce ambient light.

The question of maintenance was considered by the panel, and the manufacturers of all approved receivers have stated that they or their agents will contract to maintain the equipment.

Approved School TV Receivers

Direct viewing

Bush Radio Model 281
Clarke & Smith Mfg. (Wallington) Model SB/DV2A
Cossor Models 904 and 905 (24-in tube)
Ekco Model ST304
Ferguson Model 4227/ST
G.E.C. Models BT3251S and BT93435
H.M.V. Models 1847 and 1848
Murphy Models V290CA and V300C
Philips Model 2160U
Wired Radio Service (Chessington) Model CA21.3

Rear projection

Ferguson Model 4229ST
Wired Radio Service Model CA30.3

Colour TV on Tape

ACCURATE SERVO CONTROL OF HIGH-SPEED TAPE MOTION

By H. R. L. LAMONT*, M.A., Ph.D.

*Radio Corporation of America, European Technical Representative. This article is condensed from a lecture given to the British Kinematograph Society. It is based on a series of papers by H. F. Olson, W. D. Houghton, A. R. Morgan, M. Artzt, J. A. Zenel and J. G. Woodward, published in the *RCA Review*, Vol. 17, pp. 330-392, 1956, under the title "A Magnetic Tape System for Recording and Reproducing Standard F.C.C. Colour Television Signals" in which the development and construction of the equipment is treated in much greater detail.

IN December, 1953, the RCA Laboratories at Princeton, U.S.A., demonstrated a system for recording and reproducing colour television signals on magnetic tape[1, 2]. The equipment was experimental and some problems remained to be solved.

Since then new equipment involving major improvements has been built and installed in the studios of the National Broadcasting Company in New York. This equipment will handle both colour and monochrome signals, but the basic requirement was for a system to handle colour signals. This done, the much less stringent requirements of a black-and-white signal are met almost automatically.

In colour television operations the camera contains three pick-up tubes which provide red, green and blue signals. These three signals are processed by an encoder to provide the composite colour television signal which is radiated. This signal is decoded by the receiver into its original red, green and blue components.

In the recording of a colour signal on magnetic tape the same basic principle is used—the composite signal is decoded into its red, green, and blue video components, together with the audio signals, and these are recorded on separate parallel channels on the tape. On reproduction the process is reversed.

A basic problem is the wide frequency band involved—up to about 3.5 Mc/s. In conventional audio tape recorders the upper frequency limit, for a given tape speed, is determined primarily by the resolving capabilities of the magnetic head, which is about 2,000 cycles per lineal inch of tape. Thus a tape speed of about 8 inches per second is required for a 16-kc/s response. To record frequencies up to 3 Mc/s should require a tape speed 200 times greater—133 feet per second—but a magnetic head has been designed for this equipment with sufficient resolving ability that a tape speed of only 20 feet per second is required.

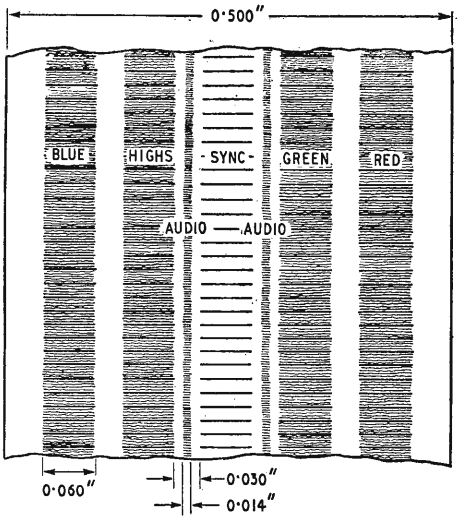


Fig. 1. Track layout on magnetic tape.

It is found that, for this tape speed, the maximum output from the magnetic head is obtained when the recording signal current is maintained constant with frequency, and the bias current is raised as an approximate inverse function of frequency. A usable frequency characteristic is obtained by dividing the range into two parts, a constant d.c. bias of 2 mA being used between 400 c/s and 1.5 Mc/s, and a zero bias above 1.5 Mc/s.

This splitting of the frequency range has been combined with the "mixed highs" principle of colour television[3]. Thus the red, green and blue signals are recorded with a bandwidth of 1.5 Mc/s on three parallel tracks on the tape, while the frequency components of the three colour signals between 1.5 and 3.5 Mc/s are mixed and recorded on the tape as a fourth "mixed highs" channel. Line synchronizing signals are recorded on a fifth channel. A quintuple head and half-inch-wide tape are used, with the track layout shown in Fig. 1. The two audio channels are recorded by a separate head.

Fig. 2 shows schematically the arrangement for recording standard F.C.C. colour television signals. The signal is first fed to a decoder unit which recovers the three primary colour components and the audio and synchronizing pulses, and these are applied to the tape heads as already described.

A major problem is the signal distortion resulting from irregularities of tape motion. This distortion is usually observed as a horizontal motion of, or in, the reproduced television picture. If the tape motion irregularities occur slowly, the picture will move as a whole; if the irregularities occur rapidly a waviness appears within the picture. In the equipment design great pains were taken to reduce these irregularities to a minimum.

The same tape transport mechanism operates both

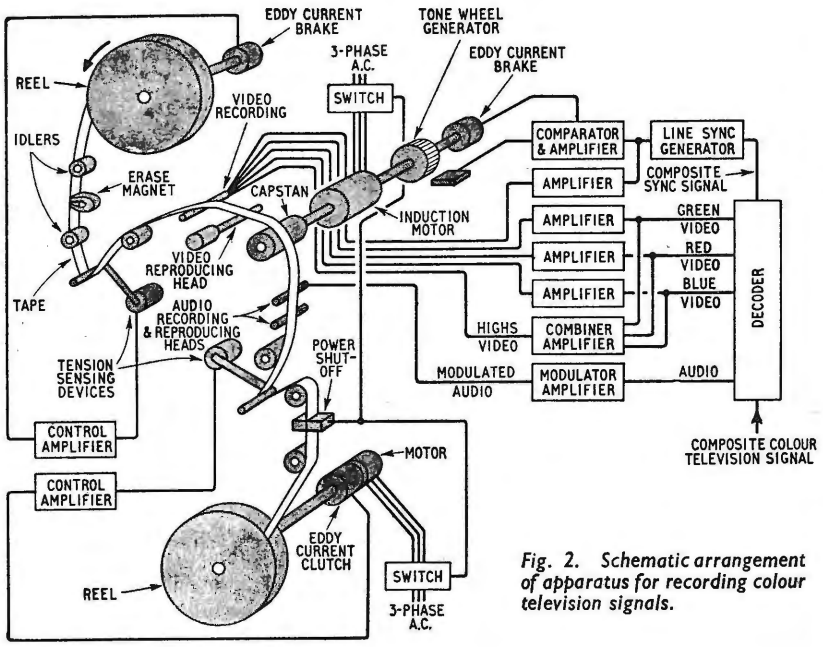


Fig. 2. Schematic arrangement of apparatus for recording colour television signals.

for recording and reproduction, and performs two basic functions. The first is that of maintaining constant tape velocity during recording so that the video signals are properly recorded on the tape. The second is that of controlling tape velocity during reproduction so as to maintain coincidence between the synchronizing signal reproduced from the tape and the signal produced from a local sync generator. It might seem that, having all the signal components recorded on the tape, it would be a relatively simple task to reproduce a composite television signal by connecting these component signals to the inputs of a standard encoder, but this is not so. The reason is that, in providing the complete composite signal, the encoder must supply a colour sub-carrier, a synchronizing burst, line drive, and synchronizing pulses, all of which must satisfy the extremely stringent specifications imposed by the F.C.C. Colour television broadcasting meets these requirements because the timing of all signals is under the direct control of a common synchronizing generator. The use of a sync generator which controls the tape velocity rather than being controlled by it is thus an essential in the system. Then any undesired variations in tape speed cannot affect the colour saturation, hue, or burst stability; instead, they will result only in a horizontal movement of the reproduced picture within the scanning raster.

It is interesting to compare the performance required with that of commercial photographic motion picture equipment. It has been shown[4] that the effective horizontal frame displacement of a 16-mm film corresponds to approximately $\pm\frac{1}{16}$in on a 21-inch television picture. This corresponds approximately to a $\pm 0.2\mu$sec displacement of the line synchronizing pulses, or to a tape displacement of $\pm 50 \times 10^{-6}$ inch. In sound recording language this represents a "wow" of approximately 0.004 per cent. This is at least an order of magnitude beyond the accepted performance of professional sound recording equipment.

In considering the tape transport when used for reproducing it is important to realize that a constant speed mechanism is not sufficient. The recorded tape will contain irregularities which require a complementary motion of the tape if the reproduced pulses are to have the desired relationship to the pulses at the transmitting station. A servomechanism as in Fig. 3, in which the local synchronizing pulses are the input function and the reproduced synchronizing pulses are the output function, solves the problem in principle. The error detector determines the lack of coincidence between the two synchronizing signals, and this operates a speed controller in the form of an eddy-current brake.

To control the tape speed during recording, a signal is required which is indicative of any irregularity in speed. There appears to be no practical method by which the instantaneous speed of unrecorded tape can be determined with the desired accuracy. The best procedure is to control the speed of the capstan and accept whatever irregularities may occur between the capstan and the tape motion.

The necesary signal for indicating irregularities in the capstan speed is derived from a magnetic tone generator attached to the capstan shaft. With this addition and a few wiring changes the reproducing servomechanism becomes the recording servomechanism shown in Fig. 4.

The speed response of a servomechanism is usually limited mainly by the inertia of the moving

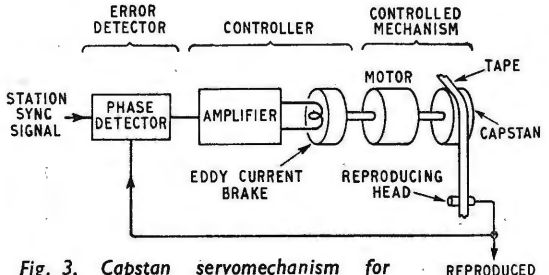


Fig. 3. Capstan servomechanism for reproducing.

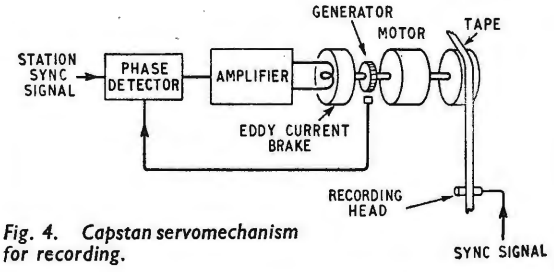


Fig. 4. Capstan servomechanism for recording.

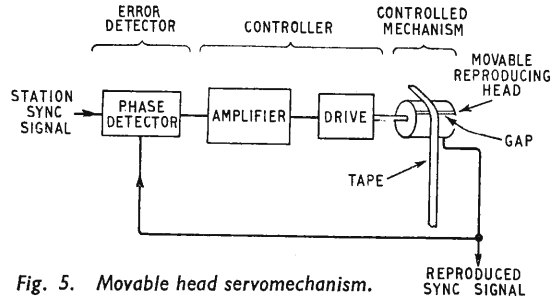


Fig. 5. Movable head servomechanism.

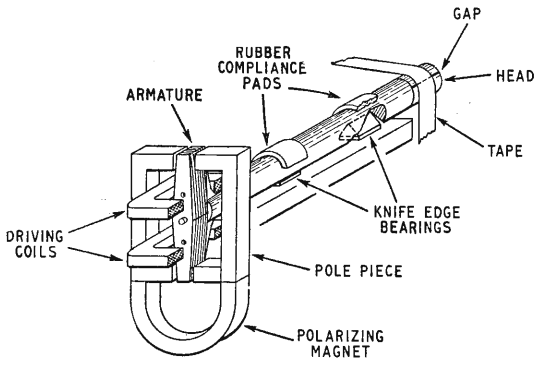


Fig. 6. Mechanical arrangement of movable head.

system, and here the capstan plus eddy-current brake have a relatively high moment of inertia. To overcome this limitation a further servomechanism with a much smaller moment of inertia is added, which is required to correct only the residual irregularities. This is achieved by making the reproducing head movable relative to the tape, as shown in Fig. 5. The head is cylindrical and the gaps are located on its periphery. Rotation of the head about its axis, over a small angle, thus gives the desired motion of the gap without disturbing the tape motion. The drive, shown in Fig. 6, is a balanced magnetic unit whose armature is connected to the magnetic head by a shaft pivoted on knife-edge bearings.

Fig. 7 shows the overall arrangement of the three servomechanisms. In the recording position (indicated by "R") the input signals are connected to the recording head, and the tone generator is connected into the tape transport system. In the reproducing position (indicated by "P") the capstan and moving head servomechanisms operate independently. To allow this the recording head, which in the reproducing position would normally be unused, is switched in to provide the reproduced synchronizing signal for the capstan servomechanism.

The mechanical design of the tape transport components calls for extreme attention to detail, and they demand the highest precision of workmanship to secure a smooth movement of the tape.

Despite the care taken in the design of the drive and synchronizing system, its effectiveness is still dependent on changes in tape tension and so these are minimized as far as possible.

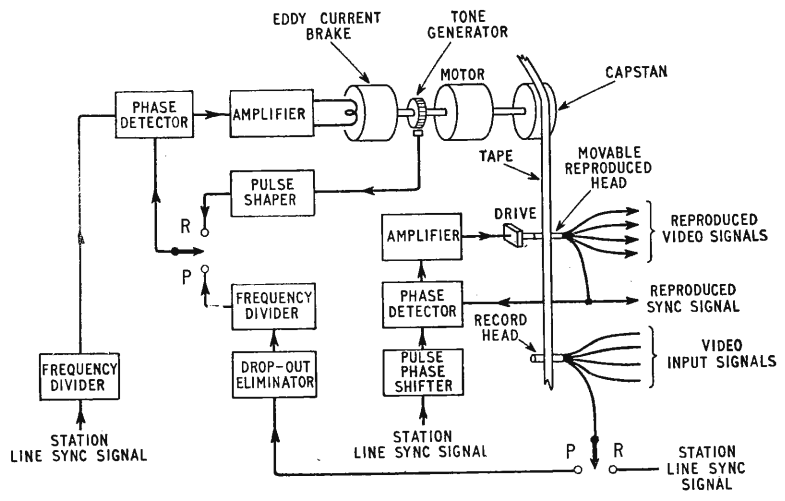
The tape is unwound from a reel to which variable braking must be applied and, after passing over the capstan, is wound up on a motor-driven take-up reel. During the process the reels are slowly changing their speeds and also their weights and rotational energies. For a constant tension on the supply side of the capstan, the braking torque applied must be directly proportional to the radius of the tape roll at that instant. Likewise, the torque of the motor on the take-up reel must be directly proportional to the radius at any instant.

For control of tension the tape passes over a spring-biased sensing arm. A shutter attached to the arm partially obstructs the path between a light source and a photocell, as shown in Fig. 8. The photocell output current then varies with angular position of the sensing arm, providing an error signal indicating changes in tension. This error signal is applied to the current coils of the eddy-current brake or clutch, similar mechanisms and circuits being used both for braking the supply reel and for driving the take-up reel. For the supply reel, the stator windings are held stationary, and the eddy-current cup acts as a brake. For take-up motion, the stator windings are motor driven in the same direction as the tape so that the eddy-current cup acts as a clutch to supply the variable take-up torque.

With this system the tape tension is maintained constant within less than 1 per cent over the entire speed range of the reels. The sensing arms also provide the resilience between the reels and the capstan which is necessary under starting and other transient conditions.

On starting, about six seconds are required for all servos to settle down to normal running conditions. To avoid undue complication only line synchronizing pulses are recorded, and frame synchronizing is therefore a manual adjustment. Frame coincidence, once established, will of course be maintained by line coincidence. The time taken to establish framing is partly dependent on the skill of the

Fig. 7. Schematic arrangement of servomechanisms for recording (R) and reproducing (P).



operator, but is usually about a further eight or nine seconds.

The tape reels used are 20 inches in diameter, and they rotate at about 230 r.p.m. when full, 540 r.p.m. when empty. With a tape of the standard 0.0015-inch thickness the playing time would be only eight minutes, but the advent of a new material called Mylar allowed 0.0075-inch thick tape to be used, which gives a playing time of 15 minutes per reel. This is adequate for most programme purposes.

In spite of the high speed, tape breakages almost never occur. Tapes stored for several months have shown no noticeable print-through, and a single tape can be erased and re-used at least 100 times without any perceptible deterioration.

Magnetic Head Design.—Under the conditions of operation the magnetic head must be capable of resolving between five and ten times as much per lineal inch as a standard audio head, and must present a reasonable impedance up to 3.5 Mc/s. It was found possible to design a head having an extremely short gap structure, and Fig. 9 shows a cross-section of a single element of this unique head. A 200-turn coil is threaded on a magnetic core consisting of three 0.002-inch strips of Hymu 80, the ends of which are pressed and held together by two half-cylinders of stainless steel. The entire assembly is bonded together with a casting resin. When the two half-cylinders press the two ends of the core together the area of contact between these ends originally extends inwards to a depth of about 0.005-inch. These ends, which are the pole faces, are carefully cut down until the depth is about 0.001-inch. No separator is used, the pole faces being in intimate contact. Thus the "gap"—a non-magnetic spacer in conventional heads—is only a concept in this unit.

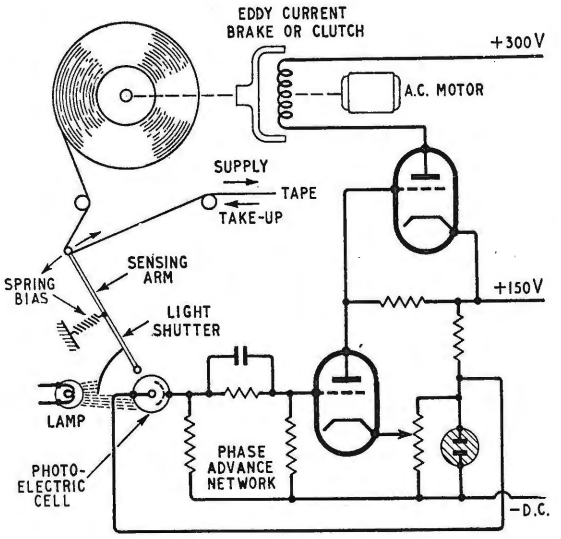


Fig. 8. Optical control of tape tension.

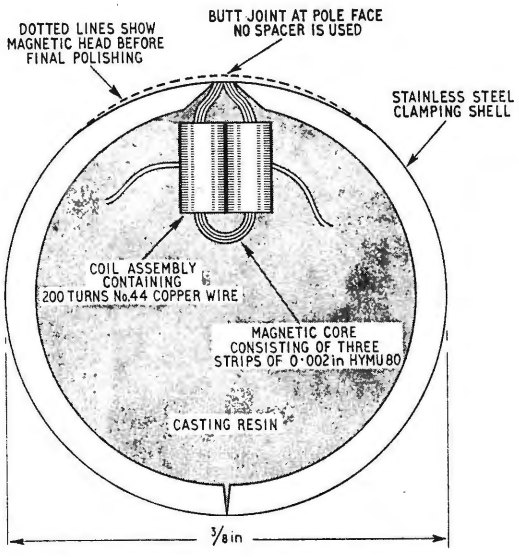


Fig. 9. Cross-section of magnetic head element.

A complete head contains five of these basic elements in a length of just under ½-inch. Even though there are no shields between the separate elements the crosstalk between them is negligible.

In its present state of development this video head can record and reproduce more than 15,000 cycles per lineal inch. The upper frequency limit is about 3.5 Mc/s, at a tape speed of 20 feet per second, and the frequency response is as shown in Fig. 10. In curve A, which extends from about 400 c/s to 1.5 Mc/s, the bias and signal are adjusted for best response at 1,000 c/s. These are the conditions used for the red, green and blue channels. In curve B the bias and signal are adjusted for best response at 1 Mc/s. These are the adjustments used for the mixed highs channel, the bias in this case being less than 0.5 mA. A d.c. bias is used to linearize the operating characteristic, in contrast to the a.c. bias normally used in audio practice. Corresponding to this d.c. bias a d.c. erasure technique is also used, the tape passing over a strong permanent magnet before reaching the recording head.

Since there is no observable null in the frequency response curves, no positive statement about the gap width can be made. However, since the information density represented by the high end of curve B is about 15,000 cycles per lineal inch, the gap length can be deduced to be not greater than one wavelength, or about 7×10^{-5} inch. One horizontal line of the picture occupies a length of 0.015 inch on the tape.

The lives at present obtained with these heads are about 100 hours.

Audio Recording System.—The techniques for recording audio frequencies on tape are highly developed, and one might expect that the addition of an audio channel to the video recording system would be a routine matter. However, the special requirements of the video channels impose unusual conditions on the audio channel. In the first place the high tape speed is a disadvantage, since it gives a greatly increased output noise voltage without a comparable increase in audio signal. The two audio tracks give a total track width of 0.028 inch, which is considerably less than the ⅜-inch and ¼-inch tracks normally employed. The effect of the narrower track is also to reduce the signal-to-noise ratio.

The two tracks are recorded by two identical head units connected in series, these being similar to the heads used in the video section. The recording and playback heads are located on the side of the driving

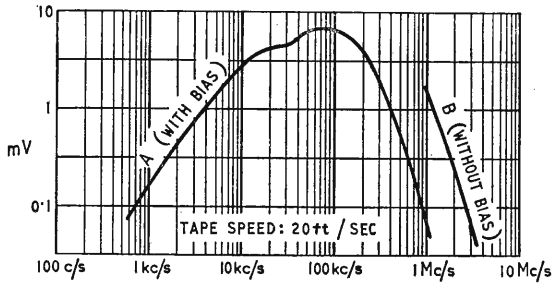


Fig. 10. Frequency response of video magnetic head.

capstan remote from the video heads. The 0.008-inch guard bands separating the audio from the video tracks are sufficient to prevent crosstalk.

Under these conditions conventional direct recording does not provide acceptable quality, so a method employing a frequency modulated carrier is used, with a mean carrier frequency of 90 kc/s and a deviation of ±15 kc/s. The wide deviation permits a higher signal-to-noise ratio, and is determined by the range over which adequate linearity of circuits can be maintained, rather than by the available bandwidth. Under these conditions the maximum signal-to-noise ratio is limited by variations in tape speed. Any change in tape speed causes a corresponding change in carrier frequency, which results in a noise voltage at the demodulator output. The tape speed at the audio heads varies less than 0.025 per cent (this is without the benefit of the movable head as used for video reproduction), and with this a satisfactory signal-to-noise ratio is obtained.

Performance.—The result of irregularities in the tape motion is seen in practice as a waviness in the vertical lines of the picture. This waviness has been observed to range from barely perceptible to a peak-to-peak amplitude of approximately $\pm\frac{1}{16}$ inch. The amount of waviness is bound up with the slight curvature often present in the tape. On occasions odd coating conditions appear to cause sticking between the tape and the magnetic heads, resulting in random waviness in the picture.

This equipment has been on field test at the National Broadcasting Company in New York since April, 1956. Television programmes originating in California and elsewhere are regularly recorded in New York, and recorded programmes have been put on the air experimentally. In October, 1956, the first on-the-air public showing of video tape, in both black-and-white and colour, was made by the N.B.C. over a coast-to-coast network.

Observers have agreed that, in its present state of development, the equipment will reproduce a television picture whose steadiness compares favourably with that of studio motion picture equipments.

It must be emphasized that the equipment is still in the development stage, and the figures given do not represent the ultimate possibilities. Under controlled conditions pictures have been recorded and reproduced with a bandwidth well over 4 Mc/s and with no perceptible jitter. Audio signals having a signal-to-noise ratio of 60 dB and undetectable distortion can be realized. When these results can be obtained under normal conditions the equipment will be ready to play an important part in the daily colour television programme activities.

REFERENCES

[1] H. F. Olson, W. D. Houghton, A. R. Morgan, J. Zenel, M. Artzt, J. G. Woodward and J. T. Fischer. "A System for Recording and Reproducing Television Signals," *RCA Review*, Vol. 15, p. 3, 1954.

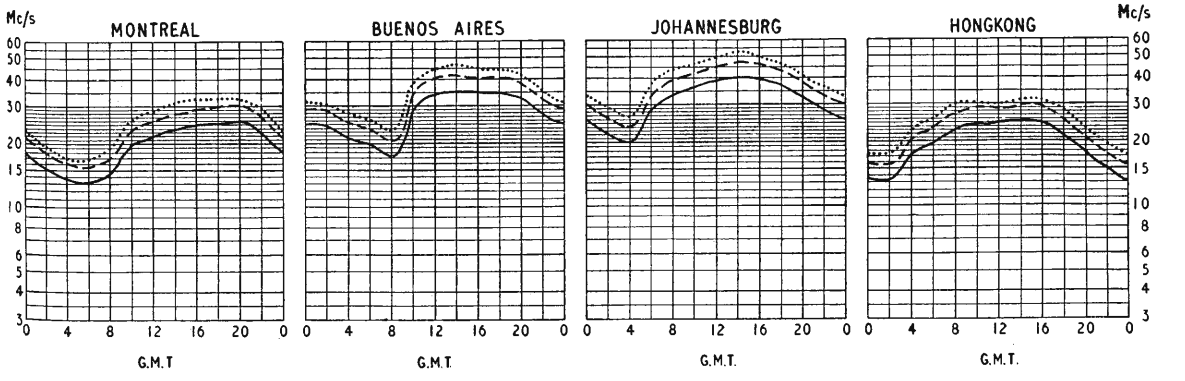
[2] C. G. Mayer. "Recording Television and Sound Signals on Magnetic Tape," *Electronic Engng.*, Vol. 26, p. 292, 1954.

[3] A. V. Bedford. "Mixed Highs in Colour Television," *Proc.I.R.E.*, Vol. 28, p. 1003, 1950.

[4] A. C. Robertson. "Dimension of 16mm Film in Exchanges," *Jour.S.M.P.T.E.*, Vol. 57, p. 529, 1951.

SHORT-WAVE CONDITIONS

Prediction for April



THE full curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during April.

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

Choosing Radar Wavelengths

Relative Performance of 10 and 25 cm for Surveillance Equipment

By R. F. HANSFORD* and R. T. H. COLLIS*, M.A., F.R.Met.S.

MODERN air traffic control systems designed to deal with high-density traffic are making more and more use of radar surveillance, either for monitoring or direct control. The increasing use of fast, high-flying aircraft calls for a radar with a long range and high altitude coverage that would have been beyond the bounds of possibility only a few years ago. The rapidly increasing number of small fighter aircraft presents the twin problems of greater danger to civil aircraft and worse detectability to the air traffic control radar. To provide safety in the air over the large regions for which the traffic control authority is responsible makes stringent demands upon the radar and the choice of suitable equipment becomes a problem requiring the most careful study. Military defence makes even more stringent demands on the long range surveillance radar. To control interception, bomber and fighter must be observed with absolute continuity.

These equipments must continue to perform their functions reliably in difficult terrain conditions or in adverse weather. This latter point in particular has led to considerable controversy as to whether 10 or 25 cm is the better operating wavelength for long-range surveillance. Indeed, it is probably one of the most controversial subjects in the whole field and it is perhaps for this reason that so little has been written on it. It is also a subject on which some serious misconceptions exist.

Coverage.—The basic detection range to be expected from a particular radar is a fundamental problem governed by known mathematical relationships.[1] It may be expressed by the following equation:—

$$R^4_{max} = \frac{PA^2f^2}{4\pi S_{min}\lambda^2} \times \sigma$$

where R_{max} = maximum detection range
P = transmitter peak power
A = area of aerial
= an aerial illumination factor (which may be between 0.7 for a pencil beam and 0.2 for a cosecant[1] beam)
S_{min} = minimum detectable signal
λ = wavelength
σ = aircraft radar cross section (radar reflecting area).

It may be seen that if the wavelength is increased by a factor of 2.5, then to achieve the same detection range either the transmitter power must be increased 6.25 times or the area of the aerial must be increased 2.5 times. The extra cost and complexity of these increases must be taken into account in deciding the operating wavelength. So far as the minimum detectable signal S_{min} is concerned there is not likely to be any great difference between 10- and 25-cm equipments. Receiver noise factors of 8 to 10 dB are now common in high-performance equipments at either wavelength and the other factors affecting S_{min} are not likely to differ greatly for equipments designed to fulfil the same purpose.

Assuming that the transmitter power and the aerial size for a radar are fixed by the limit of what is practicable, then it may be seen from the above equation that the detection range "R" will be proportional to $\sqrt{1/\lambda}$.

Taking some typical values of, say, one megawatt for the transmitter power, 50 square metres for the aerial (50 ft × 12 ft) and an aircraft of 20 square metres radar cross section (small transport), we may examine the comparative free space performance for similar 10- and 25-cm radars, the effect of ground reflections and adverse weather being

* Decca Radar Limited.

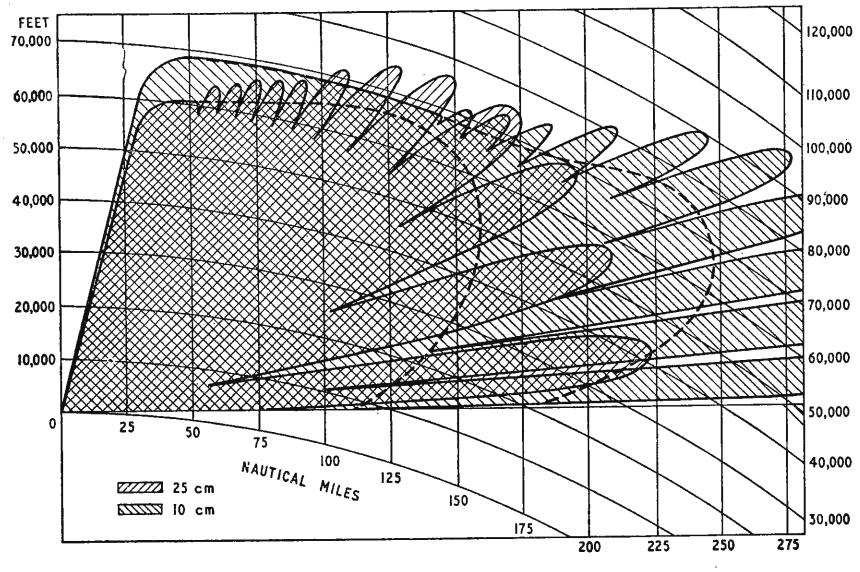


Fig. 1. Calculated coverages of 10- and 25-cm radars having same size of aerial for a large transport aircraft. Scanner height 25 ft.

dealt with below. The maximum range for such a 10-cm radar would be about 250 nautical miles and the range for a 25-cm radar having the same characteristics would be:—

$$250 \times \sqrt{\frac{1}{2.5}} = 158 \text{ miles}$$

It is now necessary to consider the effect of the energy radiated downward from the scanner and reflected from the ground. This energy interferes with the energy radiated directly from the scanner and can profoundly affect the coverage by partially breaking it up into a number of lobes; the presence of these lobes has advantages and drawbacks and it is therefore important to examine their nature.

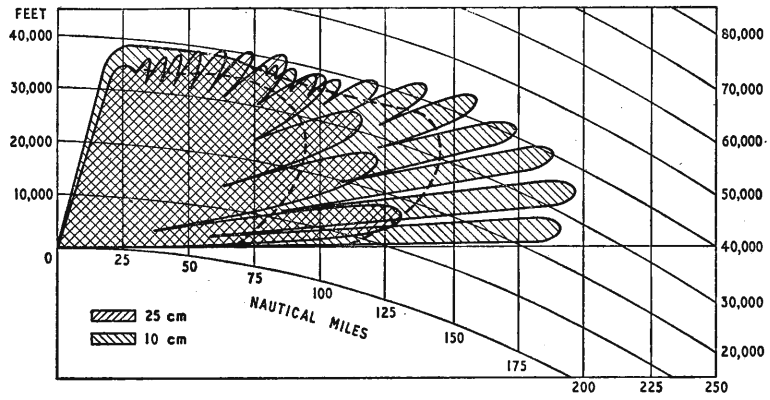


Fig. 2. Calculated coverages of 10- and 25-cm radars having same size of aerial for a small aircraft. Scanner height 25 ft.

The angle between the maxima and minima of the lobes is given approximately by the formula:—[1]

$$\alpha = \frac{\lambda}{4h} \text{ radians}$$

where α = angle between a maximum and next minimum
λ = wavelength
h = aerial height above reflecting surface.

It may thus be seen that for a given aerial height, the lobe structure has a finer pattern on 10 cm than on 25 cm and that the lowest lobe will be closer to the ground at the shorter wavelength. The length of the lobes will depend on the strength of the upward and the downward radiation from the aerial and upon the reflection coefficient of the ground. If the upward and downward radiation of the aerial are equal and if the reflection coefficient is 1, then the maximum range of the lobes will be double that of the free space range. When this advantage is achieved, the drawback must be accepted that the gaps between the lobes reach right back to zero range and the coverage is therefore exceedingly broken. In practice, the lobe structure will lie somewhere between this extreme and the unbroken free-space pattern.

The fact that the coverage is dependent upon the ground reflection means that in practice it is likely to change markedly as the aerial rotates and from day to day as the ground changes from wet to dry. This broken and varying coverage makes it difficult to give a simple answer to the question of what is the maximum range of a given radar. The practice is becoming more common of regarding the useful range of a radar as that at which a given aircraft can be detected and tracked with a 90% probability, and this must allow for aircraft fluctuation as well as lobe structure. It is obvious that such probabilities cannot be achieved in the outer regions of the interference lobes; indeed the presence of interference is more likely to reduce rather than increase the range at which a 90% probability of detection will be achieved. For these reasons it is the aim of the designer of modern radar equipment to reduce the ground reflections as much as possible. This he can do (particularly in so far as the near-in reflections are concerned which cause gaps in the high altitude coverage) by achieving the sharpest possible cut-off to the bottom of the beam. This is much more readily achieved at 10 cm than at 25 cm, beamwidth being proportional to wavelength.

The calculated coverage of 10- and 25-cm radars both having aerials of the same dimensions are given in Fig. 1 for a Viscount aircraft. A small fighter, which could provide a collision risk to a transport, may have only about one-tenth the radar reflecting area of a Viscount and it is important to consider the coverage and the gaps for such an aircraft; this is illustrated in Fig. 2. It is instructive to examine on each diagram the detection to be expected of both types of aircraft as they fly in at a given altitude.

A 10-cm equipment with an aerial width of 50ft has an effective bearing discrimination of about 0.5° corresponding to a little under 2 miles at 200 miles. A 25-cm radar having the same size of aerial would have a discrimination of about 1.3° corresponding to about 5 miles at 200 miles.

Ground Clutter.—The presence of houses, trees, hillsides and the like give rise to permanent echo clutter which can mask the presence of the wanted targets. This is generally a close-range problem and except in the case of unusually high radar sites, or in mountainous territory, seldom extends beyond some fifty miles. Within this range it can present a serious problem.

Assuming that a patch of ground clutter consists of a large number of individual objects and that this patch is larger than an area defined by the beamwidth and the pulse length, it may be shown that the relative echo strength of the clutter and a wanted target is given by the equation below (for the case when both target and clutter are substantially in the same part of the vertical beamwidth).

$$\frac{S_t}{S_{cg}} = \frac{\sigma W}{R\lambda\tau\sigma_{cg}}$$

where
S_t = target echo power
S_{cg} = ground clutter echo power
W = width of aerial
τ = pulse length in units of distance
R = range
σ_{cg} = clutter radar cross section per unit area

It will thus be seen that, other factors being equal, the target-to-clutter ratio will be 2.5 times better at 10 cm than at 25 cm. It is also of interest to note that any increase in aerial width or decrease in

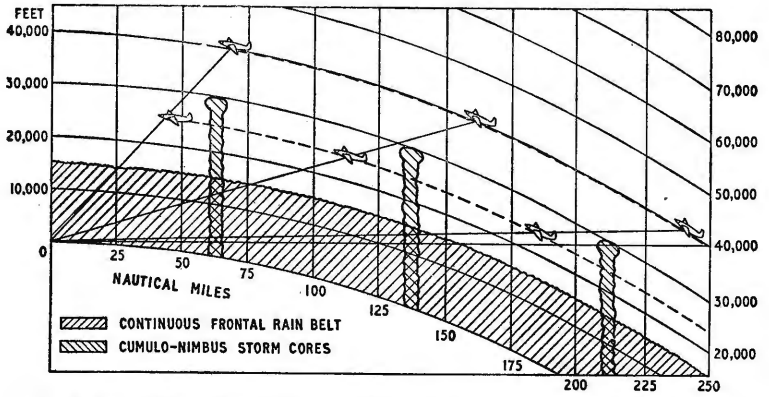


Fig. 3. Two different sets of meteorological conditions are shown here: a continuous rain belt extending up to 15,000 ft and isolated rain areas with cumulo-nimbus centres.

pulse length results in an improvement of target-to-clutter ratio.

In practice, it is usual for the radar beam to be elevated slightly above the horizontal and this will result in a decrease in the clutter amplitude, the target/clutter ratio depending upon the aircraft height above ground and the beam characteristics. Further, the sharper the bottom cut-off of the beam the smaller will be the clutter amplitude; thus the sharper elevation beamwidth usual with a 10-cm radar will also contribute toward an improved signal-to-clutter ratio at this wavelength.

The higher bearing discrimination provided by a 10-cm radar will result in the ground clutter area appearing more localized and more broken up. It is thus possible for wanted targets to be seen through the clutter more readily.

It will thus be seen that the 10-cm radar has an inherent advantage over the 25-cm one in target-to-ground-clutter ratio; advantage ratios of 6 to 12 dB are quite common for radars of the same dimensions. Nevertheless, it may well be that on both wavelengths the target echo is weaker than the clutter echo, particularly when the aircraft is flying well above the main beam. In such cases it may be necessary to resort to clutter suppression techniques, such as "moving target indication" (M.T.I.). In such systems the radar information is stored and then used to cancel the radar information obtained a short interval of time later; thus echoes which have remained unchanged (the permanent echoes) will be cancelled whilst echoes which have changed their position (such as moving aircraft) will not be cancelled.

Currently available and well tried M.T.I. systems working on pulse-to-pulse storage[1] are readily constructed for 50- and 25-cm radars and it is not uncommon for aircraft to be detected in clutter 25- to 35-dB stronger. Such systems are more difficult to construct at 10-cm wavelengths and their stability and performance are poorer; there is also a reduction in performance due to the smaller number of pulses per target obtained for the size of antenna considered here, and it is usual to expect sub-clutter visibilities of not more than some 10 to 15 dB. Newer forms of M.T.I. using rotation-to-rotation storage offer better sub-clutter visibility for the lower number of pulses per target common with high discrimination 10-cm equipments and sub-clutter visibility figures of the order of 20 dB are now possible.

On the subject of ground clutter performance it may thus be seen than an inherent advantage to 10-cm equipment of about 6 to 12 dB is offset by an M.T.I. performance which is likely to be worse by some 5 to 15 dB. There is thus basically little to choose between the two wavelengths in this respect: an individual 10-cm radar may have a better or worse clutter performance than an individual 25-cm one depending upon the actual characteristics of each.

Weather Effects.—Adverse weather conditions can effect the performance of the radar equipment in two ways:—

(a) the presence of rain can cause attenuation of the radar energy so that some of the energy passing through such weather conditions will be lost on its way to the target and back. Thus the echo from the wanted target will be weakened;

(b) some energy will be scattered back from the

(*Continued on page 191*)

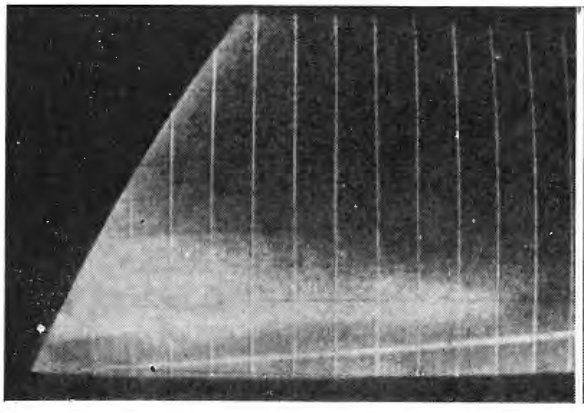


Fig. 4. Effect on typical range/height radar display of a continuous rain belt. (Courtesy Meteorological Office).

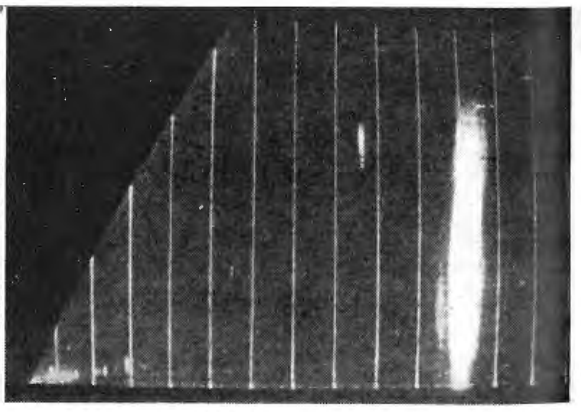


Fig. 5. Effect on typical range/height display of cumulo-nimbus cloud centre at about 7 miles. (Courtesy Meteorological Office.)

TABLE I

Rainfall Rate	Attenuation at 10 cm	Attenuation at 25 cm
10 mm/hr	0.006 dB/km	0.001 dB/km
25 mm/hr	0.015 dB/km	0.0025 dB/km

rain and will appear as clutter echoes upon the display. Such clutter echoes may mask the presence of a wanted target echo.

The importance of these two deleterious effects will now be examined. Fig. 3 shows two different sets of meteorological conditions, first of all the presence of a continuous belt of moderate intensity rain extending to a height of about 15,000 ft as in frontal or cyclonic rain; in temperate latitudes this may be taken as an extreme case, such rain not normally extending much above 10,000 ft. Also shown is the alternative situation of isolated thundery rain where the heavy centres of rain are associated with the cores of cumulo-nimbus clouds. It is particularly important to realize that in general, in temperate climates, continuous rain is of only light or moderate intensity (up to 10 mm/hr), whereas heavy rain (25 mm/hr) is of an isolated nature and of very short duration[2]. The two different types of rainfall are well illustrated in Figs. 4 and 5, which are photographs of the range/height display of a meteorological radar; the isolated nature of cumulo-nimbus clouds is also illustrated in the p.p.i. picture of Fig. 6. The two-way attenuation at a 10-cm wavelength[3] and that at a 25-cm wavelength is shown in Table I for two different rainfall rates.

Fig. 3 shows that for an aircraft low on the horizon the maximum depth of continuous rain which has to be penetrated by the radar is about 150 miles; simple calculation then shows that the attenuation would be 1.6 dB for 10 cm and 0.25 dB in the case of 25 cm. Such orders of attenuation are negligible, resulting in a loss of detection range of under 10%.

In the case of penetrating cumulo-nimbus storm cores the maximum diameter for a single core is not likely to exceed some 5 miles and calculation then shows that the attenuation for a single core would be about 0.13 dB for 10 cm and 0.02 dB for 25 cm. Again, such orders of attenuation are negligible and even in the unlikely event of some four or five storm centres lying directly between the radar and the wanted aircraft an attenuation of less than 1 dB would be realized at 10 cm with a loss in detection range of only some 5%. It can thus confidently be said that attenuation is no problem to the designer of either 10- or 25-cm radar. The back scatter energy, however, presents a much more formidable problem.

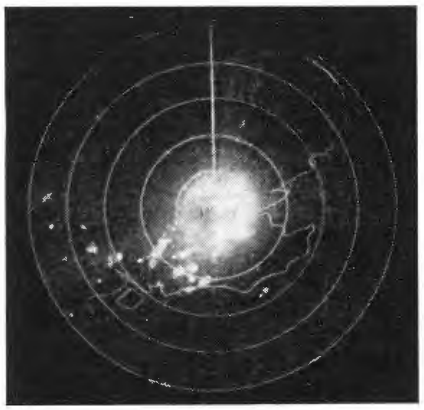


Fig. 6. Isolated cumulo-nimbus storm centres as shown on typical p.p.i. display.

The ratio of the unwanted rain-clutter amplitude to the wanted target amplitude is a function of several parameters[1]. For the basic case of a fan or pencil beam, with the target in its centre and the beam filled by the rain, the ratio may be shown to be:—

$$\frac{S_t}{S_{cr}} = \frac{2A\sigma}{R^2\lambda^2\tau\Sigma\sigma_{cr}}$$

where S_{cr} = rain clutter echo power
$\Sigma\sigma_{cr}$ = rain radar cross section per unit volume.

At first sight it would appear from this formula that the target-to-clutter ratio improves as the wavelength decreases. In fact for a given rainfall the effective radar cross section $\Sigma\sigma_{cr}$ increases sharply at shorter wavelengths and is proportional to $1/\lambda^4$. In the case of radars operating at wavelengths of the order of 10 and 25 cm and using established relations for radar cross section, wavelength and rainfall rate[3] this formula may be restated approximately as:—

$$\frac{S_t}{S_{cr}} = \frac{A\lambda^2\sigma}{FR^2\tau r^{1.23}}$$

where F = an empirical constant
r = rainfall rate.

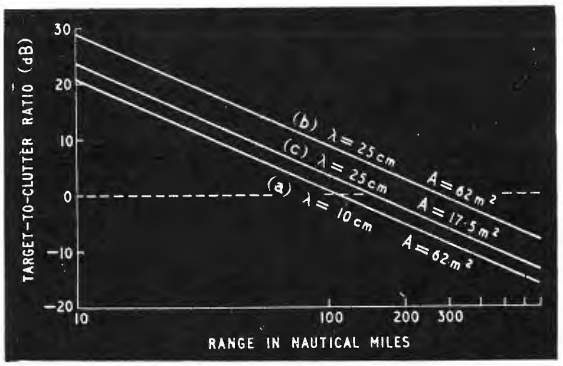


Fig. 7. Theoretical comparison of target-to-rain clutter ratio at 10 and 25 cms for large transport aircraft.

It should be noted from the above that any improvement in discrimination brought about by increase of aerial size or decrease in pulse length results in a directly proportional improvement in target-to-clutter ratio.

Fig. 7 shows a theoretical comparison for 10 and 25 cm of the ratio of echo power from a Viscount aircraft to that from rain of 10 mm/hr, assuming that the aircraft is in the centre of the beam and that the beam is filled by the rain; for simplicity a fan beam has been assumed. Curves (a) and (b) show the performance for the 10- and 25-cm equipments having the same size aerials. However, many 25-cm equipments at present in production

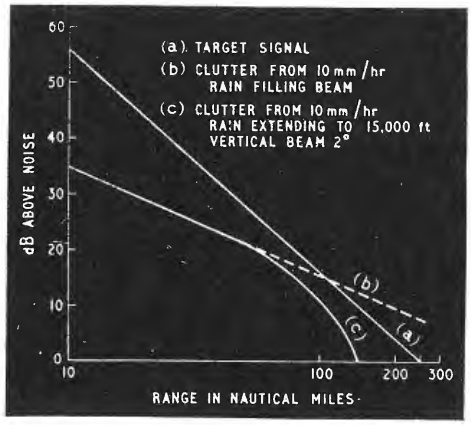


Fig. 8. Practical target and rain clutter amplitudes at 10 cm with large transport aircraft.

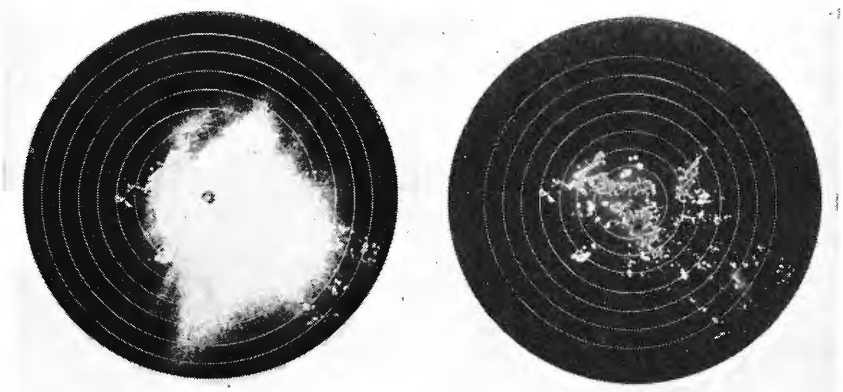
use aerials smaller than 20 square metres and curve (c) shows the performance for a 25-cm radar having the smaller aerial.

The target-to-clutter ratio for the 10-cm radar is 3 dB worse than that of the 25-cm radar with the smaller aerial and 8 dB worse than that with the larger aerial. Of more direct importance is the inference that the the Viscount aircraft would be lost in the clutter at 110 miles on the 10-cm radar and would be held out to 140 miles with a 25-cm radar and smaller aerial or 270 miles with the larger aerial. However, it should be emphasized again that these curves are based on the assumption that the beam is completely filled by the rain at all ranges; this cannot occur in practice with a long-range radar, as may be seen from Fig. 3.

Fig. 8 shows how the story is modified by practical conditions and the case of a 10-cm, high-discrimination radar is now taken, again for simplicity, assuming a fan beam. Curve (a) shows the strength of echo to be expected at various ranges for a Viscount aircraft in the centre of the beam, curve (b) shows the strength of clutter to be expected from 10-mm/hr rainfall filling the beam, curve (c) shows how the intensity of this clutter decreases below the theoretical value at longer ranges until the top of the rain layer falls below the horizon at a range of about 150 miles. It will now be seen that the echo strength of a Viscount aircraft on such an equipment remains greater than the echo strength or 10-mm/hr rainfall at all ranges.

On this basis, it may be said that with the type of fan-beam radar discussed above, the only time when clutter strength is likely to exceed that from a transport aircraft is in the case of the heavy rainfall cores of cumulo-nimbus clouds; such cores occupy only isolated positions on the radar display and it will, in any event, be usual to keep aircraft away from these cores in order to avoid the severe turbulence to which the aircraft would otherwise be subjected. It may thus be seen that with a high-discrimination radar operating on 10 cm the problem of back scatter is by no means so severe as might at first sight have been imagined.

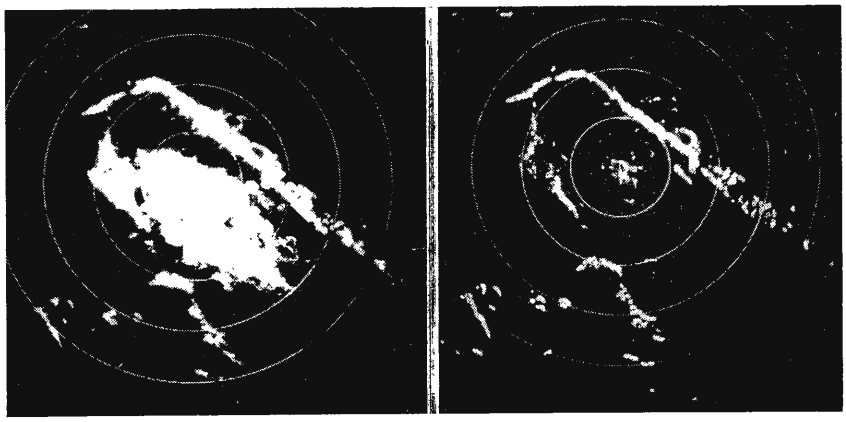
At this stage some attention must be given to the use of cosecant aerial patterns. For the case of an aircraft flying down the main beam, the above arguments continue to apply. For an aircraft which is flying at high altitude at close range and thus in the cosecanted part of the beam, its echo will be relatively weaker than that from rain in the main part of the beam at the same range. Thus, a worsening of the target-to-clutter ratio must be expected, the amount depending upon the characteristics of the cosecanting and the relative altitudes of the aircraft and the rain. This degradation of the ratio may be considerable at high altitude and close range, and if the maintenance of cover at close range is a vital operational requirement, may present a serious problem. It should be remembered, however, that the cosecant technique is not the only way of obtaining high-angle cover and some of the alternative methods avoid or reduce this difficulty. Where the problem remains severe, recent advances in the means of reducing the effect of back-scatter clutter energy are of great value. If a radar transmits circularly polarized radiation, the echoes returned from the spherical rain drops are substantially circularly polarized, but have the characteristic that the direction of the polarization is reversed; such echoes are virtually rejected by the circular polarizing element in the receiver aerial system. [1,4] On the other hand, the echoes returned from aircraft are substantially linearly polarized and their echoes are accepted by the receiver aerial system. By this means a big improvement in wanted target-to-clutter ratio can be obtained. In the latest type of radar variable polarization is employed so that adjustment may be made from time to time to secure the maximum rejection under particular clutter conditions. Improvement ratios in the region of 15 to 25 dB have been obtained under practical conditions with this system. Figs. 9 and 10 show the improvement which has been obtained with variable polarization; the results were in fact obtained with a 3-cm radar where rain clutter presents more severe



Left: Fig 9. Effect on p.p.i. display of rain-storm, with horizontal polarization. Right: Fig. 10. Same rain-storm as in Fig. 9 but with circular polarization. Aircraft responses could easily be seen through the small residue of clutter.

problems than at 10 cm.

While circular polarization brings about a substantial improvement in target-to-clutter ratio, the technique of using a logarithmic amplifier has quite another purpose. To appreciate the purpose of logarithmic amplifiers for clutter reduction, it must be remembered that on a p.p.i. display, quite weak clutter echoes can saturate the display and hence mask very much stronger target echoes. It is here that the logarithmic amplifier technique in the radar receiver is of great value. The use of a logarithmic amplifier followed by a differentiating circuit may be shown mathematically[6] to have the property of reducing the strength of all randomly fluctuating signals to a common level. The echo intensity from rainfall fluctuates approximately in this manner, as does the receiver noise; consequently when rain-clutter echoes are passed through a logarithmic amplifier and differentiating network, they appear at the output to have the same level as the receiver noise. On the display, the rain-clutter echoes will therefore be indistinguishable (or scarcely distinguishable) from the background noise, thus clearing the clutter from the display and allowing the stronger target echoes to be seen. In practice very strong clutter echoes are reduced substantially to noise level; this is illustrated in Figs. 11 and 12, which were again taken with a 3-cm radar.



Left: Fig. 11. Effect of rain storm using linear amplification in receiver. Right: Fig. 12. Same rain storm as in Fig. 11 but using logarithmic amplification and differentiation in the receiver. Ground clutter is still present, but reduced in intensity.

Summary.—A 10-cm radar having the same bulk of equipment as a 25-cm one can offer a 58% greater range of detection in clear weather. Such equipment offers a 2½-times improvement in discrimination and a continuity of cover which is difficult to obtain at longer wavelengths. On the subject of ground clutter there is little to choose between the two wavelengths.

Attenuation in rain is no problem for either a 10-cm or a 25-cm equipment. The back-scatter clutter from rain presents greater problems on 10 cm than 25 cm; however, the problems at 10 cm are, for the most part, not too serious with a high-discrimination radar and great strides have been made in anti-clutter techniques.

This investigation has not given an unequivocal answer to the question of which is the better operating wavelength; indeed in the authors' opinion there is no direct general answer. A particular 10-cm radar may be either better or worse than a particular 25-cm one in almost any of the respects examined above. It is the authors' opinion that no choice should ever be based on a general preference for either wavelength; a particular choice should be based on a thorough study of the parameters of the individual radars available and this should be examined in relation to the operational requirements.

REFERENCES

[1]Ridenour, L. N. *Radar System Engineering.* McGraw Hill.

[2]Ryde, J. W. "Attenuation and Radar Echoes at Centimetre Wavelengths" Meteorological Factors in Radio Wave Propagation. Physical Society, London.

[3]Gunn, K. L. S. and East, T. W. R. "Microwave Properties of Precipitation Particles." *Q.J.R. Meteorological Society*, London, 1954.

[4]Ramsey, J. F. "Proceedings of a Conference on Centimetric Aerials for Marine Radar." H.M.S.O., London.

[5]Croney, J. "The Reduction of Sea and Rain Clutter in Marine Radar." *J. Inst. Nav.*, Vol. 7, No. 2. John Murray, London.

U.K. GEOPHYSICAL YEAR

MUCH valuable information has been compiled on the constitution of the radio reflecting layers by probing the ionosphere with radio signals transmitted from the ground. During the present year it is hoped to add considerably to this knowledge by sending aloft in rockets radio transmitters and receivers. Plans have been made, as part of the United Kingdom contribution to the International Geophysical Year (July, 1957, to December, 1958), to commence these investigations shortly at the Woomera rocket range in Australia, where preparations have been in hand since mid-February.

It is the object of the experiments, which are under the direction of the Royal Society, to determine, with greater exactitude than has been possible hitherto, the degree of ionization and also the actual types if ion or atom present in the ionosphere. Ions will be collected by suitable equipment in the rocket, which will be able to determine their mass, nature of their electrical charge and any other relevant details, and transmit the acquired information to the ground by radio as the rocket ascends through the E and F layers. Some of these experiments are framed to provide precise data on the variation of free electron concentration in the troposphere and ionosphere with height.

The greater part of this work is being undertaken by the physics and electrical engineering departments of the University of Birmingham, University Colleges of London and Swansea, and the Royal Air Force. Assistance is afforded by the Royal Naval Scientific Service in the provision of special equipment.

Transistor Graphical Symbols

A Critical Analysis of Existing Ideas and Conventions

By "CATHODE RAY"

WHEN last discussing transistors (Dec., 1956, issue) I thought I was probably sticking my neck out recklessly for in urging all concerned to abolish the ticks, dashes, primes, or whatever you call them, that distinguish common-emitter parameters from common-base. I thought—and still think—it quite fantastic that everyone should be condemned for the rest of time to keep on writing α', r_o', h'_{12}, etc. (and putting the dashes in again whenever the typist or compositor misses them out), while reserving α, r_c, h_{12}, etc., for the small and diminishing number of occasions when the common-base configuration is intended. The sooner this false start is corrected the better. But from past form I expected the people who had been using the unticked symbols for several years for common-base conditions would object strongly to the idea of changing them over to mean something different, no matter what could be said in favour. So I cautiously interpreted the total absence of correspondence on this subject as silent contempt.

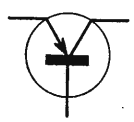
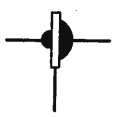
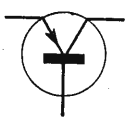
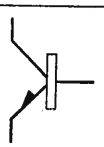
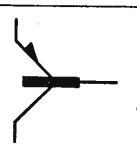
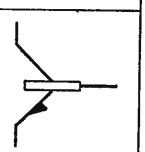
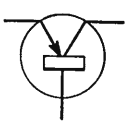
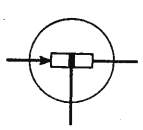
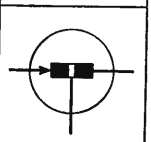
Imagine, then, my pleasurable surprise when, at a well-attended gathering of transistor educationalists, the suggestion was not only endorsed by several authorities but well received by the rest, with no audible opposition. I shall be even more pleased and surprised if, in a year or two, it will be safe to interpret references to "α" as meaning current amplification factor in common-emitter, except where the contrary is specified, or in antiquarian contexts relating to point-contact transistors.*

Having already developed at some length the arguments for dropping the decorations from α, etc., I will not repeat them here but will go on to the question of graphical symbols for transistors. Fig. 1 shows some of those that have been suggested. There are probably others.

What do we say? Well, one thing that sticks out clearly from all the diversity of ideas is (with due respect to Mr. Thompson) that the symbol originally invented for the point-contact transistor is a good one—for the point-contact transistor. It fulfils all the requirements for a circuit symbol: it strongly suggests the thing it represents; it is easy to draw; it fits in easily to circuit diagrams; and it has become generally accepted. So, say I, as Glasgow says about itself, let it flourish.

So good is it that it has become generally used, though less enthusiastically, to represent junction transistors too. The lack of enthusiasm is demonstrated by the number of alternatives that have been proposed. Yet nearly everybody keeps on using it. And it is the only kind shown in the recent Supplement No. 4 to BS.530 ("Graphical Symbols for Telecommunications"). Why shouldn't it be?

Fig. 1. Some of the many proposed transistor symbols. (The blobs on the envelopes normally used by Wireless World have been deliberately omitted).

PROPOSER	REFERENCE	POINT CONTACT		JUNCTION	
		p-n-p	n-p-n	p-n-p	n-p-n
HENRY MORGAN	WIRELESS WORLD APRIL 1954 p.178				
P.M.THOMPSON	WIRELESS WORLD JULY 1954 p.325				
E. AISBERG	WIRELESS WORLD MARCH 1955 p.125				
G.B.B.CHAPLIN	PROC. I.E.E. (B) NOVEMBER 1955 p.788				
H.J. COOKE	WIRELESS WORLD DECEMBER 1956 p.600				

* Since the above was written a letter has appeared, from M. O. Felix, of Canada, advising me to adopt β as the substitute for α'. With all respect I disagree, for β (or B) in amplifier contexts is well understood to mean feedback ratio, and to use it also to mean an amplification factor is to make confusion worse confounded.

There are at least two reasons, so strong that in my humble opinion they demand action.

The first is that it doesn't in the least suggest a junction transistor. If the Editor will pardon my saying so, this applies especially to the *Wireless World* version, in which a great thick slab, like a foundation stone, is used to represent the thinnest possible layer of solid that modern technique can contrive. An even more obvious discrepancy is that the two other electrodes of a junction transistor are *not* on the same side of the base, and they are *not* points.

The other reason is that the conventional symbol, when used for a junction transistor, strongly suggests something that it *isn't*. It completely fails to make an important distinction. So, looking at a transistor circuit diagram, one wastes time searching for information on which kind of transistor is meant. If point-contacts become completely obsolete that objection will disappear, but we will still be left with an absurdly inappropriate symbol.

Again, the sooner the false start is corrected the easier it will be.

What about the alternatives in Fig. 1?

To qualify for consideration, any suggested symbol should be (1) suggestive of a *junction* transistor, (2) easy to draw quickly on paper or blackboard, and (3) easy to distinguish from all other symbols. For judging between otherwise equally good entrants, one might also have to take into account (4) adaptability to circuit diagrams, (5) adaptability to future developments in transistors—more electrodes, for example—and (6) some measure of existing use.

Under requirement (2) I would immediately rule out all symbols with areas that have to be blacked (or whited) in. Life these days is just too short. It is bad enough having to do it for non-thermionic rectifiers, but (looking forward) at least those occur less often than transistors. The difference between p-n-p and n-p-n can much more easily be shown by an arrowhead as heretofore. That disposes at once of all the suggestions in Fig. 1 except for those by E. Aisberg. While it grieves me to criticize adversely such a good friend's proposal, I cannot avoid pointing out that it perpetuates the error of showing emitter and collector on the same side of the base. So all go.

Textbook Symbol

If I were to put forward a brand-new suggestion of my own it could be shot down under requirement (6), at least. Fortunately that is not necessary. There is a symbol which is used throughout one of the transistor world's most popular textbooks—"Transistor Electronics," by Messrs. Lo, Endres, Zawels, Waldhauer and Cheng, all of the Radio Corporation of America. To descend from the sublime to the ridiculous, it has also been used privately for some time with great satisfaction by "Cathode Ray," who is determined to continue using it until something better can be shown. Regular readers will testify that I am not unduly biased in favour of American practice, even when advocated by authors of such widespread ancestry as the above names suggest. The basis for my enthusiasm is that their symbol, shown here as Fig 2, adequately fulfils all the other five requirements too.

(1) Though it could be argued that some of the alternatives in Fig. 1 more closely resemble a junction transistor—the gap between collector and base in Fig. 2 could be criticized, for example—there can be little doubt about the superiority of Fig. 2 over the point-contact type of symbol; in particular, the essential thinness of the base is emphasized. Accepted practice rightly favours circuit symbols that primarily suggest function, with only a very general hint of outward appearance—liable to change in detail.

(2) Both for quick sketching and formal drawing, Fig. 2 has a marked advantage over any of the symbols shown in Fig. 1.

(3) There can be no doubt that the important distinction between point-contact and junction transistors is duly made. At the same time it clearly points the analogy between the junction transistor and the valve. In fact, the only criticism I can

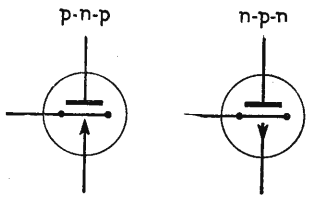


Fig. 2. This junction transistor symbol, used by five RCA engineers, has advantages over any of those in Fig. 1.

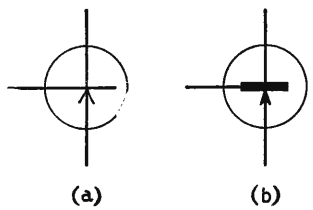


Fig. 3. (a) is a recent suggestion, by James Franklin; it can be regarded as a simplified form of Fig. 2. The corresponding n-p-n symbol would presumably have the arrow pointing downwards. At (b) is a similar version used by W. T. Bane and D. L. A. Berber.

imagine as having any weight (though it has none with me) is that this analogy is pointed *too* clearly. There is, I believe, a school of thought that deprecates likening a transistor to a valve. Personally I hold that transistors have so much in common with valves, as regards function, methods of use, and to some extent internal workings, that it is futile *not* to note the similarities. I haven't found in practice that there is any danger whatsoever of actually confusing the Fig. 2 symbol with that for a valve. Use of the point-contact symbol for junction transistors, however, certainly is confusing to learners.

(4) and (5) Just as the original valve symbol has proved itself adaptable to all the many elaborations that 50 years of history have forced upon it, so Fig. 2 should be equal to all eventualities, and be no less at home in circuit diagrams.

Another suggestion since the above was written is that by James Franklin, Fig. 3 (a), with a slightly more elaborate version from the *Journal of Scientific Instruments* at (b). This is even quicker to draw than Fig. 2, and escapes the criticism about the collector gap and also any objection on the ground of too closely resembling a valve. I regard it as a simplified and preferred version of Fig. 2 and wholeheartedly support it.

While on this subject, we might give some attention to the old question: To envelope or not to envelope? There are a few authorities on both sides

of the Atlantic who draw valve symbols all naked. No doubt they argue that the bottle is just an external covering, and mere external coverings are not shown in circuit diagrams unless they have some electrical function, such as screening. On the other side it can be argued that no valve would function electrically or in any other way without its envelope. This argument loses some of its force with a transistor, because it could work without, though probably not very long in our climate, and not very well, because it is affected by light. So it is rather commoner to omit the container from transistor symbols. But to my mind the real reason for drawing it round valve electrodes is to make the valves—which are key components—stand out clearly in the diagram. The test is: Are circuit diagrams in which the valves are represented only by their electrodes more difficult to read? To me they certainly are. This line of argument applies a shade less to conventional transistor symbols, in which all the electrodes are in contact; but even so they are not entirely easy to distinguish from mere circuit connections, and I am sure the envelope is helpful.

But please, Mr. Editor, may I appeal for the omission of the blobs where the leads pass through the envelope? Everywhere else these blobs mean electrical connection, so when used in valve and transistor symbols they indicate that all the electrodes are shorted to one another!

Drawing Supply Lines

Another point of practice in transistor circuit diagrams has been debated a good deal lately, so I think it ought to be mentioned here, even though this time I agree so much with both sides that I haven't been able to come down permanently on either. It has for long in Britain (though less so in America) been standard practice to draw circuit diagrams with a thick horizontal line to represent wiring at earth potential and to place positive parts above it and negative below. In this way the diagram not only shows how the components are connected up but by indicating the relative potentials it helps one to see how the whole thing works.

But when we come, full of helpfulness, to draw transistor circuits, what do we do? If we follow the same plan we have to draw the diagram apparently upside down, with "earth" at the top and "h.t." at the bottom; for the only transistors readily obtainable here just now are p-n-p types, which need negative supplies. This arrangement is rather disconcerting to those who have become used to the other way. On the other hand, if we draw the diagram the "right" way up, so that it is easily recognizable, we break the ancient and honourable custom of making potential increase positively upwards, and thereby introduce difficulties of another sort.

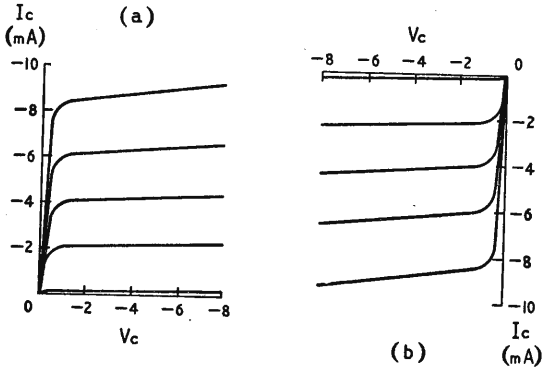


Fig 4. (b) is undoubtedly the correct way of drawing p-n-p characteristics, but most people still use (a).

To the conscientious it is an agonizing choice. It almost—but not quite—drives me into the camp of those who scrupulously avoid any hint of a suggestion that transistors have anything in common with valves, for it gives them one of the very few real opportunities to justify this viewpoint, by making transistor circuits look as unlike valve circuits as possible. To those of us who find the resemblances too striking to be ignored, it is hard to adhere to a principle that deprives us of the opportunity of showing beginners how easy transistors are—by substituting transistor symbols (preferably of the Fig. 2 variety!) for the valves in almost any amplifier circuit, and adding bias resistors from "h.t." to bases. Yet admittedly this easy-at-first way does make difficulties in detailed analysis of circuit action, especially in circuits of the less usual kinds, such as those including both p-n-p transistors and valves, or both kinds of transistors. Of course, if n-p-n became the rule rather than the exception, this dilemma would disappear. In the meantime, my way out (as you may have noticed last September) is to introduce transistors via valves by assuming the n-p-n variety, and then casually mentioning that the only sort you can actually buy is the p-n-p, which is the same except for all the polarities being reversed —a difference too trifling, of course, in these days of the nation's critical financial position to justify the expense of a new diagram solely to show it. And then one passes hurriedly on to something else. But sooner or later one has to draw a practical circuit, and then. . . . ! Some authorities postpone the issue by continuing to draw diagrams which apparently are conventional, unless one notices "−h.t." at the top right-hand corner where "+h.t." was wont to be. But Nemesis overtakes even them in time, for evil spirits lure them into writing an I.E.E. paper, which naturally has to include circuits sufficiently tricky to justify acceptance; and then they come in for a lot of pointed criticism from the floor for failing to adhere to standard practice based on common sense.

This is not all, for precisely the same dilemma awaits us when we draw characteristic curves. Ought we to show them as at Fig. 4 (a) or (b)? I suppose I ought to condemn (a) with ruthless scorn, but cannot yet bring myself to be strictly logical in this matter, any more than with the circuit diagrams. I rather hope (b) will come in time, though.

Readers of past ruthless scorns may wonder that I should have conceded so much as to write "h.t." even in inverted commas, when the description "*high* tension" is even more absurd applied to transistor batteries than it is low-power valve circuits. Yes, it does seem to me a misuse of language, to put it mildly; but in thinking so I am probably in a minority of one.

A more important matter arises when one begins to study the transistor in earnest. This is the stage where one treats it as a box of mystery (Fig. 5)

(*Continued on page* 197)

investigated exclusively by measuring the input and output currents and voltages. To do this without getting into a muddle with plus and minus signs, one has to decide beforehand which directions to call positive. If everybody decides the same way, the advantages are obvious. Faced with Fig. 5, what would you do, chum?

I imagine that nobody would seriously question a decision to reckon the positive direction of input current as *into* terminal 1. Nor, I guess, would riots break out on the announcement that the positive polarities of input and output voltages are those of terminals 1 and 3 respectively with reference to the common or earth terminals 2 and 4. It is the direction of output current that causes the trouble.

Being a simple sort of bloke, I tend to think of "output current" as the current that comes out. No doubt that is a shockingly unreasonable thing to do, in view of those pundits who have ruled that the positive direction of outward current is *into* the output terminal. So far I have not been able to trace any reasons for this ruling. On the contrary, nearly all the authorities on passive and non-transistor active four-terminal circuits show the output current coming out. Perhaps one or two of the transistor pundits would write and tell me why they reverse the accepted convention. Perhaps they will suppose it had not occurred to me that the right answers can be obtained by following either convention, so that the choice is purely arbitrary and therefore not open to question on grounds of rightness or wrongness. But unless some overriding consideration comes in, it does seem kinder to decide on what is likely to come most natural to the tender student. In my simplicity I would be inclined to suppose that terminal 3 being positive (relative to 4) would tend to imply a positive current coming *from* 3 into 4.

I can see, of course, that if one is so naive as to forget that the box contains an equivalent circuit, with magic generators and things, and not a transistor or valve, there arises the old controversy about which way the signal current flows in a valve anode circuit. This is further complicated by the newer controversy as to whether a transistor is or is not something like a valve. One can get caught both ways. A long time ago* I proved to my own satisfaction, with a generous output of ruthless scorn, that according to the established custom of reckoning the anode potential with respect to the cathode, and not the other way about, there is no escape from the conclusion that the logical positive direction of signal current is *out* from the terminal of the equivalent circuit that represents the anode. That is to say, it is opposite to the feed current, which is irrelevant in an equivalent circuit. This conclusion, of course, was far from original, for it agreed with many reputable authorities. And none of the others has contested the argument.

If one holds that a transistor *is* something like a valve, then logically *its* equivalent circuit in the common-emitter configuration should have its positive output current coming *out* from terminal 3. Those who are with me on the first point, but who delight in every chance to emphasize the differences between transistors and valves, will no doubt seize this one. and thereby align themselves with the pundits. On the other hand, some of those who admit the transistor-valve analogy may perhaps insist on valve signal current going the same way as its breakfast. But I can't believe there are no others, especially since the educationalists, who showed their enlightenment by endorsing my views on what the Duke of Wellington would have called "those d—— dashes," further demonstrated their quality by strongly deprecating the inward output current convention. If they carry these opinions into the classrooms and lecture theatres there is hope for the future generation.

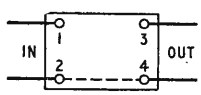


Fig. 5. In this "black box" representation of a transistor, which do you regard as the positive direction of output current?

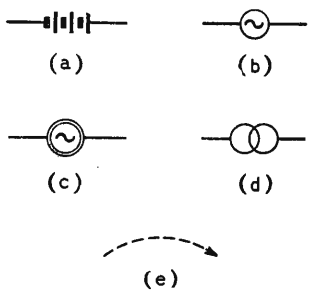


Fig. 6. The direct (a) and alternating (b) voltage generator symbols have no generally accepted current counterparts, though (c), (d) and (e) have been used.

The coming of transistor equipment circuits has greatly increased the frequency of occasions when it is necessary to indicate a current generator, and thereby has accentuated the unsatisfactory symbol position. A theoretical voltage generator is something that provides an e.m.f. in series with a current path without adding any impedance. Practical voltage generators such as batteries and a.c. machines can approximate quite closely to this specification, so their recognized symbols, Fig. 6 (a) and (b), are appropriate. A theoretical current generator is something that transfers current from one point to another without adding an admittance. Such a thing does not exist in real life, so perhaps it is hardly surprising that there is difficulty about a symbol.

The best practical approximation is a very high voltage generator in series with a very high resistance, but this would be confusing if shown in standard symbols. Recently I consented, under protest, to symbol (c) being used for my diagrams. It doesn't seem to me to be an obvious current counterpart to (a) or (b), and it certainly doesn't suggest an open circuit. Alternative (d) is no better except for being more widely used, and has the disadvantage of being the same as an international symbol for a transformer. The British Standards Institution has no symbol for any kind of signal generator—not even (b)—an astonishing fact to which I would draw the attention of the appropriate B.S.I. committee.

Some time ago (April, 1952, issue) I made use of an American idea—a curved dotted arrow (e), which at least suggests an open circuit and shows the positive direction, but does not always specify the terminal points closely. Moreover it is not particularly suggestive of a generator, and unless anyone can do better I would like to propose the already well-established theoretical alternating signal

* *Wireless World*, September 1946. (Chapter 30 in *Second Thoughts on Radio Theory*.)

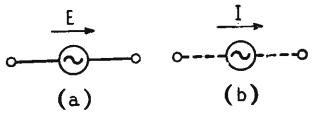
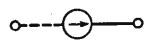


Fig. 7. (b) would seem to be the natural counterpart to (a); the dotted line implies the required open circuit.

Fig. 8. The dotted line appears in this current-generator symbol by Arguimbau and Adler.



generator symbol—Fig. 6 (b)—for both voltage and current, the absence of conducting path in the current case being indicated by dotted leads, as in Fig. 7 (b). This symbolism would give logical expression to what the two things have in common and to what distinguishes them.

P.S.—I have just seen that in the new book "Vacuum-Tube Circuits and Transistors," by Arguimbau and Adler, they denote a current generator by the symbol Fig. 8. I see no justification for replacing the well-known a.c. generator device of a sine wave by a straight arrow, which suggests something different, but I do welcome support of the dotted line idea from a source for which I have great respect.

COMPONENTS SHOW EXHIBITORS

A RECORD number of exhibitors (listed below) are participating in the annual Components Exhibition (April 8th to 11th) at Grosvenor House and Park Lane House, London, W.1.

Free admission tickets are obtainable from the Radio and Electronic Component Manufacturers' Federation, 21, Tothill Street, London, S.W.1, by engineers and technicians in the "user" industries, research and the Services. The Show opens daily at 10.0, closing at 6.0 on the first three days and 5.0 on the last day.

A.B. Metal Products
A.K. Fans
Advance Components
Aero Research
Air Control Installations
Allan Radio
Anglo-American Vulcanized Fibre
Antiference
Ashdowns
Avo

Bakelite
Belling and Lee
Bird, Sydney S., & Sons
Bray, Geo., & Co.
Brayhead (Ascot)
Brimar
British Communications & Electronics
British Electric Resistance
B.I. Callender's Cables
British Moulded Plastics
British Physical Laboratories
Bulgin
Bullers

Carr Fastener
Cathodeon Crystals
Clarke and Co. (Manchester)
Collaro
Colvern
Connollys (Blackley)
Cosmocord
Creators

D.S.I.R.
Daly (Condensers)
Darwins
Dawe Instruments
De La Rue
Diamond H Switches
Dubilier
Duratube and Wire

Eddystone
Edison Swan
Egen Electric
Electro Acoustic Industries
Electro Methods
Electronic Components
Electronic Engineering
Electrothermal Engineering
Enalon Plastics
English Electric
Enthoven Solders
Erg Industrial Corp.
Erie Resistor
Ever Ready

Ferranti
Film Industries
Fine Wires
Fortiphone

G.E.C.
Garrard
Goldring
Goodmans
Gresham Transformers
Guest Keen and Nettlefolds

Haddon Transformers
Hallam, Sleigh and Cheston
Harwin Engineers
Hassett and Harper
Hellermann
Henley's
Hunt (Capacitors)

Imhof
Insulating Components and Materials

Jackson Bros.
J. Beam Aerials

K.L.G. Sparking Plugs

Langley London
Linton and Hirst
Lion Electronic Developments
London Electrical Mfg. Co.
London Electric Wire Co.
Long and Hambly
Lustraphone

Magnetic and Electrical Alloys
Magnetic Devices
Mallory Batteries
Marrison and Catherall
McMurdo Instrument Co.
Measuring Instruments (Pullin)
Mica and Micanite Supplies
Micanite and Insulators Co.
Minnesota Mining and Mfg. Co.
Morganite Resistors
Mullard
Mullard Overseas
Multicore Solders
Murex
Mycalex and T.I.M.

N.S.F.
Neill, James, and Co.

Painton
Parmeko
Partridge Transformers
Permanoid
Plannair
Plessey Co.
Plessey International
Power Controls

Radio Instruments
Reliance Electrical Wire Co.
Reproducers and Amplifiers
Rola Celestion

Salford Electrical Instruments
Salter, Geo., and Co.
Scott, Geo. L., and Co.
Shell Chemical Co.
Simmonds Aerocessories
Simon Equipment
Sims, F. D.
Spear Engineering Co.
Stability Capacitors
Standard Insulator Co.
Standard Telephones and Cables
Static Condenser Co.
Steatite and Porcelain Products
Stocko (Metal Works)
Suflex
Supply, Ministry of
Swift Levick and Sons
Symons, H. D., and Co.

Taylor Electrical Instruments
Technical Ceramics
Telcon Magnetic Cores
Telegraph Condenser Co.
Telegraph Construction & Maintenance
Telephone Manufacturing Co.
Thermo-Plastics
Thorn Electrical Industries
Truvox
Tucker, Geo., Eyelet Co.
Tufnol

Vactite Wire Co.
Vitavox

Walter Instruments
Wandleside Cable Works
Waveforms
Wego Condenser Co.
Welwyn Electrical Laboratories
Westinghouse
Weymouth Radio Manufacturing Co.
Whiteley Electrical
Wiggin, Henry, and Co.
Wimbledon Engineering Co.
Wingrove and Rogers
Wireless Telephone Co.
Wireless World and *Electronic & Radio Engineer*
Woden Transformer Co.
Wolsey Television
Wright and Weaire

Zenith Electric Co.

APRIL MEETINGS

LONDON

1st. I.E.E.—"Colour television" talks by L. C. Jesty and Dr. E. L. C. White at 5.30 at Savoy Place, W.C.2.

4th. I.E.E.—The forty-eighth Kelvin Lecture on "Infra-red radiation" by Dr. G.B.B.M. Sutherland at 5.30 at Savoy Place, W.C.2.

4th. London U.H.F. Group.—"Crystal control circuits" by a representative of Cathodeon, Ltd., at 7.30 at the Bedford Corner Hotel, Bayley Street, W.C.1.

5th. Royal Institution.—"The first transatlantic telephone cable" by Sir Gordon Radley at 9.0 at 21 Albemarle Street, W.1.

10th. I.E.E.—"The remote and automatic control of semi-attended broadcasting transmitters" by R. T. B. Wynn and F. A. Peachey at 5.30 at Savoy Place, W.C.2.

10th. Radar Association.—"Radar techniques and research on wave propagation" by Dr. R. L. Smith-Rose at 7.30 at the Anatomy Theatre, University College, Gower Street, W.C.1.

12th. B.S.R.A.—"Properties and performance of magnetic tape" by Dr. G. F. Dutton at 7.15 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

17th. British Kinematograph Society.—"A new approach to telerecording" by A. E. Sarson and P. B. Stock, with an introductory survey by L. C. Jesty at 7.15 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

24th. Brit.I.R.E.—"The properties of semi-conductor devices" by Dr. A. A. Shepherd at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

26th. Institute of Navigation.—"Methods of obtaining a ship's aspect and speed by radar" by Captain R. G. Swallow and A. L. P. Milwright at 5.15 at the Royal Geographical Society, 1 Kensington Gore, S.W.7.

29th. I.E.E.—"Radio in air-sea rescue" talks by G. W. Hosie, D. Kerr and W. Kiryluk at 5.30 at Savoy Place, W.C.2.

30th. Plastics Institute.—"Thermoplastics in the submarine-cable industry" by Sir John Dean at 6.30 at the I.E.E., Savoy Place, W.C.2.

CHELTENHAM

5th. Brit.I.R.E.—"Colour television" by Dr. G. N. Patchett at 7.0 at the North Gloucestershire Technical College.

EDINBURGH

16th. I.E.E.—"An introduction to some technical factors affecting point-to-point communication systems" by F. J. M. Laver at 7.0 at the Carlton Hotel, North Bridge.

26th. Brit.I.R.E.—Special process instrumentation in atomic energy projects" by H. Bisby at 7.0 at the Department of Natural Philosophy, University of Edinburgh.

GLASGOW

4th. Brit.I.R.E.—"Telemetry" by A. Cowie at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

LIVERPOOL

11th. Brit.I.R.E.—"Electronics in aircraft installations" by F. Ellson-Jones and "A negative feedback circuit for magnetic c.r.t. deflection" by S. L. Fife at 6.45 at the Chamber of Commerce, 1 Old Hall Street.

MALVERN

8th. I.E.E.—"Stereosonic sound" by H. A. M. Clarke at 6.0 at the Winter Gardens.

MANCHESTER

4th. Brit.I.R.E.—"Electronic control of machine tools" by H. Ogden at 6.30 at the Reynolds Hall, College of Technology, Sackville Street.

NEWCASTLE-ON-TYNE

1st. I.E.E.—"The B.B.C. sound broadcasting service on very-high frequencies" by E. W. Hayes and H. Page at 6.0 at King's College.

SHEFFIELD

17th. I.E.E.—"The B.B.C. sound broadcasting service on very-high frequencies" by E. W. Hayes and H. Page at 6.30 at the Grand Hotel.

STONE

15th. I.E.E.—"Electronics and automation: some industrial applications" by Dr. H. A. Thomas at 7.0 at the Duncan Hall.

TORQUAY

4th. I.E.E.—"Television interference" by P. W. Crouch at 3.0 at the Electric Hall.

LATE MARCH MEETING

London

29th. R.S.G.B.—"Mobile operation." Discussion opened by F. W. Crabtree (G3BK) and R. G. Shears (G8KW) at 6.30 at the I.E.E., Savoy Place, W.C.2.

CLUB NEWS

Bradford.—A. R. Bailey, B.Sc. (G3IBN) will deal with d.f. equipment when speaking at the meeting of the Bradford Amateur Radio Society on April 9th. The meeting will be held at 7.30 at Cambridge House, 66, Little Horton Lane. On the 30th the club is visiting Yeadon Airport. Sec.: F. J. Davies, 39, Pullan Avenue, Eccleshill, Bradford, 2.

Derby.—The Derby and District Amateur Radio Society, which has a membership of 100, continues to meet each Wednesday at 7.30 at 119, Green Lane. On April 24th N. Birkett (G3EKX) will speak about radar equipments. Sec.: F. C. Ward (G2CVV), 5, Uplands Avenue, Littleover, Derby.

Warrington.—The programme of the bi-monthly meetings of the Warrington and District Amateur Radio Society includes a course on radio fundamentals. The club meets at 7.30 on the first and third Thursdays of each month at the Royal Oak Hotel, Bridge Street. Sec.: J. Mather, 28, Chapel Road, Penketh, Nr. Warrington, Lancs.

Wellingborough.—"Transistor receivers" is the subject to be dealt with at the meeting of the Wellingborough and District Radio and Television Society on April 11th. The club meets every Thursday at 7.30 at Silver Street Club Room. Sec.: P. E. B. Butler, 84, Wellingborough Road, Rushden.

RANDOM RADIATIONS

By "DIALLIST"

Guarantees

REFERRING to my recent protest against the mingy guarantees of valves and c.r. tubes in sound and television receivers, the editor pointed out in the February issue that Ambassador and Baird are now throwing in an extra year's guarantee on the tubes in their sets. This is indeed a step in the right direction and one which will greatly increase goodwill by setting the television receiver owner's mind at rest. And, I imagine, the extra cost to set manufacturers who offer these extended guarantees will be almost negligible. J. W. Ridgeway, chairman of the B.V.A., speaking on the findings of the Monopolies Commission, reminded us that a tube which survives the first few months of its life is likely to go on giving satisfactory service for at least three or four years. Incidentally the report certainly shows who takes the biggest slice of the profit on c.r. tubes—the Government! A break-down of the prices prevailing in 1954 (they have since been reduced) shows that of the £20 10s 1d charged for a 14-inch tube, £5 15s 1d went to the Chancellor of the Exchequer in purchase tax. Of the present-day price of £25 18s for a 21-in tube, the manufacturer gets £11 4s, distribution costs account for £6 16s and P.T. for £7 18s.

Two-year Comprehensive

I am much obliged to a Radio Rentals branch manager, who writes "with practically every sale we make there is a two-year guarantee. The only exceptions are the very occasional customers who wish to purchase at a slightly lower cost price and forgo this guarantee." The guarantee (of which he sends me a copy) is simple, comprehensive and unambiguous. Besides the valves, c.r. tube and components it covers all service and maintenance charges. The customer doesn't obtain a free replacement of some small part and have to pay, maybe, five or six times its value for having the "dud" taken out and the new one put in. The difference between the "with" and "without" such guarantee prices are surprisingly low. They work out at £7 17s 6d for each of the two years for a 17-inch table model television receiver and 31s a year for an a.m./f.m. receiver. It seems obvious that a full year's guarantee for valves and tubes, without service and maintenance, could be given by set manufacturers without any substantial increase in prices. Something of the sort will certainly have to come and the sooner it comes, the better for all concerned.

We Like F.M.!

AS I'VE mentioned before, reception in many parts of East Anglia was pretty hopeless when we were served by a.m. transmitters and nothing else. Now that the Norwich f.m. transmitter is radiating on full power people who have gone in for v.h.f. receivers are lost in admiration of the clarity and high quality of their reception, and of the complete freedom from interference they enjoy. Being unable to make the medium-wave and long-wage ranges serve any useful purpose, most of the folk I know have bought or intend to buy f.m.-only sets. There are comparatively few such models on the market, and I'm sure it would pay more manufacturers to offer them. And may I ask any maker who is contemplating the marketing of such a set to consider what a strong selling point press-button tuning for three pre-set frequencies would be?

Geophysical Year

THE coming International Geophysical Year—or rather, year-and-a-half, for it starts on the coming first of July and lasts till the end of next year—should bring results of the greatest value for broadcasting and for telecommunications. The previous concerted researches of this kind, held in 1882-83 and 1932-33, were called international polar years, for they were concerned mainly with the polar aspects of the earth's magnetism. In the coming Geophysical Year observations will not be restricted to the polar regions but will be made and records kept at stations all over the world. From these and from the instruments sent up in artificial satellites and in giant rockets we should come to know a great deal more than we do now, not only about such things as the aurora borealis and magnetic storms, but also about the upper troposphere, the ionosphere and other reflecting layers. I shouldn't be a bit surprised if some of our present accepted ideas about the long-distance propagation of electromagnetic waves in some parts of the radio spectrum have to be consider-

ably revised as the result of discoveries based on observations and on the records made by the instruments we send aloft.

Printed Circuits

THE increasing use of printed circuitry in both sound and television sets is undoubtedly a good thing. You can, of course, make good, sound joints of low resistance by soldering; but the trouble is that it's so easy for the careless (or perhaps tired) factory hand to make bad ones, and the dry joint is one of the biggest of dealers' and servicemen's headaches. Every set is supposed to be most carefully inspected during the various stages of its progress along the assembly line, and I've no doubt that it is. But it's extraordinary that so many dry joints should escape notice. Dealers have shown me several in new sets straight out of their cartons. A wartime experience I shan't forget is receiving a GL2 radar receiver, which had come about 50 miles over good roads. It wouldn't work and the reason, we found, was that there were over a score of dry joints in its superhet.

Radio Exports

OUR exports of capital equipment, domestic receivers and recording gear and of valves, c.r. tubes and components are rapidly becoming a very important item in the country's overseas trade. Their sales in markets abroad have grown amazingly fast. In 1947 we thought we weren't doing too badly by exporting £10.2M worth of such goods. At the end of 1955 the total for the year had reached the then all-time record of £33M. But last year was a long way beyond this with £40.3M. Thus in the 10 years 1947-1956 inclusive the industry's exports of radio and electronic equipment have increased fourfold—a really wonderful achievement.

Built-in Aerials

THE little town in which I now live must be a good 150 miles from Wrotham; yet I've received the London programmes quite well at times with a set using a built-in aerial and working in a ground-floor room. Sometimes these aerials may be effective enough, but that may be their undoing, for they pick up every bit of interference that's going on Band II. One friend complained almost tearfully about the motor-car ignition interference he was getting. I told him I was pretty sure he'd get rid of it, if he had an outdoor aerial put up. He did and he has.

UNBIASED

By FREE GRID

Ateliphony

IN THE February issue I pointed out that, in readiness for the day when radio transmission of power bursts upon us, we ought to equip ourselves with a snappy, but correctly derived, word for it, lest some wretched hybrid like "dynamission" be foisted upon us. A correspondent points out that in Webster's dictionary (1910 edition) the word "telekino" is given as meaning "An apparatus for transmission of electrical energy without a conducting wire."

Such a revelation almost caused me to lose the respect I have always felt for Mr. Webster but, on reflection, I realized that it is the duty of a lexicographer to record "English as she is spoke." The word "telekino" can only mean something to do with "motion at a distance"; only by fantastic stretching could it mean "power transmission."

Another correspondent tells me that I am incorrect in thinking that the word "telephone" could, with equal accuracy, be applied to a speaking tube. He says that the coiner of this word originally intended it to be written teliphone and that it was altered by some ignorant scribe who thought a spelling error had been made. If this be true then it would certainly imply transmission of speech over a wire, for the word "teli" (τελι) is given as meaning "wire" in a modern Greek lexicon. There are certainly some grounds for belief in what my correspondent says as at the time the telephone came into existence the followers of Byron had definitely put modern Greece and its language on the map.

Surely the acceptance of the foregoing explanation should enable us to jettison the cumbrous expression radio-telephony for the simpler ateliphony, as "ateli" would literally mean "wireless."

We could even speak of ateligraphy, although there can be no doubt that the word telegraph was coined long years before the invention of wired telegraphy. It was first used in 1794 to describe the semaphore system, invented by the Frenchman Chappe, which was installed on the roof of the Admiralty to give hill-to-hill communication with Portsmouth and elsewhere.

Operation Phœnix

WE often hear speculation about the origin of cosmic radiation which reaches us from outer space. I believe these radiations to be man-made but I certainly don't think they are messages from the inhabitants of some other world.

I hold firmly to the theory that many times in the 4×10^9 years since this planet started on its travels, mankind has attained to a degree of scientific knowledge which it is now once more approaching. In previous eras of civilization man managed to split the atom and brought civilization to the brink of the abyss just as we have done now.

But before all hell was let loose it occurred to somebody like myself to record all scientific and other knowledge, literature and works of art both visual and aural so that a future civilization would know what manner of men they were. The problem was to know where to store these precious records so that they would be free from destruction by earthquakes, by moth and rust and by the depredations of a new race of primitive man which would arise phœnix-like from the ashes of the old world.

Clearly the only space to store them was in the indestructible ether. It was obvious, for instance, that if, say, a page of a scientific textbook was scanned and radiated by the usual television technique, using a wavelength sufficiently short to penetrate the various ionized layers, it would get out into outer space. If beamed at the moon it would return in two to three seconds, but by beaming it at one of the giant nebulæ it could be made to return in, say, 30 million years, or at any time desired, by choosing the right nebula.

It is my belief that these present cosmic radiations are the preliminary warning signals, the series of ···— which every wireless man knows. These signals are heralding the coming of amazing data concerning this former civilization.

Optical Turret TV

I WAS interested to read in the February issue that "Diallist," like myself, favours projection television receivers. I certainly didn't know that one of the snags was the difficulty in getting servicemen with the necessary skill to adjust the optical system but I do appreciate the skill needed in optical work.

I recollect once throwing my binoculars out of the bedroom window at a lovelorn tomcat sitting on the fence crooning to a fellow feline of the opposite sex. Apart from getting me a warning from one of the animal protection societies, my action put the prisms of the binoculars out of collimation. I tried re-collimating them myself but, I can assure you, never again.

I do not see, however, why the optical system in a TV receiver could not be made as robust as that of a first-rate home-ciné projector with the same sort of woman-proof focussing arrangement. In fact I would go further and suggest two lenses of different focal lengths mounted on a rotating turret such as is used nowadays in some amateur ciné cameras, and in all professional ones.

Decrooning and de-collimating

My idea is simply to make the picture fit the audience. I would have a large screen so that when several people were viewing the picture would fill the screen and they could all sit well back and view in comfort. For more intimate viewing, when there were only Mrs. Free Grid and myself, I would prefer to draw our chairs up a little closer to the screen. To avoid eyestrain of the hat-peg type I would swing the turret round to change the lens and so obtain a smaller picture on the same screen. I do know what I am talking about as I have done the same thing with a lens turret on a home-ciné projector: this optical turret TV receiver will, I feel sure, be the set of the future and the sooner manufacturers get down to it the better.

"Radio Cosmos"

SPEAKING as one who has been a reader of *W.W.*'s sister journal, *Electronic & Radio Engineer,* since the days when it was called *Experimental Wireless* and right through the years when it was *Wireless Engineer,* I don't altogether approve of the disappearance of the good old word "wireless" from the title.

I am not unmindful of the fact that "this 'ere progress; it goes on," as one of H. G. Wells' characters said, but all the same I hope the editor of *W.W.* doesn't contemplate making a similar change. There is no more solid and down to earth title than *Wireless World.* It smacks of solid and sober reliability.

May the day be long deferred when *Wireless World* becomes *Radio Spheroid* or even *Radio Cosmos.*

MODEL 7 50 RANGE

Universal AVOMETER

Fifty ranges...

in one instrument

THE wide scope of this multi-range AC/DC measuring instrument, coupled with its unfailing reliability, simplicity of use and high degree of accuracy, renders it invaluable wherever electrical equipment has to be maintained in constant, trouble-free operation.

CURRENT	VOLTAGE
1mA D.C. only	50mV D.C. only
2 ,, ,, ,,	100 ,, ,, ,,
5 ,, A.C. & D.C.	500 ,, ,, ,,
10 ,, ,, ,,	1V ,, ,,
50 ,, ,, ,,	5 ,, A.C. & D.C.
100 ,, ,, ,,	10 ,, ,, ,,
500 ,, ,, ,,	50 ,, ,, ,,
1 A ,, ,,	100 ,, ,, ,,
5 ,, ,, ,,	200 ,, ,, ,,
10 ,, ,, ,,	400 ,, ,, ,,
	500 ,, ,, ,,
	1,000 ,, ,, ,,

RESISTANCE

10,000 ohms, 100,000 ,, } using internal 1½ volt cell

1 Megohm using internal 9 volt battery

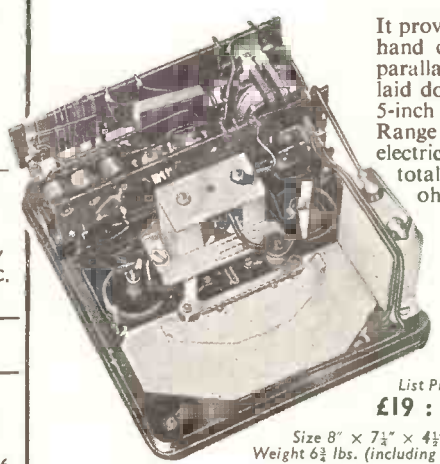
10 Megohms, 40 ,, } using external source of A.C. or D.C. voltage

CAPACITY 0·01—20 mFds.

POWER AND DECIBELS

Impedance	Power	Decibels 0 dB = 50W
500 ohms	200 mW	—25 to + 6
5,000 ohms	2W	—15 to + 16
50,000 ohms	200 mW	—25 to + 6

Various accessories are available for extending the wide range of measurements.



It provides 50 ranges of readings on a 5-inch hand calibrated scale fitted with an anti-parallax mirror. Accuracy is within the limits laid down in Section 6 of B.S.S. 89/1954 for 5-inch scale industrial portable instruments. Range selection is effected by means of two electrically interlocked rotary switches. The total resistance of the meter is 500,000 ohms.

The instrument is self-contained, compact and portable, simple to operate, and is protected by an automatic cut-out against damage through inadvertent overload.

Power and Power Factor can be measured in A.C. circuits by means of an external accessory, the Universal AvoMeter Power Factor & Wattage Unit.

List Price

£19 : 10s.

Size 8" × 7¼" × 4½"
Weight 6¾ lbs. (including leads)

...you can depend on

Illustrated Brochure available on request.

Sole Proprietors and Manufacturers:—

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.

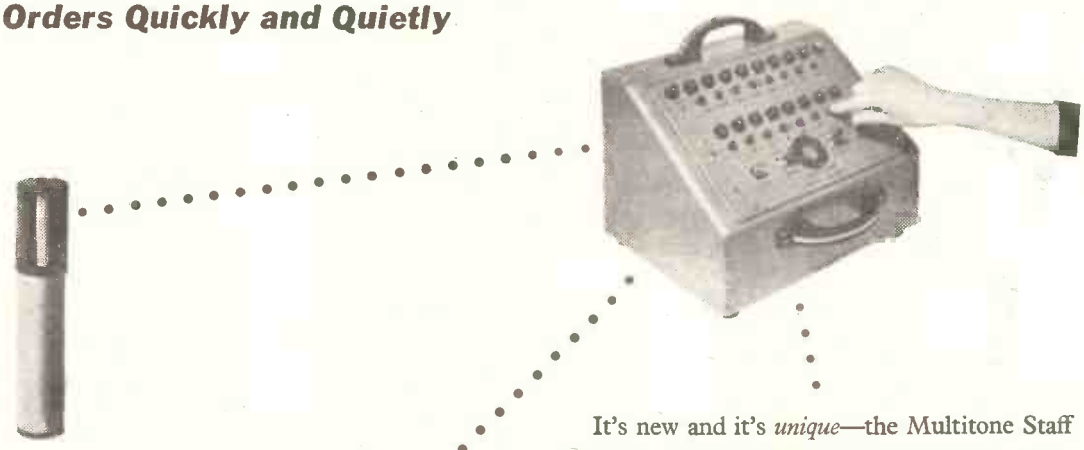
AVOCET HOUSE • 92-96 VAUXHALL BRIDGE ROAD • LONDON • S.W.1. *Telephone: VICtoria 3404 (9 lines)*

A7/9

NOW

A CONFIDENTIAL STAFF LOCATION SYSTEM!

Verbal Orders Quickly and Quietly



It's new and it's *unique*—the Multitone Staff Location System. There've been loudspeakers, bells, lights and even buzzers, but not a system in which confidential messages can be delivered to individual members of a staff—whether numbered in tens or hundreds. However compact or scattered an organisation may be, this is going to be the biggest business time-saver yet. Originally developed in conjunction with St. Thomas' Hospital, this system is now far in advance of anything yet made and is sold at a highly competitive price!

HOW IT WORKS. A magnetic induction loop is laid round the building from the Coder/Oscillator unit. Anyone needed to be on call carries a receiver (only 5″ long, 1″ diameter and it only weighs 5 oz. with battery!). On being alerted by his call signal, which is received by him alone, he can hear a direct speech message without anyone else being disturbed.

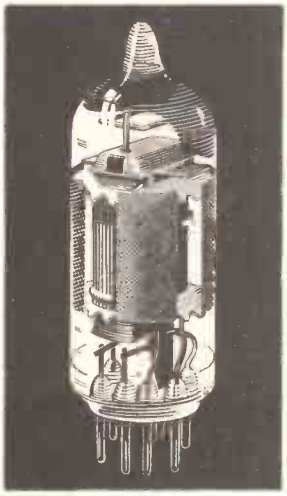
WHAT IT COSTS. The average cost of an installation with 50 receivers would be under £1,500 including the cost of the loop. The receiver incorporates four transistors and is powered by a single cell. Since the quiescent current is less than 0.5 m.a. it will only cost a few shillings a year to run each receiver—considerably less than any other electronic system.

multitone

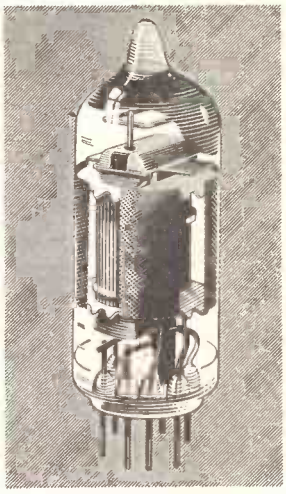
STAFF LOCATION SYSTEM

Multitone Electric Co. Limited, 12-20 Underwood Street, London, N.1. Clerkenwell 8022

CRC 2M



SPECIAL QUALITY VALVES



and special quality valves ... there is a difference

Mullard Special Quality valves can be supplied in accordance with various standards of reliability including, for instance, the full British Government CV4000 specification and the American MIL specifications. An economical choice of types is therefore available for equipment designers to satisfy particular standards of reliability which would include future NATO requirements.

Mullard achievement in the production of Special Quality valves to defined standards is indicated by the fact that Government establishments have already been supplied with many hundreds of thousands of Mullard valves to the rigorous and complicated full CV4000 specification.

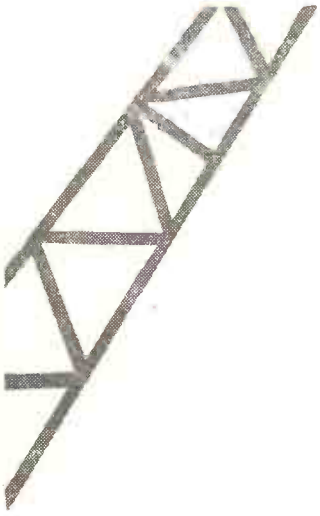
Details of the range of Mullard Special Quality valves for military and industrial applications are available from the address below. Assistance in selecting the most suitable types for particular applications may also be obtained from the Technical Advisory Service at the same address.

Mullard

Mullard
COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

MULLARD LIMITED · MULLARD HOUSE · TORRINGTON PLACE · LONDON · W.C.I

MVT313b



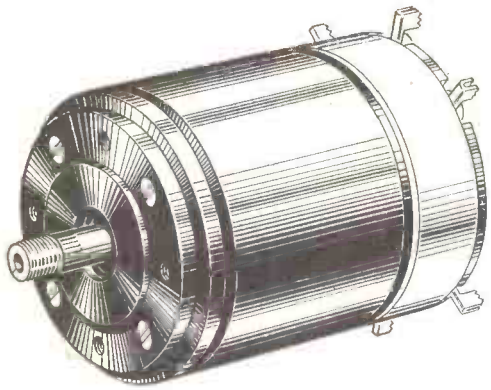
It is gratifying to know that in a world of rising prices our policy of maintaining and, in many instances, reducing prices has resulted over the years, and especially at this period, in ever increasing sales.

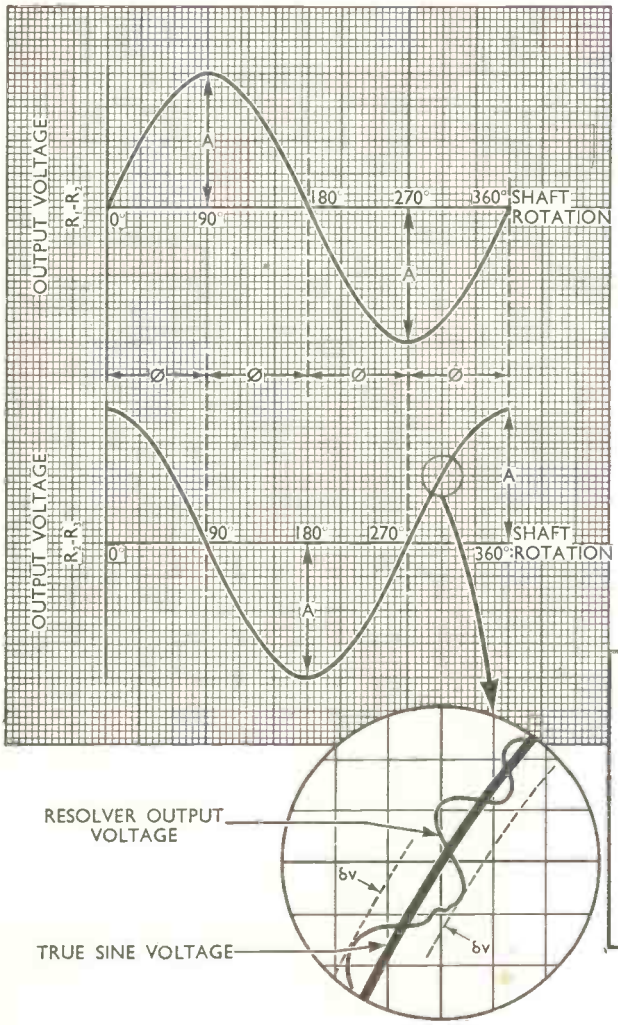
We carry a stock of 2,000 types of receiving, transmitting and special purpose tubes, and invite your enquiries not only for commercial grade tubes but also for those tested to C.V., JAN and MIL specifications.

Our Organisation is A.R.B. Approved.

If you are not already on our Mailing List, please send for latest Price and Stock Lists.

Consider the accuracy of the SPERRY size 15 Synchro Resolver





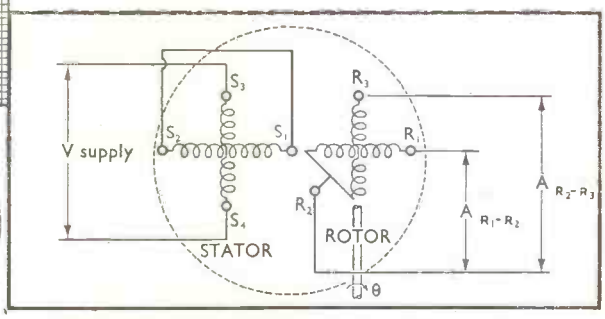
A Synchro Resolver consists of a rotor carrying two windings at right angles which rotates in a stator also having two mutually perpendicular windings. If the synchro is connected as shown below, the voltages A_{R1}–A_{R2} vary sinusoidally as shown in the accompanying graphs. How closely the voltages of a Sperry size 15 Resolver follow this sine relationship can be judged from these performance figures :

(a) Angular separation of Nulls = Ø = 90° ± 4′

(b) Transformation Ratio A = KV
where $K = 1 \pm \begin{matrix}1\% \\ 0\%\end{matrix}$ from model to model
Variations in K = ± 0.2% in any one model

(c) Voltage departure from true sine
= δV = ± 0.2% A

Precision resolvers offer the solution to a wide range of computing problems, and may also be used for position control.



Sperry size 15 Resolvers having the performance described are **AVAILABLE EX STOCK.**

Advice on their application to your problem is available

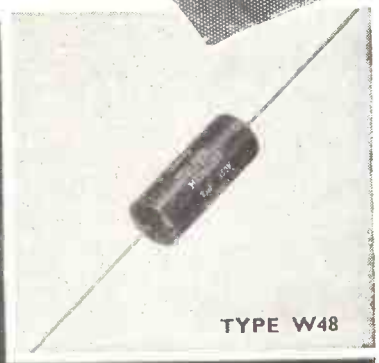
SPERRY SYNCHROS

SPERRY GYROSCOPE COMPANY LIMITED, GREAT WEST ROAD, BRENTFORD, MIDDLESEX Telephone : EALing 6771

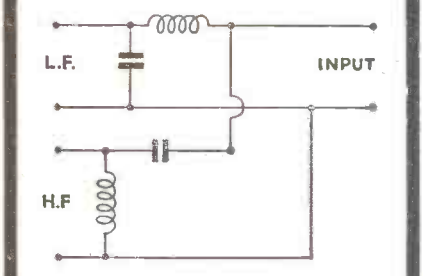
Hunts Hi-Fi CAPACITORS

FOR CROSS-OVER NETWORKS

Hunts patented Metallised Paper Capacitors are particularly suitable for loudspeaker crossover networks and are used extensively for this application. They have negligible self inductance with consequent lack of self resonance within the audio frequency range, and with the special method of end connections used on the capacitor unit, the equivalent series resistance down to zero applied volts is extremely low.
The capacitors listed below are considerably smaller in dimensions than conventional types, occupying only 25-30% of the space required for their lowest voltage counterparts in foil and paper construction.



TYPE W48



A basic circuit for a twin speaker combination is shown on the left. The number of circuit elements and their capacitance and inductance values depends on the number of loudspeakers, their individual characteristics, and the required crossover frequencies.

TYPE W54/1

STANDARD CAPACITANCE RANGE

LIST NO.	CAP μF	VOLTS D.C. Wkg.	TYPE REF.	DIMENSIONS L D	LIST PRICE
A 316	1.5	150	W48	1⅞″ × 11/16″	4/9
A 304	2	150	W48	1⅞″ × 11/16″	5/-
B 557	3	150	W49/1	1¾″ × ¾″	7/6
B 550	4	150	W49/1	2½″ × 1″	10/-
B 551	6	150	W49/1	2½″ × 1″	12/6
B 552	8	150	W49/1	2½″ × 1⅜″	17/6
WP 45	10	150	W54/1	2½″ × 1⅜″	20/-
WP 38	12	150	W54/1	2½″ × 1⅜″	22/-
WP 247	16	150	W54/1	3¼″ × 1⅜″	26/6

TYPE W49/1

REGISTERED TRADE HUNTS MARK CAPACITORS

A. H. HUNT (Capacitors) LTD.
WANDSWORTH, LONDON, S.W.18. Tel: BATtersea 1083

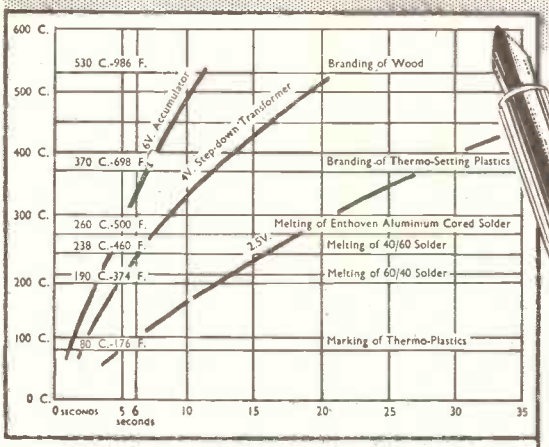
And in Canada: HUNT CAPACITORS (Canada) LTD. AJAX, ONTARIO
Factories also in Surrey and North Wales.

The Superspeed SOLDERING IRON

heats up from cold in 6 seconds!

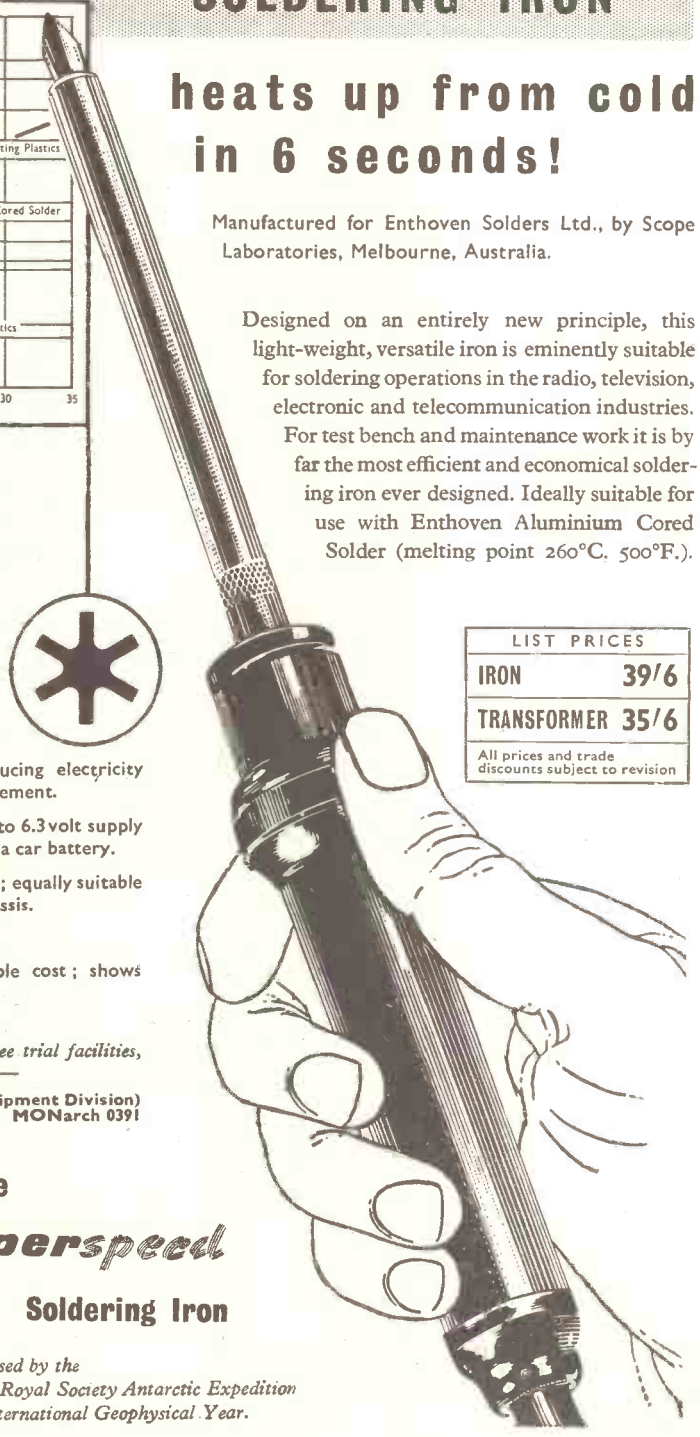
Manufactured for Enthoven Solders Ltd., by Scope Laboratories, Melbourne, Australia.

Designed on an entirely new principle, this light-weight, versatile iron is eminently suitable for soldering operations in the radio, television, electronic and telecommunication industries. For test bench and maintenance work it is by far the most efficient and economical soldering iron ever designed. Ideally suitable for use with Enthoven Aluminium Cored Solder (melting point 260°C. 500°F.).



TIME/TEMPERATURE CURVE CHART from the SUPERSPEED SOLDERING IRON TIP/TEMPERATURE TIME CHECK

The effect of different voltages on initial heating-up time is shown. Whilst 4V is the standard voltage normally employed, 6V will cause no harm, and accumulators are a useful source of current supply.



LIST PRICES	
IRON	39/6
TRANSFORMER	35/6

All prices and trade discounts subject to revision

* Activated by light thumb pressure on the switch ring. When pressure is released, current is automatically switched off — thus greatly reducing electricity consumption, wear on copper bit and carbon element.
* Length, 10"; weight, 3½ ozs.; can be used on 2.5 to 6.3 volt supply (4 volt transformer normally supplied) or from a car battery.
* More powerful than conventional 150-watt irons; equally suitable for light wiring work or heavy soldering on chassis.
* Simple to operate; ideal for precision work.
* Requires minimum maintenance — at negligible cost; shows lowest operating costs over a period.

For full particulars, including guarantee terms and free trial facilities, please write to the sole concessionaires in this country :—

ENTHOVEN SOLDERS LTD. (Industrial Equipment Division)
Dominion Buildings, South Place, London, E.C.2. MONarch 0391

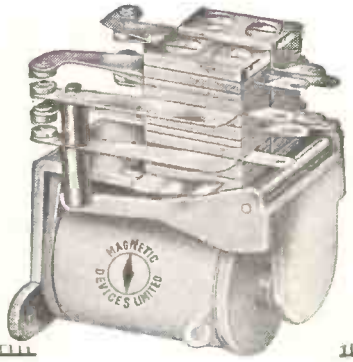
Switch to the

Superspeed

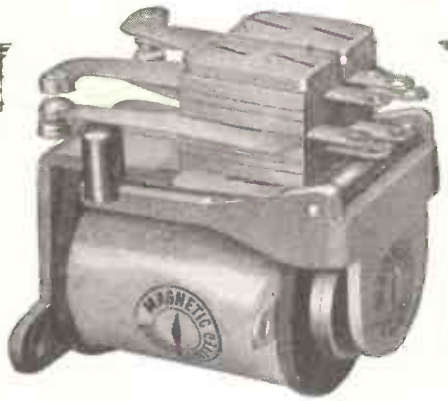
Soldering Iron

as being used by the Royal Society Antarctic Expedition for the International Geophysical Year.

When it's **RELAYS** contact



Magnetic Devices LTD.



R. E. C. M. F. Exhibition
Park Lane House
VISIT US ON STAND V
April 9—11

Upper Illustration; Series 596. D.C. operated, Max. V. 140. Contact rating up to 5A. continuous. Switching: One to six poles in various combinations. Overall size: 1 7/16″ long by 1 3/32″ wide by 1 25/32″ deep. Coil consumption 0.5 to 3 watts.

Lower Illustration; Series 590. A.C. operated, Max. V. 250. Contact rating up to 5A. continuous. Switching: One to four poles in various combinations. Overall size: 1 7/16″ long by 1 3/32″ wide by 1 25/32″ deep. Coil consumption 2 or 4VA.

Coils are wound for standard voltages up to 250V.A.C. and 140V.D.C. Coils can be supplied vacuum impregnated if required.
Please write for illustrated leaflet.

A.I.D. & A.R.B. approved.

MAGNETIC DEVICES LIMITED

Magnetic Devices LTD.

EXNING ROAD NEWMARKET

Telephone: Newmarket 3181/2/3

Telegrams: Magnetic Newmarket.

-15° Centigrade 67° 30 North

Operating well within the Arctic Circle is the most Northerly taxi service in Europe. Situated in Sodankylā, the group have their main station in the house of the eldest taxi driver in the village—Mr. A. Marttiini, who started his career herding reindeer.

The group find that radio-telephone equipment is invaluable in saving time and avoiding wasted mileage, in this wide area of lonely forests, frozen lakes and wandering herds of reindeer.

For working under these strenuous and exacting conditions they have selected equipment manufactured by British Communications Corporation. A wise choice where fine performance and utmost reliability are vital factors.

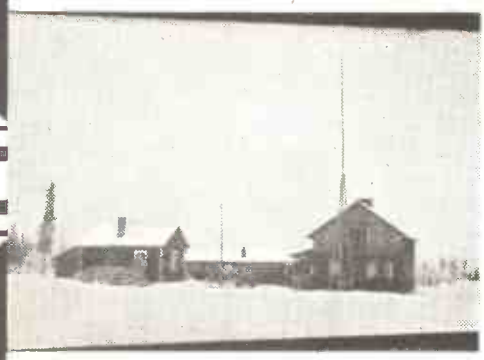
BCC

British Communications Corporation Limited

Second Way · Exhibition Grounds
Wembley · England

Telephone: Wembley 1212 *Cables: BeeCeeCee*

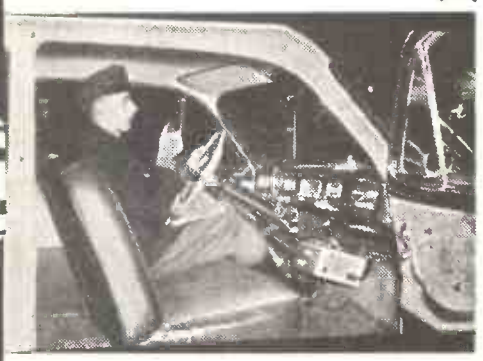
BCC



The 70ft. wooden aerial mast at the main station, a typical Lapland log cabin.

Reindeer rooting for lichen outside the main station fence.

Reindeer herdsmen visiting Mrs. Marttiini who operates the control station.



One of the Sodankylā installations, carried out by the taximen and supervised by Nores & Co., representing B.C.C. in Finland.

LOUD SILENCE

Connoisseur equipment will reproduce silence —as well as music.

The ability of hi-fi equipment to reproduce silence is perhaps a keener test of its quality, than is its ability to reproduce a full orchestra in spate.

When you are listening to Connoisseur equipment a pause is a pause—an interval of silence. It is silence you can hear.

This is why. Connoisseur equipment is designed by a perfectionist. It is built under his close supervision.

The Connoisseur transcription motor is a fine job, possessing outstanding qualities and unique features. On all three speeds there is a 4% variation which is obtained without braking action. The motor is synchronous and will maintain its synchronisation with up to 25% variation in line voltage. Price £20 plus £8/11/- tax.

The Connoisseur Pick-up is made like a watch—a precision instrument with a downward pressure of only 4 grams. It has a frequency range from 20 to 20,000 cycles at 33⅓ r.p.m. The armature retracts into the head if accidentally dropped and the coil is perfectly screened by a magnet to minimise hum.

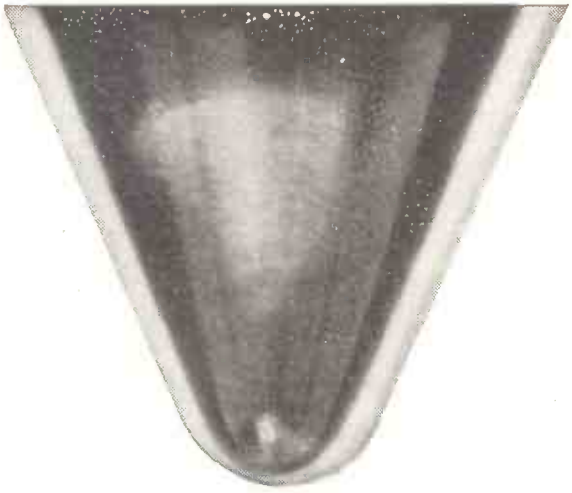
Prices: Pick-up complete with 1 head fitted with Diamond Armature £8/19/- plus Purchase Tax £3/16/6. Head only £6/12/- plus Purchase Tax £2/16/5. Replaceable Armature System £4/10/- plus Purchase Tax £1/18/6.

Pick-up complete with 1 head fitted with Sapphire Armature £5/17/- plus Purchase Tax £2/10/-. Head only £3/10/- plus Purchase Tax £1/19/11. Replaceable Armature System £1/4/- plus Purchase Tax 10/4.

A. R. SUGDEN & CO. (Engineers) LTD.

WELL GREEN LANE · BRIGHOUSE · YORKSHIRE

Telephone: Brighouse 2397 Telegrams: Connoiseur, Brighouse



Acos diamond ∫ × 500 too

With diamond styli, everything is in the superlative:

longest life (twenty times that of sapphire),

kindest to the record, most economical in the long run.

The hardest of all. But therefore also the most difficult to shape accurately.

The Acos diamond is shaped and polished with utmost precision.

What is more, like all other Acos styli,

the diamond stylus, too,

is tested at 500 times magnification,

making most sure that it is the very best.

There is now an Acos diamond for every current Acos pick-up.

acos ARE DOING THINGS IN STYLI

COSMOCORD LTD. WALTHAM CROSS HERTS. TEL: WALTHAM CROSS 5206 (London telephone subscribers please dial WA4 5206)

Single pillar lampholder supplied completely prewired with 3 ft. leads ready for immediate installation. Reference No. 80/10/0155

Thorn pillar lampholders for the illumination of instrument panels . . .

Originally designed for aircraft control panels (and widely used throughout the British aircraft industry) these Thorn pillar and bridge piece lampholders are of universal application for industrial use wherever instrument panels require illumination. A full range of these components is available.

. . . and bridge pieces

The special advantage of Thorn pillar and bridge pieces is their notable economy of panel space and the clear illumination they provide. Wiring arrangements are extremely simple and bridge pieces can be quickly added to existing control panels without any difficulty.

Bridge pieces are supplied with double entry leads for emergency stand-by lighting if required.

The present range of bridge lighting units is as follows:—

TYPE A	Mk. G4B Gyro Compass	4 lamps
TYPE B	Artificial Horizon	2 lamps
TYPE C	Large S.A.E. Case (4BA screws)	2 lamps
TYPE D	Small S.A.E. Case (4BA screws)	2 lamps
TYPE E	Horizontally mounted Double Desynn	2 lamps
TYPE F	Large S.A.E. Case (2BA screws)	2 lamps
TYPE G	Small S.A.E. Case (2 BA screws)	2 lamps
TYPE H	Large Air Ministry Case	2 lamps
TYPE J	Instruments with 3" P.C.D. fixing	2 lamps
TYPE K	Double Desynn mounted vertically	2 lamps

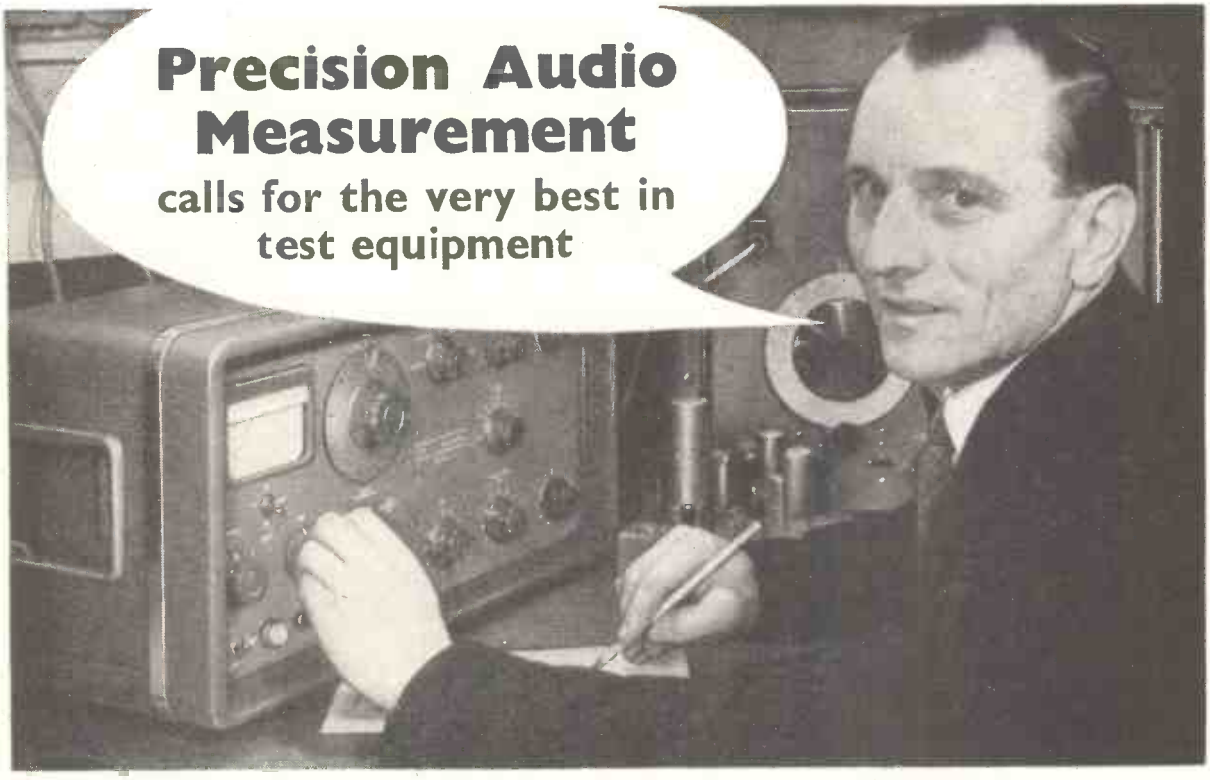
SPACE SAVING: All these components are of minimum size because they are designed round the unique Atlas Midget lamp only 0.575" long and 0.249" in diameter.

Three types of Thorn midget panel bulbs are available.

28 volts	0.04 amps
12 volts	0.1 amps
6 volts	0.1 amps

Write for illustrated brochure giving full details

Thorn Electrical Industries, Aircraft Components Division, Great Cambridge Road, Enfield, Middlesex. Tel.: Enfield 5340



An unrivalled Range of Marconi Instruments

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

MARCONI INSTRUMENTS

BEAT FREQUENCY OSCILLATOR TYPE TF 195M

A reliable, low-distortion signal source for all audio measurements. Frequency range: 10 c/s to 40 kc/s. Up to 2 watts can be delivered into loads of either 600 or 2,500 ohms. At 0.5 watt output, individual harmonics are less than 0.2%.

BEAT FREQUENCY OSCILLATOR TYPE TF 195M/5

A wide-range instrument, the TF 195M/5 covers from 50 c/s to 200 kc/s in one band. Its output circuit includes a resistive step attenuator and a continuously-variable slide wire.

DISTORTION FACTOR METER TYPE TF 142F

Measures total spurious content, up to 30 kc/s, of inputs within the fundamental frequency range 100 c/s to 8 kc/s. Distortion measurement range: 0.05 to 50%. The input can be at any level between 500 mV and 500 volts.

WAVE ANALYSER TYPE TF 455E

Gives amplitude and frequency of individual components of either audio signals or the modulation envelopes of r.f. signals. Its a.f. range is 20 c/s to 16 kc/s and its amplitude measurement range is 30 μV to 300 volts.

OUTPUT POWER METER TYPE TF 893

A wide-range absorption-type power meter for use in the frequency range 20 c/s to 35 kc/s. The power measurement range is 20 μW to 10 watts and the input impedance can be set to any of 48 different values between 2.5 ohms and 20 kΩ.

AM & FM SIGNAL GENERATORS · AUDIO & VIDEO OSCILLATORS
FREQUENCY METERS · VOLTMETERS · POWER METERS
DISTORTION METERS · FIELD STRENGTH METERS
TRANSMISSION MONITORS · DEVIATION METERS
OSCILLOSCOPES, SPECTRUM & RESPONSE ANALYSERS
Q METERS & BRIDGES

MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTFORDSHIRE · TELEPHONE: ST. ALBANS 56161

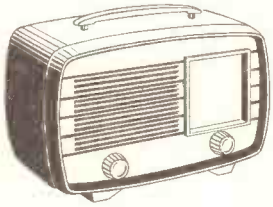
London and the South: Marconi House, Strand, London, W.C.2. Tel: COVent Garden 1234

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

WORLD-WIDE REPRESENTATION

TC 98

BAKELITE CABINET



PRICE **15/6** Plus 3/- p.p.

Ideal for midget construction. Available in Walnut or Green. Size 12in. long, 7in. high, 5½in. deep. Complete with handle, back, dial and two knobs.

RADIO/GRAM CHASSIS

TYPE AM5: 5 valve Superhet 3 waveband ..... **12 Gns.**

TYPE AM7: 7 valve Superhet with push-pull output 3 waveband ..... **16 Gns.**

TYPE AM/FM47: 7 valve Superhet with FM/VHF Band (4 waveband)..... **23½ Gns.**

TYPE AFM49: 9 valve Superhet with FM/VHF Band (4 waveband). Push-pull output including one speaker ..... **26 Gns.**

Carriage and Packing 12/6 extra.

! BARGAIN ! CONDENSER OFFER

(new, unused and of current manufacture)

ELECTROLYTIC PARCEL containing

1—50 x 50 mfd x 350 volt B.E.C. Can.
1—40 x 40 mfd. x 450 volt B.E.C. Can.
1—32 x 32 mfd. x 450 volt B.E.C. Can.
2—32 x 32 mfd. x 350 volt B.E.C. Can.
2—32 x 32 mfd. x 275 volt Hunts Can.
6—25 mfd. x 25 volt B.E.C.

Price 32/6 plus 1/6 postage.

PAPER TUBULAR PARCEL containing

6—.005 mfd. x 1,000 volt Dubilier.
6—.01 mfd. x 1,000 volt Dub/Sprague.
6—.02 mfd. x 750 volt Sprague.
12—.05 mfd. x 350 volt Plessey.
12—.1 mfd. x 500 volt Plessey.

Price 15/- plus 1/6 postage.

SUPERIOR BUREAU

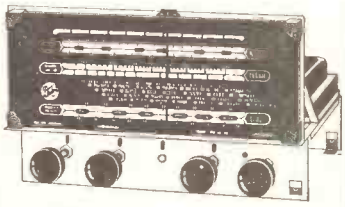
An elegant cabinet in richly figured walnut veneer, internal panels in polished sycamore. A drop front lid covers a sloping, uncut control panel (16in. long x 10¾in. high) alongside which is an uncut base-board (15¾in. long x 13½in. back to front). The inside of the drop front lid is panelled in beige leatherette. In the lower part of the cabinet are two large storage cupboards (13½in. high, 7½in. wide, 16½in. deep). The lid and cupboard handles are in chased Florentine bronze. Overall dimensions (33in. high, 34in. long, 16½in. deep).

PRICE **16½ GNS.** Plus 25/- carriage.

UNREPEATABLE CHASSIS OFFER!

THE DULCI F3

RADIO/GRAM CHASSIS ASSEMBLY



PRICE **£4 - 5 - 0**

CONTAINING:

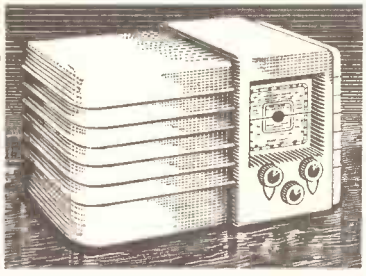
★ Punched chassis, Backplate, etc. Size : 12in. x 7in. x 8in.
★ Multi-colour Glass Dial L.M.S.G.
★ Drive Drum and Spindle.
★ Continental Control Knobs.
★ 1 pair Midget I.F.T.s.
★ Mains Transformer.
★ Output Transformer.
★ Twin Gang (500 pF) Condenser.
★ Wave Change Switch.
★ Two Controls Vol/Tone.
★ Smoothing Condenser.
★ Five Valve Holders.

Theoretical circuit and rough component layout free with each assembly.

!! CONSTRUCTORS WILL WELCOME !!

THE REGENT

CABINET ASSEMBLY



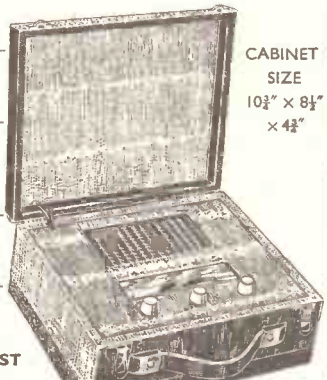
PRICE **30/-** Plus 3/6 p.p.

Comprising a cream bakelite cabinet and back, size 11in. x 6in. x 7in. Attractive three-colour dial and pointer. Metal chassis punched for 4 valve (B.9.A) superhet and fixing brackets. Drum, Drive-Spindle, Spring, Pointer and 3 knobs.

CONSTRUCTION BOOKLET on the REGENT 4-valve superhet available shortly. Watch for details.

THE SUPEREX "55" BATTERY PORTABLE

FOUR VALVE SUPERHET
LONG WAVE MEDIUM WAVE
LARGE ELLIPTICAL SPEAKER
MINIATURE B7G VALVES

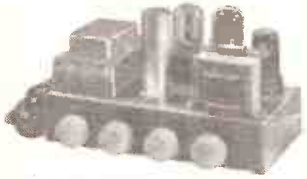


CABINET SIZE 10¾" x 8¼" x 4¼"

BUILDING COST £7.15.0 plus 4/- carriage

SEND 1/6 FOR CONSTRUCTION BOOK

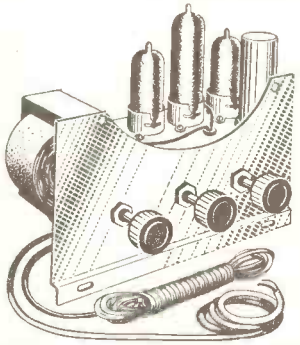
AMPLIFIERS



PRICE **£5.15.0** Plus 3/6 postage and packing.

High quality three valve three watt amplifier for A.C. Mains 200/250 volts. Four controls give a wide tone variation. 3 ohm speaker output. Chassis fully isolated. Valve line-up: 6SG7, 6V6, 6X5. Bronze finished chassis size 8in. x 4in. x 5in. high. Supplied built and tested and guaranteed for twelve months (90 days valves).

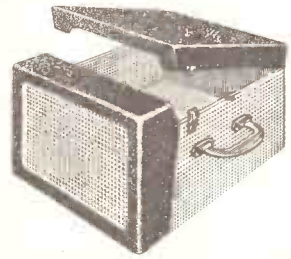
TWO COMPACT RECORD-PLAYER AMPLIFIERS



THREE VALVE TYPE (ECC83, EL84, EZ80). A high quality amplifier designed to satisfy the requirements of the more discriminating record enthusiast. Three controls give a very wide variation of tone. Output approx. 2 watts. Fully isolated chassis. Overall size approx. 6¾in. x 5in. x 2½in. Price £4/10/-. plus 2/6 postage and packing. 2-3 ohm O/P transformer 6/- extra.

THREE VALVE (EBC41, EL41, EZ41). Ideal for use in a low priced record player. Output approx. 2 watts. Two controls—volume and tone. Mains transformer and fully isolated chassis, less output transformer which is available separately. Overall size approx. 6¾in. x 5in. x 2½in. PRICE £3/19/6 plus 2/6 postage and packing. 2-3 ohm O/P Transformer 6/- extra.

!! SUPERB QUALITY !!



Rexine covered cabinet suitable for housing speaker and amplifier in end compartment. Adjustable uncut motor board 14¼in. x 12½in. Internal clearance from lid to base of cabinet 9in. Two colour covering in blue and grey or wine and grey rexine. Handle fittings, locks and hinges are in gilt with a solid white plastic handle. Overall size 18in. long, 9¼in. high, 13½in. back to front.

PRICE £4/5/-.
Plus 7/6 carriage and packing.

RECORD PLAYERS. Latest four speed auto-changers single play units by Collaro, BSR and Garrard.

HIGH FIDELITY AMPLIFIERS. We can supply any of the high-quality amplifiers and pre-amplifiers by LEAK, QUAD, ARMSTRONG, GRAMPIAN and WHITELEY; also home construction kits suitable for OSRAM 912 and MULLARD 510.

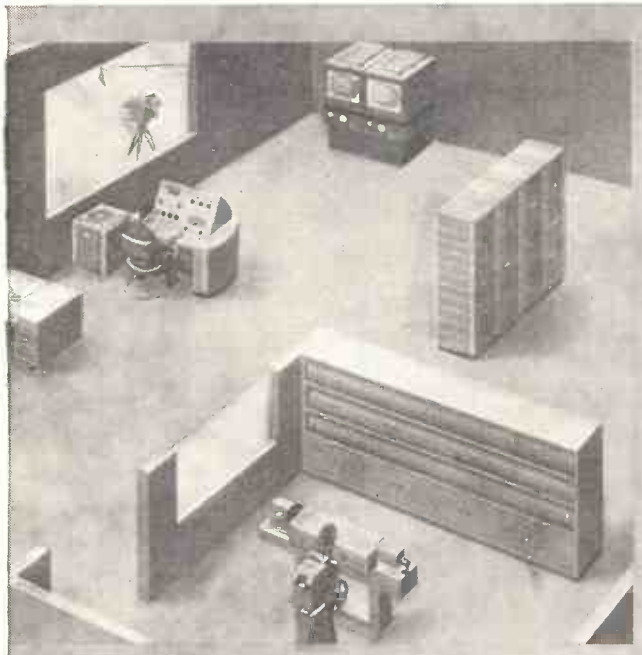
QUALITY SPEAKERS. A good quality speaker is an essential part of any radio or sound system. Always in stock, speakers from 3½in. to 12in. by GOODMANS, WHITELEY, WHARFEDALE, G.E.C. and ELAC.

TERMS C.W.O. OR C.O.D. U.K. ONLY

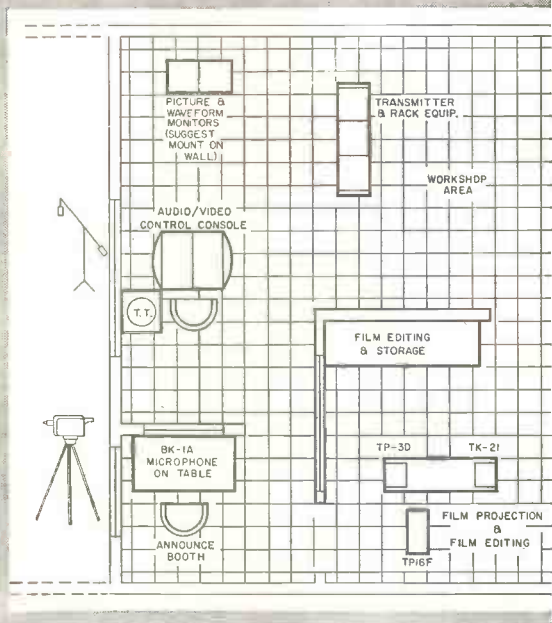
Superior Radio supplies
37 HILLSIDE, (HARROW ROAD)
STONEBRIDGE, N.W.10. *Elgar 3644*

RCA BASIC TELEVISION STATION

provides complete facilities for versatile programming with minimum investment



Centralized Control Room for Basic Station



Typical Floor Plan—scaled in one foot squares

EQUIPMENT "PACKAGE" for basic TV station consists of an RCA vidicon film camera chain, picture and waveform monitoring facilities, 16-mm film projector, slide projector, multiplexer, studio synchronizing generator, master audio-video switching console, stabilizing amplifier, turntable, microphone, transmitter, antenna, audio editing equipment, spare parts, installation tools and materials.

A complete television broadcasting "package", comprised of equipment basic to all television stations, is offered by RCA to those planning television broadcasting on a small but highly efficient scale. The Basic Television Station enables the broadcaster to start programming with a relatively small investment, and reduces operating costs to the minimum.

All units in the "package" meet RCA's world-famous standards of good engineering for high quality performance. Proved and tested in the field, this equipment assures continuous, dependable service with minimum operating and maintenance personnel. The Basic Television Station offers many important advantages:

ECONOMICAL ONE-MAN OPERATION . . . One man can easily operate all program controls which are located in the unique two-section Audio-Video control and switching console. The operator of this centralized control can also handle any additional live and film cameras that might be added later.

PROGRAMMING VERSATILITY . . . The RCA Basic TV Station provides facilities for: Network or incoming "off-air" satellite programs; local 16-mm programming; local film and slide programs; local live programming.

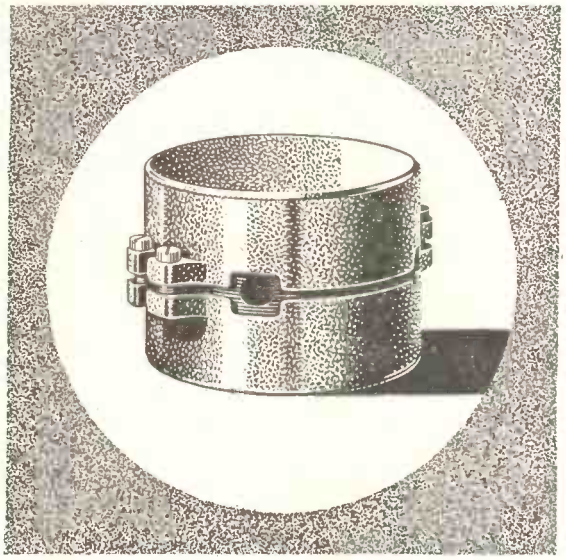
EASILY EXPANDED . . . "Matched" design permits quick and easy expansion—without obsoleting the basic equipment. "Matched" live camera and remote pickup facilities can be added when desired; or an increase in power can be made at a later date with RCA "Add-On" Amplifiers or higher power transmitters.

See your RCA Distributor for additional information on the RCA Basic Television Station. Or write Dept. TV-49-D, RCA International Division, Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N. Y., for free booklet giving complete details.

RCA INTERNATIONAL DIVISION
RADIO CORPORATION of AMERICA
30 Rockefeller Plaza, New York 20, N. Y., U. S. A.
Trademark ® Registered

NEW GRADE OF FERROXCUBE RESULTS IN

HIGHER EFFICIENCY POT CORES FOR AUDIO FREQUENCIES



Following the development of audio frequency grades of Ferroxcube, Mullard now introduce a series of 30mm pot cores with exceptionally low losses and high effective permeabilities.

Initial permeability μ_o of 1,400 with a loss factor of $\frac{\tan \delta}{\mu}$ of 2.5×10^{-6}.

The added advantages of simple construction and light weight make them specially suitable for use in cable splicing and audio frequency output transformers.

Designers requiring full technical details on this new series of high efficiency pot cores are invited to write to the address below.

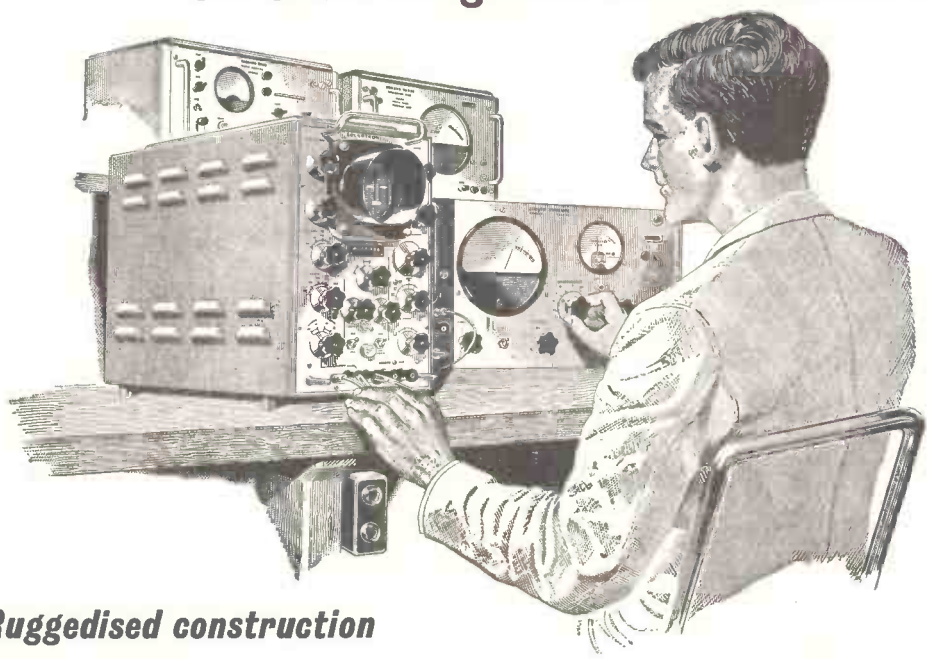
Mullard

'Ticonal' permanent magnets
Magnadur ceramic magnets
Ferroxcube magnetic cores

MULLARD LTD., COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1

MC256

Solartron Oscilloscope
CD. 523S designated Joint Services CT. 386



Ruggedised construction
Components to D.F. 5000
Approved for Inter Services use

A standard CD.523 oscilloscope was subjected to rigorous environmental tests by a Government establishment, including 1½ hours on a vibration table, and has now been designated CT.386 (reference No. 10S-17003) for Joint Services use. This is a further proof of the quality and reliability of Solartron electronic instruments.

Where a high quality precision instrument is required, suitable for field trials or operating under adverse conditions, specify the CD.523S.

BRIEF SPECIFICATION:

MAX. BANDWIDTH:
D. C. — 10 Mc/s at 10 V/cm

SENSITIVITY:
1 mV/cm—10 V/cm
in 6 ranges

TIME BASE:
0.1 μsec/cm to 1 sec/cm
with expansion up to × 5

Internal/External
Sync or Trigger

DIMENSIONS:
16¼" x 10" x 23" long

All components conform to approved Government Standard, materials and construction to the latest issue of D.F.5000. Transformers and chokes are hermetically sealed, oil-filled "C" core types.

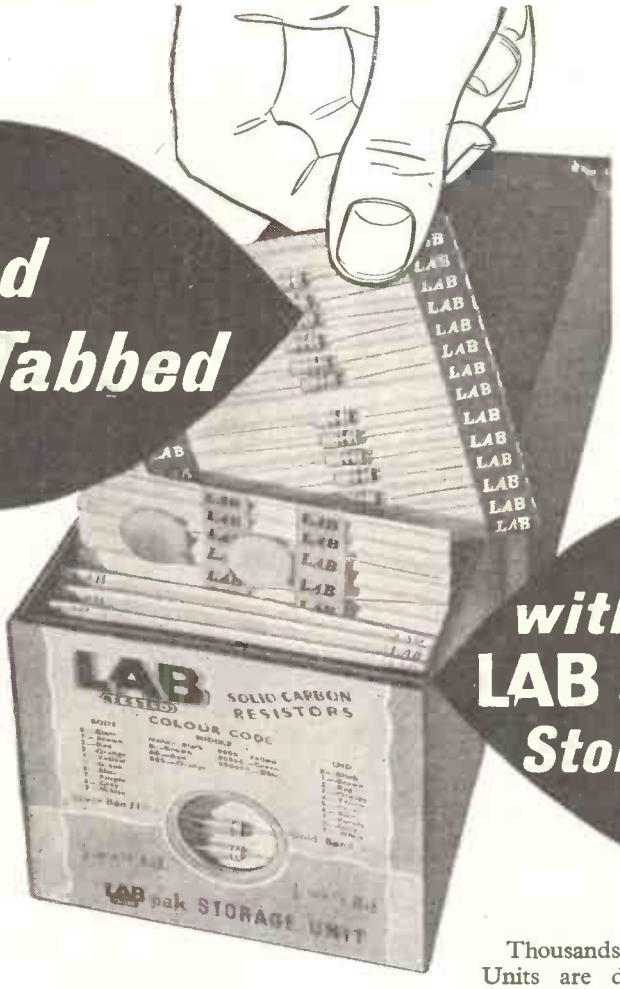
Interesting developments at the Physical Society Exhibition, 25th-28th March — **STAND NO. 84.**

THE SOLARTRON ELECTRONIC GROUP LTD.

RELIABILITY: *Under our 12 months' guarantee, costs have never exceeded 0.2% of sales.*

THAMES DITTON SURREY · TELEPHONE: EMBerbrook 5522 · CABLES: SOLARTRON THAMES DITTON

Typed and Tabbed with LAB Continuous Storage Units



REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
RESISTORS					
T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500
Tolerances available ±20% 10% 5%					
HIGH STABILITY RESISTORS					
HS3	½	750	1 to 500M	93	500
Tolerances available ±5% 2% 1%					
WIREWOUND RESISTORS					
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
CERAMICAPS					
CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500
Tolerances available ±2% 10%					

Thousands of LAB Continuous Storage Units are daily solving the problem of control and storage of the great range of resistors. Compact, and capable of storing up to 720 separate resistors, LABpak make selection positive, simple and speedy. Now that Ceramicaps, Histabs and Wirewound resistors have been added to the carded range the usefulness of LABpak storage units is enhanced.

FREE with any purchase of the LABpak range, these units are the complete answer to the storage problems of small production units, laboratories, etc.

MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK

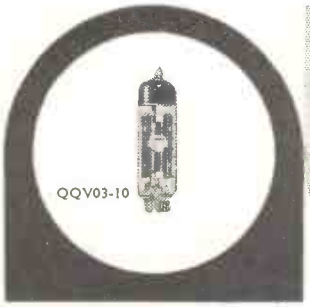
All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

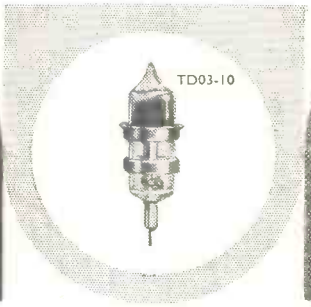
The LAB Continuous Storage Units are available from your normal source of supply, but more detailed information and literature can be obtained from

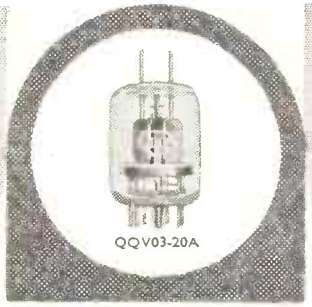
THE RADIO RESISTOR COMPANY LIMITED

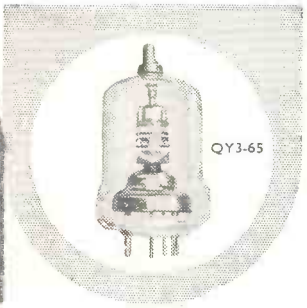
50 ABBEY GARDENS, LONDON, N.W.8 • *Telephone:* Maida Vale 5522

a transmitting all communications

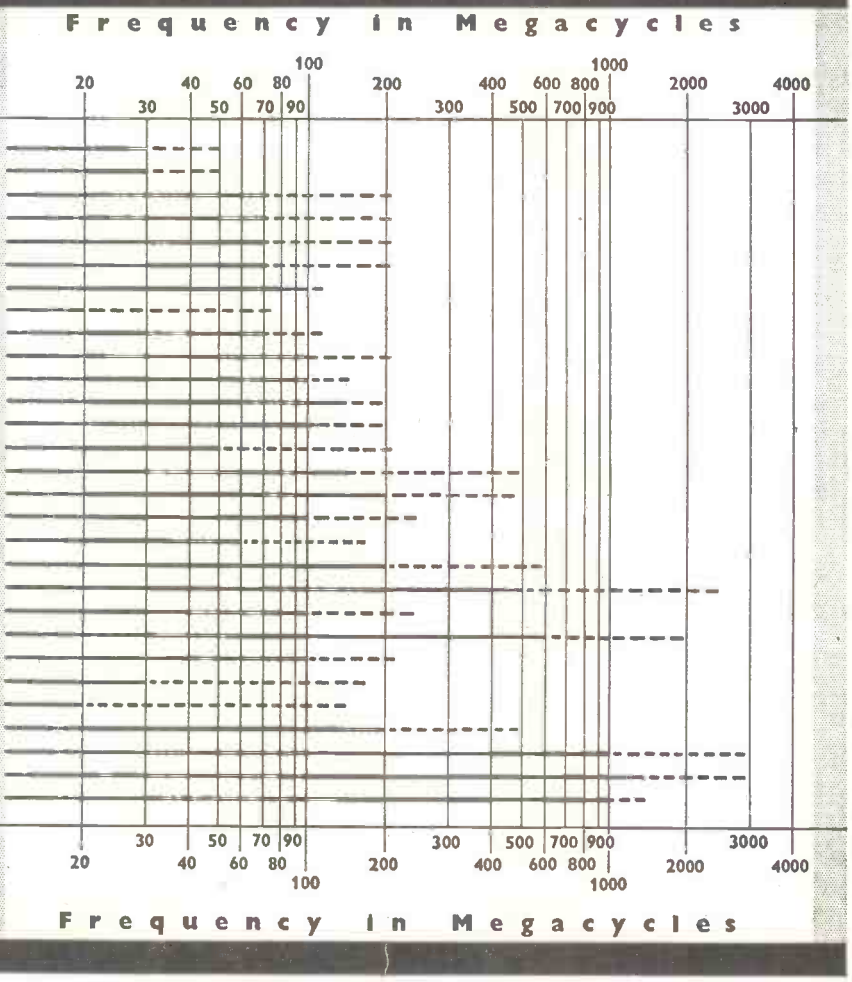








Valve Output Power in Watts	Type Number
10,000·0	TY7-6000A
10,000·0	TY7-6000W
6,900·0	TY6-5000A
6,900·0	TY6-5000W
4,100·0	QY5-3000A
4,100·0	QY5-3000W
1,690·0	TY4-500
1,440·0	TY4-350
1,000·0	QY4-250
900·0	QY4-500A
845·0	TY3-250
390·0	TY2-125
375·0	QY3-125
280·0	QY3-65
195·0	QV1-150A
90·0	QQV06-40A
87·0	QQV07-40
52·0	QV06-20
48·0	QQV03-20A
27·0	TD1-100A
26·0	QQV04-15
23·0	TD04-20
16·0	QQV03-10
10·0	QV03-12
7·9	QV04-7
6·0	QQV02-6
2·8	TD03-10
2·0	TD03-10F
0·02	TD05-12



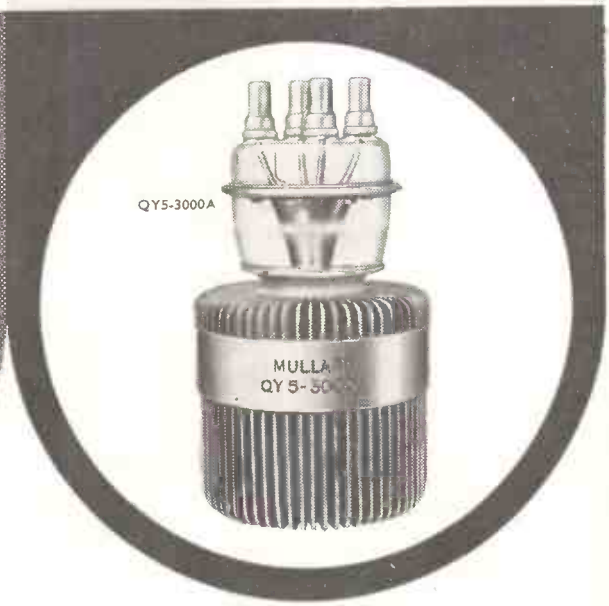
valve range for equipment

This extensive range of work-proven transmitting valves fills the wide and diverse needs of communications equipment manufacturers. The performance of this valve group extends to frequencies as high as 3,000 Mc/s for 0.5W and to powers up to 6.9kW at lower frequencies.

The Mullard technical advisory service is always at the disposal of manufacturers to answer questions relating to the applications and suitabilities of these valves.

Transmitting Valve Data

The chart on the left has been compiled to acquaint designers with the range and scope of Mullard transmitting valves available for communication purposes, and to facilitate the selection of suitable types for given applications. The power quoted is the maximum valve output available with Class C telegraphy operation up to the frequency indicated by the junction of the solid and broken lines. The extent to which a valve may be used at higher frequencies with reduced ratings is given by the broken line.
More detailed information may be obtained from a leaflet on this range of valves and from individual data sheets—all of which are available on request at the address below.



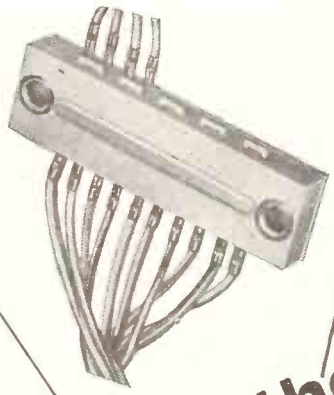
Mullard

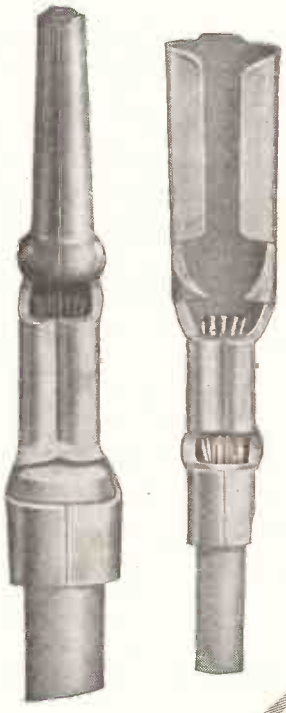
COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

MULLARD LIMITED · MULLARD HOUSE · TORRINGTON PLACE · LONDON · W.C.1

MV305a

AMP Taper Technique





improves the product

cuts the cost

AMP Taper Pins, Taper Bloks, Taper Tips, Taper Tabs and Taper Tab Receptacles offer great flexibility in circuit design and ensure maximum electrical stability. They cut material cost, labour cost and assembly time. Taper Technique benefits manufacturers of business machines, aircraft, guided missiles and electronic equipment. Write or 'phone us for further information.

IMPORTANT FEATURES

1. Taper pin diameter standard over a wide range of wire sizes.
2. Self-locking. Resists stress and vibration.
3. High contact pressure giving high conductivity and electrical stability.
4. Automatically crimped connections ensure uniformity.
5. Cuts assembly time. Cuts labour and material costs.

AMP AIDS EXPORTS The AMP solderless method meets wire termination specifications in foreign countries. Use of the AMP method will enable you to compete in world markets. It is particularly significant that AMP systems are standard practice in the U.S.A.

AMP SOLDERLESS TERMINATIONS—

THE CREATIVE APPROACH TO BETTER WIRING

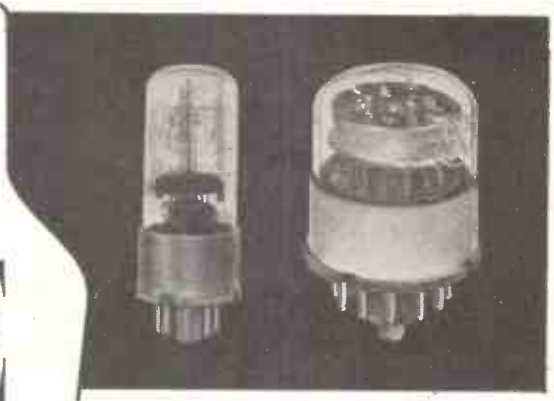
AMP TRADE MARK

AIRCRAFT-MARINE PRODUCTS (GT. BRITAIN) LTD.

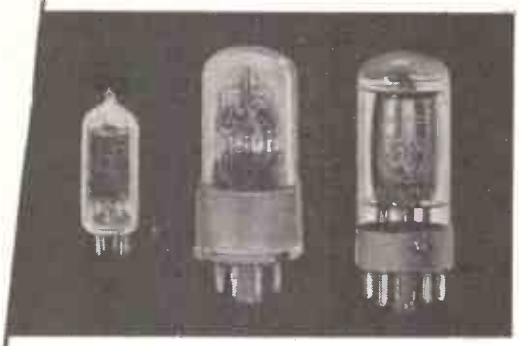
London Sales Office: DEPT. 15, 60 KINGLY STREET, LONDON, W.1. Telephone, REGENT 2517-8 and 3681-2-3.

Works: SCOTTISH INDUSTRIAL ESTATES, PORT GLASGOW, SCOTLAND

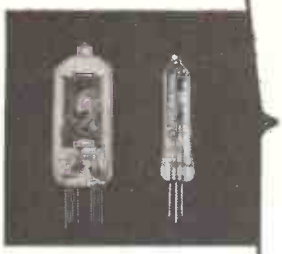
AP 323-47

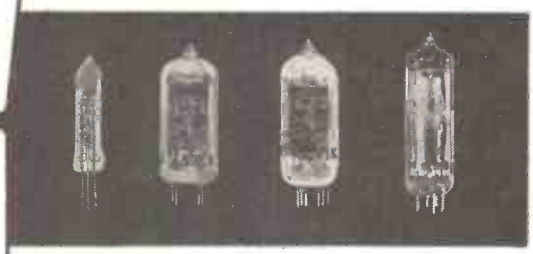


COLD CATHODE *GAS FILLED* TUBES



for
STABILISERS
and for
TRIGGER TUBES

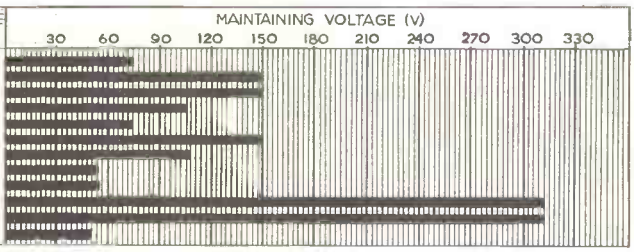




Standard Telephones and Cables Limited manufacture a comprehensive range of Cold Cathode Gas-filled Voltage Stabilisers and Trigger Tubes, designed to cover a wide range of voltage and cathode current values.

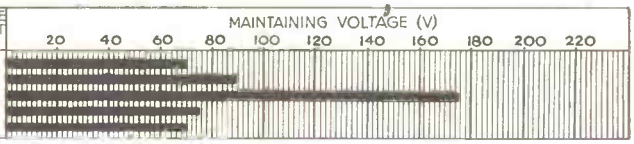
STABILISERS

VALVE CODE	CATHODE CURRENT mA
G75/3G	60
GI80/2M	45
SV-VR150/30	40
SV-VR105/30	40
SV-VR75/30	40
SV-OA2	30
SV-OB2	30
G55/1K	30
GI20/1B	30
G400/1K	4
G400/2G	4
G50/1G	0·5



TRIGGER TUBES

VALVE CODE	CATHODE CURRENT mA
GI50/2D	30
G240/2D	30
GI/37IK	10
4313C	10
GI/236G	1·5

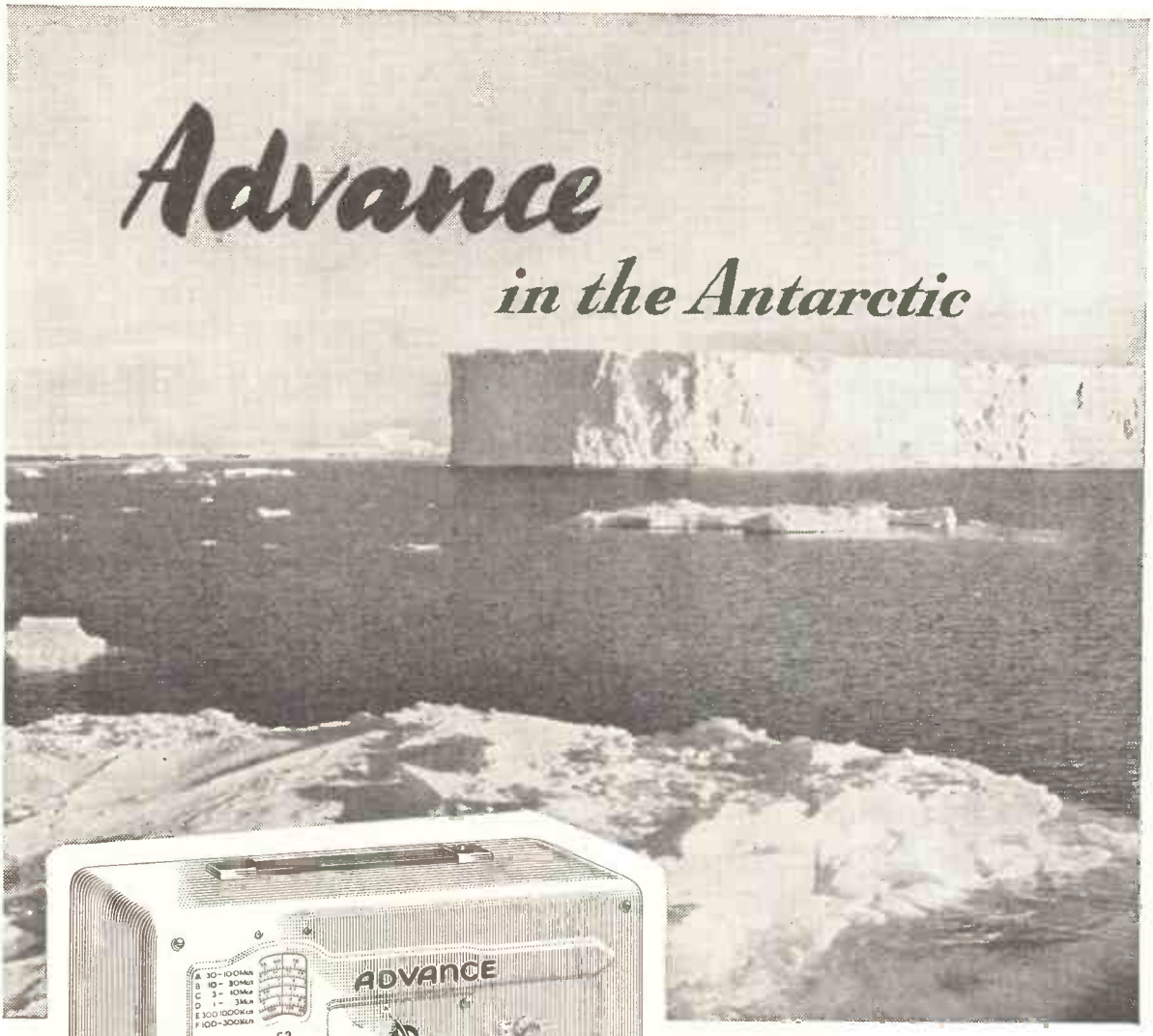


Technical data sheets giving full operating characteristics are available from the Special Valve Sales Department.

Standard Telephones and Cables Limited

CONNAUGHT HOUSE • 63 ALDWYCH • LONDON W.C.2.

Advance in the Antarctic



The huge tabular icebergs passed in the Weddell Sea at 76° South, on Jan. 29th, 1956.

Amid the hazards of Antarctica "Advance" E2 Signal Generators are playing their vital part in helping to maintain the all-important "communications." Their selection by the technicians of Dr. Fuchs' Trans-Antarctic Expedition is a measure of their confidence in the reliability of these world-famous instruments. By the same token you'll find instruments from the comprehensive "Advance" range in the tropics too, and indeed in all places throughout the world where accuracy and reliability must be sustained irrespective of climatic conditions.

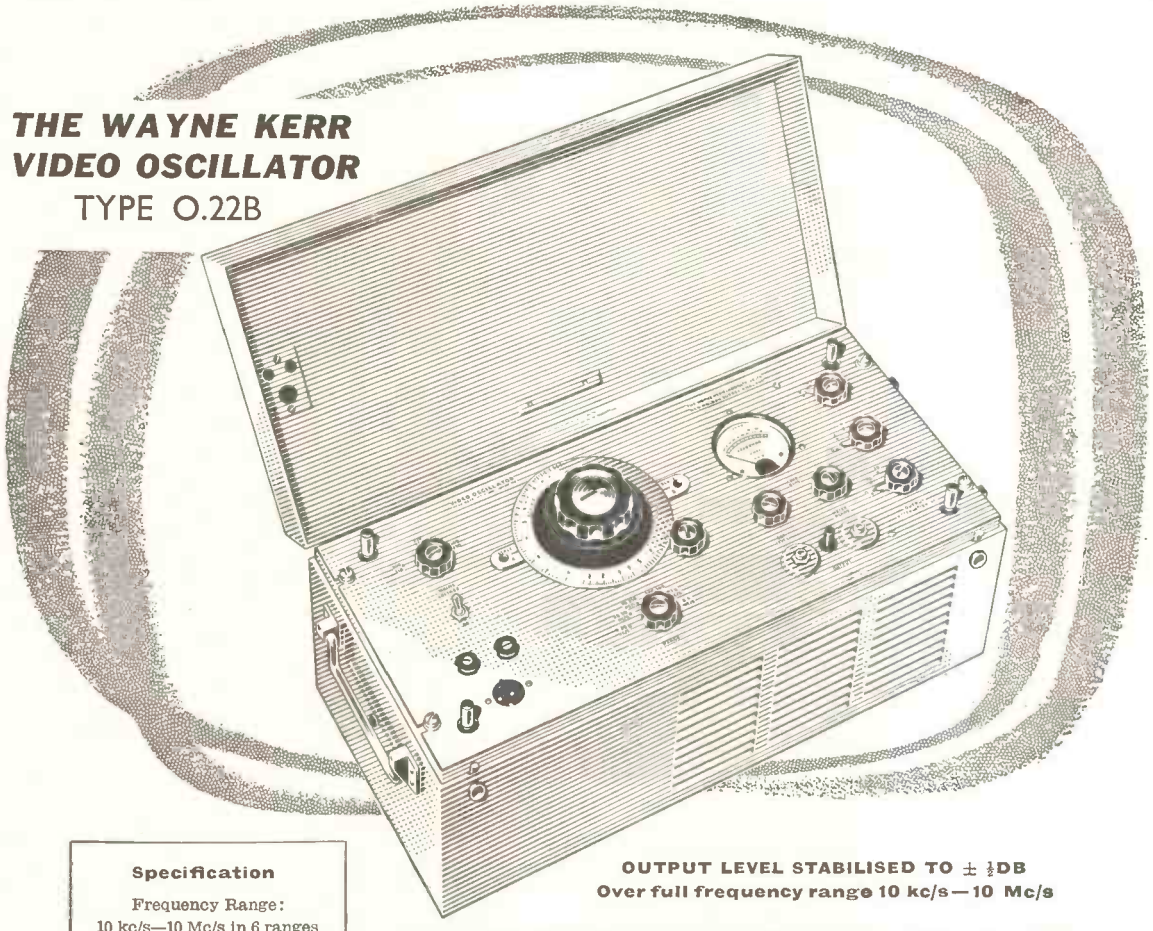
The Advance E2 Signal Generator covers 100 kc/s to 100 Mc/s. Write for leaflet W42.

ADVANCE COMPONENTS LTD. **Roebuck Road, Hainault, Ilford, Essex**

Telephone: HAInault 4444 GD 20

THE WAYNE KERR VIDEO OSCILLATOR

TYPE O.22B



OUTPUT LEVEL STABILISED TO ± ½DB
Over full frequency range 10 kc/s—10 Mc/s

Specification

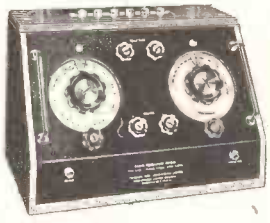
Frequency Range: 10 kc/s—10 Mc/s in 6 ranges and 50 c/s square wave. Frequency Stability: better than 1 in 10^3 in 1 hour. Frequency Accuracy: 1%. Output Range: + 10 db to — 50 db on IV p-p. Output Level: Constant to ± 0.5 db at any frequency setting. Output Impedance: 75 ohms. Total Harmonic Content: less than 1%.

An outstanding feature of the Wayne Kerr Video Oscillator Type 0.22B is a thermistor bridge circuit stabilising the amplitude. Once set the output level will remain constant within 0.5db while the oscillator frequency is varied over its full range of 10 kc/s to 10 Mc/s.

Other advantages are the facility for indicating the modulus of the load impedance to which the instrument is connected and a 50 c/s square wave output for examination of the low frequency characteristics of video networks.

In transportable case £165, or for standard 19" Rack mounting £158

WAYNE KERR

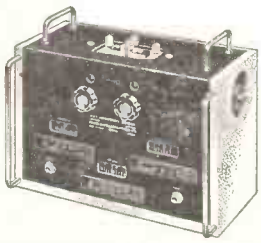


Radio Frequency Bridge Type B601

A wide range transformer ratio-arm bridge for the measurement of resistance, capacitance, inductance and complex impedance between 15 kc/s and 5 Mc/s. Impedances between any two terminals of a three terminal network can be measured. Price £125.

V.H.F. Bridge Type B.801

An extremely stable transformer ratio-arm bridge designed for aerial, feeder, cable and component measurements, balanced or unbalanced, at frequencies between 1 and 100 Mc/s. Price £150.



DETAILS OF FULL RANGE FROM: THE WAYNE KERR LABORATORIES LTD., ROEBUCK RD., CHESSINGTON, SURREY. LOWER HOOK 1131

Plessey

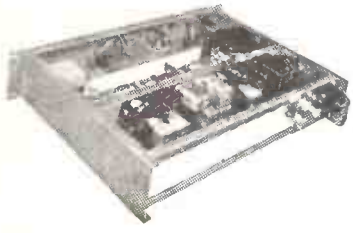
Communications Equipment

TWO

examples from a wide range

Electronic Muting Unit PV97A...

During non-working periods the Plessey E.M.U. ensures freedom from annoying 'background' noise—but such is its sensitivity that a signal exceeding the noise by as little as ½dB will unmute the receiver to full signal reception. This sensitivity is adjustable—by potentiometer control—to a point where a signal plus noise-to-noise ratio of 12dB is necessary to unmute the receiver output for both R/T and W/T reception.



...and the V.H.F. Aerial Multicoupler PV95A

This unit will eliminate clusters of aerials and their attendant siting problems. It provides aerial outputs for up to six receivers when fed from a single Broad Band V.H.F. aerial in the band 100-156 Mc/s. Cross couplings are reduced to a minimum.

The low noise factor coupled with high gain, ensures that the unit causes no deterioration at low signal levels and with the majority of receivers effects an overall improvement in performance. The risk of intermodulation between strong signals is negligible.

The operation of these Plessey units is unaffected by wide temperature variations as all components are fully tropicalised.

For technical details and data, Communications Planning Engineers are invited to request copies of Plessey Publication No. 842 regarding E.M.U. PV97A and No. 783 regarding Aerial Multicouplers PV95A.

THE PLESSEY COMPANY LIMITED, ILFORD, ESSEX

✳

Plessey is always ready to design and manufacture similar types of equipment to meet specialised specifications.

ELECTRONIC & EQUIPMENT GROUP

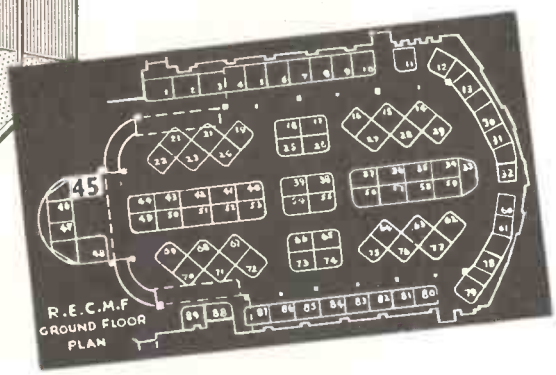
D

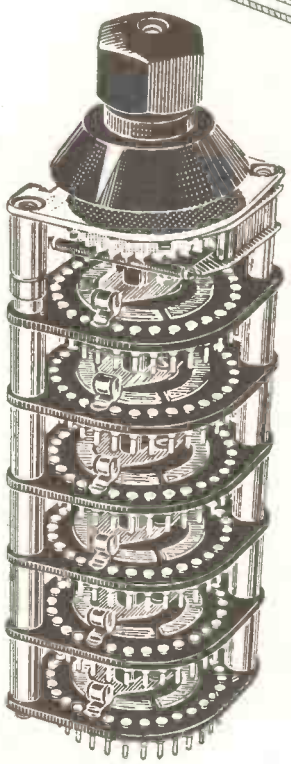
EE3a

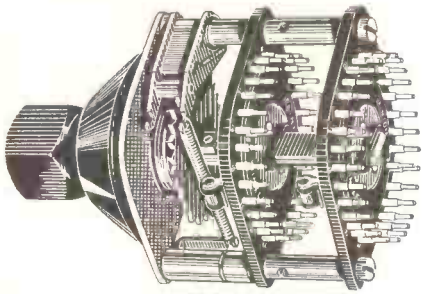
PAINTON

By Appointment to the Professional Engineer

STAND NO. 45
R.E.C.M.F. EXHIBITION







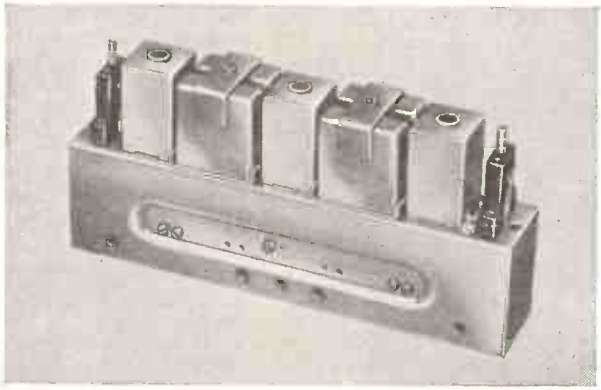
PAINTON WINKLER SWITCHES
2 bank and 6 bank

We cordially invite you to visit our stand at this years R.E.C.M.F. Exhibition where a complete range of products will be displayed

PAINTON

Northampton England

ATTENUATORS AND FADERS · STUD SWITCHES · TOGGLE SWITCHES · PUSH BUTTON SWITCHES
HIGH STABILITY CARBON RESISTORS · 'METLOHM' METAL FILM AND GLASS FIBRE RESISTORS
FIXED AND ADJUSTABLE WIREWOUND RESISTORS · WIREWOUND POTENTIOMETERS
MIDGET R.F. CHOKES · KNOBS, DIALS & POINTERS · TERMINALS, PLUGS & SOCKETS



Mullard

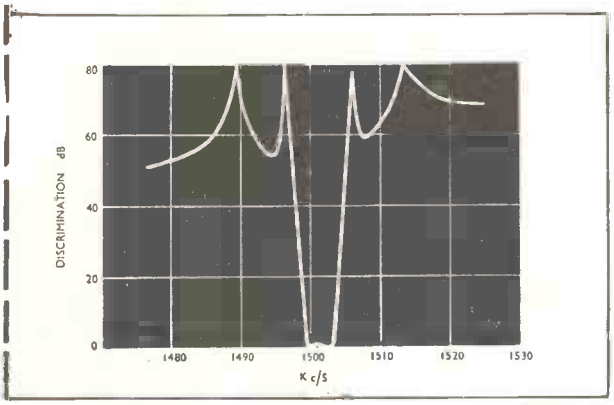
may have the answer to *your* filter problems too!

A special team at Mullard is constantly engaged in dealing with difficult filter problems. You too can benefit from this team's wide experience in the design and manufacture of filters employing both crystal and L.C. techniques.

Write or telephone Mullard — problems can be investigated and, where necessary, filters made to meet individual requirements.

★

The response curve at the foot of this page illustrates the exceptional performance of the compact 1.5 Mc/s filter shown above which has been designed and manufactured by Mullard for incorporation in airborne equipments.



Mullard
SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LIMITED · EQUIPMENT DIVISION
Mullard House · Torrington Place · London W.C.1
Telephone: LANgham 6633

ME607

G.E.C.

KT88

A New Audio Output Valve with an anode dissipation of 35 watts

An addition to the well tried and popular range of G.E.C. Audio Valves, of which the KT66 has set a standard in its class the world over, the new G.E.C. KT88 is now available to meet conditions of use requiring higher power.

POINTS ABOUT THE KT88

1 The KT88 is a beam pentode with aligned grids for maximum efficiency.

2 50 watts output is available from a pair connected in the ultra linear circuit with auto bias and an H.T. line voltage not exceeding 500.

3 100 watts output is available from a pair connected in the ultra linear circuit with fixed bias and an H.T. line voltage not exceeding 560.

4 25 watts output is available from a pair triode connected with auto bias and an H.T. line voltage not exceeding 500.

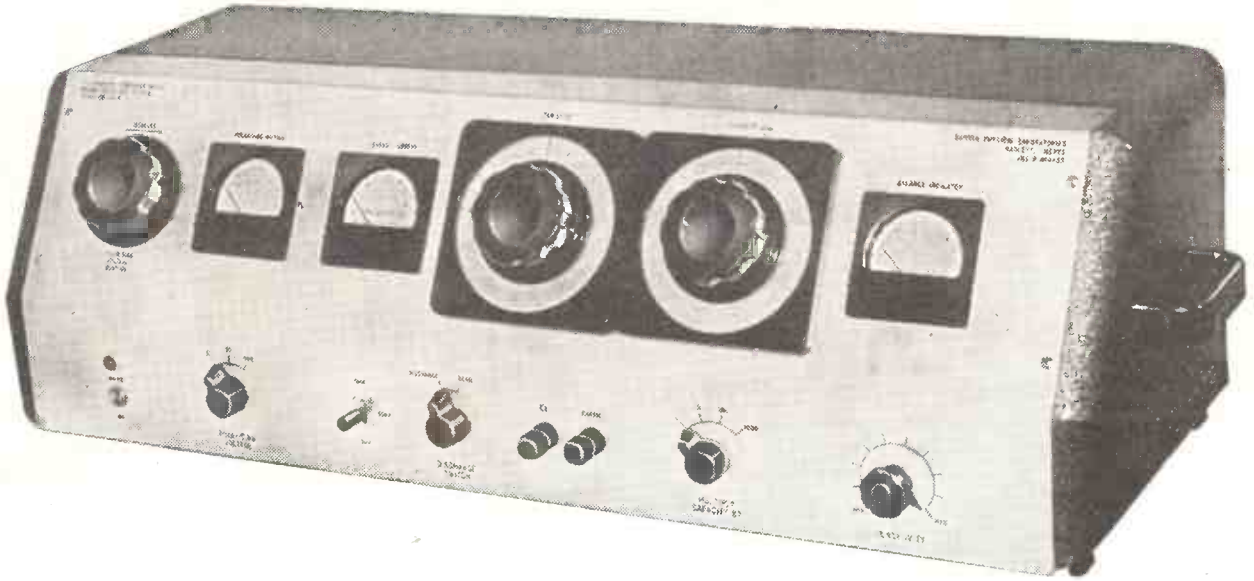
5 The mutual conductance of the KT88 is 11 mA/V.

6 An all-glass ring seal replaces the conventional pinch seal giving increased strength, higher rating and reduced dimensions.

7 The valve is mounted on an international octal base and has a heater rating of 6.3 volts., 1.8 amps.

Full particulars of these valves can be obtained from the G.E.C. VALVE & ELECTRONICS DEPT.

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2



Capacitance Bridge specifically designed to measure

ELECTROLYTIC AND TANTALUM CONDENSERS

Capacitance Range: 0.1 to 11,000 μFd, Power Factor Range: 0.1 to 30%. Polarising Voltage: 0.5 to 600 volts.

This is one instrument from our range which includes:

VALVE VOLTMETERS · OSCILLATORS · PULSE GENERATOR · ATTENUATORS · MEGOHMMETER
BREAKDOWN TESTER · BRIDGES FOR MEASUREMENT OF R.C.L.

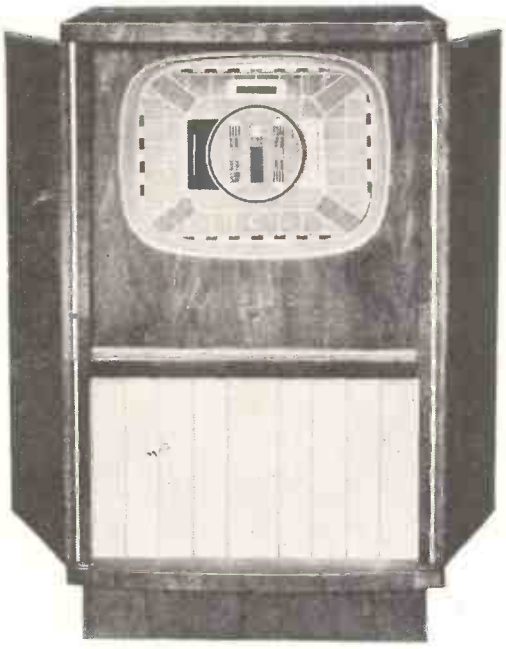
Your enquiries for our comprehensive range of sensitive METERS are invited.

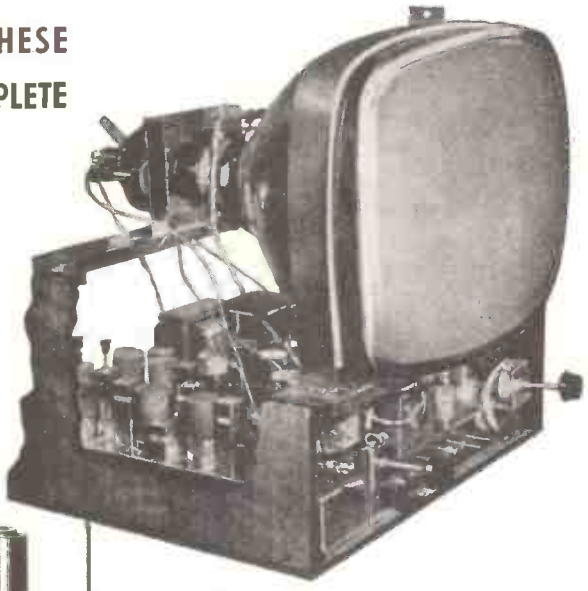
BRITISH PHYSICAL LABORATORIES · RADLETT · HERTS

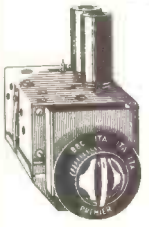
Telephone: RADLETT 5674.

You'll do better

SAFETY FIRST! BUILD THESE PREMIER TELEVISORS WHICH GIVE COMPLETE SAFETY TO THE CONSTRUCTOR.







These Televisors use a double wound mains transformer which gives you complete safety from contact with the mains supply when handling the chassis or controls

CONSOLE CABINETS with full length doors for 14in., 16in. and 17in. tubes PRICE £14/14/- H.P. Terms: Deposit £7/7/6 and 9 monthly payments of 18/6. CONSOLE CABINETS. Half door, previously advertised, still available at £12/12/-. H.P. Terms: Deposit £6/6/- and 8 monthly payments of 18/3.
On above cabinets add 21/- for pkg. and carr.

★ **B.B.C. & I.T.A. DESIGN No. 1 with NEW TURRET TUNER MAY BE BUILT FOR £33-7-11** PLUS COST OF C.R.T.

★ **B.B.C. (ALL CHANNELS) DESIGN No. 2 MAY BE BUILT FOR £27-9-4** PLUS COST OF C.R.T.

BUILD IN 5 EASY STAGES. FULL CONSTRUCTION DETAILS AVAILABLE. INSTRUCTION BOOK 3/6 POST FREE INCLUDES BOTH DESIGNS.

The NEW "PREMIER" TAPE RECORDER

★ Case finished in Brown and Antique Fawn. Size 15in. × 12½in. × 7¾in., with the very latest type continental gilt fittings. For A.C. mains 200-250 volts 50 cycles.

- ★ **Two speeds 7½ and 3¾in. per sec. playing time of 1 hour and 2 hours.**
- ★ **Standard 7in. reels 1,200ft.**
- ★ **Drop-in tape loading.**
- ★ **Positive brakes no tape "spilling" after braking.**
- ★ **Fast rewind forward or reverse without removing tape.**
- ★ **One knob for deck operation.**
- ★ **Amplifier may be used for gramophone or microphone purposes giving high-quality reproduction.**
- ★ **Superb reproduction of pre-recorded tapes.**
- ★ **Microphone compartment.**
- ★ **Complete with reel of Scotch Boy Tape (1,200ft.), and spare reel.**
- ★ **Acos type 33-2 microphone with on/off switch.**
- ★ **Latest type Lane Mark 6 Tape Deck.**
- ★ **Dual input channels providing mixing facilities.**
- ★ **Detachable lid and control cover.**
- ★ **Control panel finished in matching colours with the tape deck.**
- ★ **Elliptical speaker of the latest type 7in. × 4in.**
- ★ **Magic eye recording level indicator.**

£5 DEPOSIT & 8 MONTHLY PAYMENTS OF £4.18.6 or CASH PRICE £40 plus 21/- pkg. & carr.

H.P. Terms: Deposit £20 and 12 monthly payments of £1.17.1

PREMIER RADIO COMPANY,

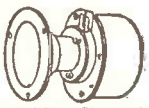
with PREMIER

THE NEW "WHARFEDALE" SFB/3

3-SPEAKER SYSTEM

Consists of Speakers W12CS, Bronze 10CSB, Super 3HF and a special Crossover Unit fitted into a very attractive Cabinet, size 34in. × 31in. × 12in. Weight 60 lb. Cash £39/10/-. Credit deposit £5/0/0 and 8 monthly payments of £4/17/-, or H.P. deposit £19/15/- and 12 monthly payments of £1/16/8. Packing and carriage 21/-.

New GOODMAN'S TREBLE UNIT THE TREBAX



At £6/4/- is a high efficiency pressure driven reproducer covering 2,500 c.p.s. to 16 kc/s. It makes an excellent 2-speaker system when used with the Axiom 150 Mark II at £10/15/9. A special Crossover Unit type X05000 is available at £1/19/-. The complete system £18/18/9 cash. Credit terms deposit £2/7/9 and 8 monthly payments of £2/6/6, or H.P. Terms deposit £9/9/4 and 11 monthly payments of £1/1/-. Packing and carriage 7/6.

THE NEW TSL FM TUNER HIGH STABILITY MODEL

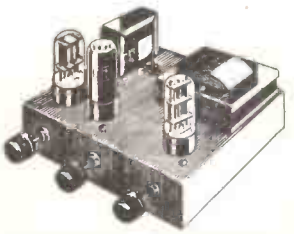
6 Valves including Magic Eye and Power Supply using the latest type Gorler permeability Unit complete with first audio stage and preset output volume control. Maximum radiation less than 10 microvolts per metre. Sensitivity better than .5 microvolts. Cash price £17/10/- (inclusive) or on H.P. terms, deposit £8/15/- and 9 monthly payments of £1/1/8. Credit terms deposit £2/3/9 and 8 monthly payments of £2/3/4. Postage and packing 5/- extra.

Why not make the best !

MULLARD AMPLIFIER KIT

NOW SUPPLIED WITH ULTRALINEAR OUTPUT TRANSFORMER.

All the components for model 510, PLUS pre-amplifier on one chassis (total six valves) chassis gold hammer finished. May be purchased for £12/12/- plus pkg. & post 7/6, or pre-amplifier and tone control in a separate unit £14/14/- plus pkg. and post 7/6.



4 WATT AMPLIFIER

MAY BE BUILT FOR **£4 . 10 . 0** Plus 2/6 Pkg. & Postage

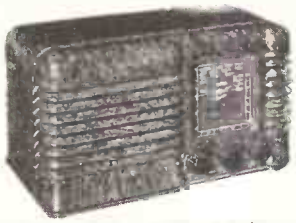
Instruction Book 1/- post free.

A steel case is now available, complete with engraved panel, for 15/6 extra. The amplifier may be supplied complete for £5/5/- plus pkg. and post 3/6, or fitted in case at £6 plus pkg. and post 3/6. Engraved panel 3/6. Post Free.

IS THERE A BABY IN THE HOUSE?

The famous Premier Baby Alarm which is a device to enable Baby's cries, or even breathing, to be heard in any selected room in the house. May be left permanently connected. Extra Microphones in different rooms may be used. The microphone may be positioned up to 100ft from the main unit. Suitable flexible lead can be supplied at 5d. per yard extra.

Completely wired and tested at **90/-** Plus 2/6 post and pkg.



2-BAND TRF RECEIVER MAY BE BUILT FOR £5.15.0

plus pkg. & post 3/-

3 BAND SUPERHET RECEIVER

MAY BE BUILT FOR **£7 . 19 . 6** Plus 3/- Pkg. & Postage

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12in. × 6½in. × 5½in. in either walnut or ivory bakelite or wood. Individual instruction books 1/- each, post free.

ALL DRY BATTERY PORTABLE RADIO RECEIVER

MAY BE BUILT FOR **£7 . 8 . 0** Plus 3/- Pkg. & Postage

4 Miniature valves in a supe-het circuit covering medium and long waves, Rexine-covered cabinets 11½in. × 10in. × 5½in., in two contrasting colours, wine with grey panel Instruction book 1/6 post free, which includes full constructional details and list of priced components.

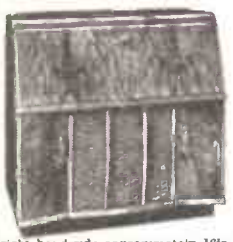
WILLIAMSON AMPLIFIER

MAY BE BUILT FOR **£15 . 15 . 0** Plus 7/6 Pkg. & Postage

Supplied completely wired and tested for £20, or available on H.P. or Credit terms. postage and packing 10/-.

PRE-AMPLIFIER & TONE CONTROL UNIT

Available completely constructed, £5/5/- plus 2/6 packing and postage.



PREMIER BUREAU DE LUXE

A superb cabinet in finely figured walnut veneer. Interior light sycamore, with rexine matching lining. Overall dimensions: 33in. high, 34in. long, 17½in. deep. Uncut control panel on right hand side approximately 16in. × 10½in., uncut baseboard on left hand side 15½in. long, 13½in. deep. Two full size felt-lined storage cupboards in the lower part of the cabinet.

Cash price 16½ gns. H.P. Terms, deposit £8/13/6 and 12 monthly payments of 16/1.

Credit Terms, deposit £2/3/10 and 8 monthly payments of £2/2/10. Packing and Carriage 25/- extra.

SPECIAL OFFER!

GOODMANS AUDIOM 50. £4/17/6 plus packing and postage 5/-.

THE WOLSEY BAND III CONVERTER

This converter has been designed to receive alternative programmes on Band 3 Channels 6 to 13, selection of Channel being made by rotation of Switch Knob. Mains supply 200/250 v. A.C only. The high gain of this Converter (minimum 20dB) together with low noise factor ensures good picture quality. A variable gain control makes it possible to balance a Band 1 and Band 3 signal inputs to the receiver. Any single channel Receiver of either T.R.F. or Superhet design may be fed from the Converter. Separate input sockets are provided for Band 1 and Band 3 inputs. Cash price £9/19/6. Credit Terms deposit £1/5/6 and 8 monthly payments of £1/5/6. IMPORTANT, please state your Band 1 station. Packing and postage 3/- extra

207, EDGWARE RD., LONDON, W.2. Tel: Ambassador 4033 & Paddington 3271

PREMIER RADIO COMPANY

PORTABLE TAPE RECORDER CABINETS

All Rexine Covered

Tape Deck	Amplifier	Type	Price
Lane Mk. VI	Premier	Mi. VI	£4 19 6
Lane Mk. VI	Premier	de Luxe	£4 19 6
Truvox Mk. III	Truvox C	T.D.3	£4 4 0

Plus Postage and Packing 5/-.

BARGAIN OFFER

LATEST TYPE RUBBER ESCUTCHEON SUITABLE FOR 17in. RECTANGULAR TUBES AT A SPECIAL PRICE OF 10/-. PLUS PACKING AND POST 1/6

THE NEW COLLARO TAPE TRANSCRIPTER

SPEEDS 3¾, 7½ & 15 inches per Second £20 plus pkg./post7/6

We carry a comprehensive stock of components by all leading manufacturers.

CABINETS—PORTABLE

MODEL PC/2

Grey Lizard Rexine covered 45/-
Overall dimensions 15in. × 15in. × 6in. Clearance under lid when closed 3in.

MODEL PC/2 DE LUXE

Two colours, wine and grey, with cutout for speaker and amplifier 55/6
Dimensions as above.

MODEL PC/3

Grey Lizard Rexine covered 69/6
Overall dimensions 16¾in. × 14¼in. × 10¼in. Clearance under lid when closed 6¼in.

MODEL PC/3 DE LUXE

As above but with cutouts for Speaker and Amplifier 79/6
Dimensions as above.

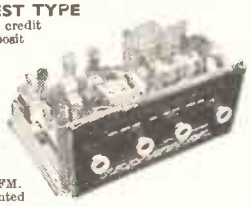
THE ABOVE CABINETS ARE COMPLETE WITH CARRYING HANDLE FASTENERS AND PANEL.
Packing and Postage 3/- each.

Junction Transistors 10/- each
Equivalent of the OC70 Type

A RANGE OF BAND 3 AND F.M. AERIALS IS NOW AVAILABLE

Air spaced co-axial wire, 1/9 per yard.

AM/FM RADIOGRAM CHASSIS OF THE LATEST TYPE



Cash £22/10/-, or credit terms £2/16/3 deposit and 8 monthly payments of £2/15/6. H.P. Terms £11/5/- deposit and 12 monthly payments of £1/0/11. Packing and Carr. 7/6. This chassis has 8 valves and covers short, medium and long F.M. and Gram. Printed circuit on F.M. ensures a high degree of stability. Overall size 14in. long, 6¼in. high, 9in. deep. Dial size 12 × 5¼in.

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-10 cycles. All primaries are screened.

SP175B. 175-0-175, 50 mA., 4 v. @ 1 a., 4 v. @ 2-3 a. 15/-
SP350A, 350-0-350, 100 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a. 21/-
SP351A, 350-0-350, 150 mA., 4 v. @ 2-3 a., 4 v. @ 3-6 a., 4 v. @ 1-2 a., 4 v. @ 1-2a. 30/-
SP352 350-0-350 150 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a. 6.3 v. @ 2-3 a. 30/-
SP425A. 425-0-425, 200 mA. 6.3 v. @ 2-3 a., 6.3 v. @ 3-5 a., 5 v. @ 2-5 a. 52/6
250-0-250, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a. 22/6
350-0-350, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a. 22/6
200-230-250 output 3 v.-30 v. @ 2 a. 17/6

T.S.L./Lorenz.

LP 312-2 Speaker System	£14 19 6
LPH 65 Treble Speaker	£1 19 6
LP 215 Concert Speaker 8in.	£6 17 10
Concert Soundcorner	£13 16 3

Send for illustrated catalogue on above.

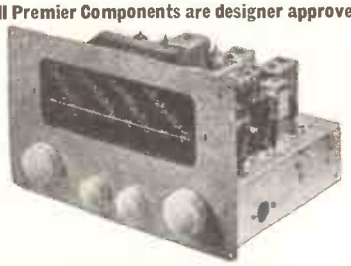
★ **IT WILL PAY YOU TO VISIT OUR NEW HI-FI DEMONSTRATION ROOM.**

MAKE YOUR OWN ROD AERIAL

Ferrite rod 6in. × 5/16in., complete with descriptive constructional details. These aerial rods are suitable for medium and long wave reception. Price 5/3, post free.

THE JASON "ARGONAUT" MW/FM DESIGN

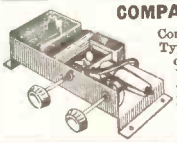
All Premier Components are designer approved



The very latest FM Receiver design PLUS a medium waveband, as described in "The Radio Constructor." ALL components to build the complete Receiver, including output stage, may be purchased for £15/5/-, or all components less output stage but including Power Supply, for £13/19/6, plus packing and postage 3/6 on each. The chassis, front plate, dial flywheel drive assembly special tuning condenser and wavechange switch (which includes mains switch) supplied completely assembled. This is also available separately at £4/4/- plus packing and postage. 2/6.

SEND 2½d. STAMP FOR OUR NEW 1957 CATALOGUE

COMPACT GRAM AMPLIFIER



Complete ready to connect to any Type of Pick-up and Speaker (3 ohms) A.C. Mains 200/250 volts. Volume and tone control fitted with knobs. Overall size 7½in. long × 3½in. wide × 2½in. high

£2 . 19 . 6

Plus packing and postage 2/6.

WHY BUY SURPLUS OR RE-CONDITIONED TUBES WHEN THESE FULLY GUARANTEED WIDE ANGLE TUBES ARE AVAILABLE? THE LATEST TYPE 17" RECTANGULAR TUBE MW43/64 BY TELEFUNKEN AT £17 (INC. TAX) POST AND PACKING 21/- EXTRA. ALSO 14" RECTANGULAR TUBE TYPE 14 LP4, £13/17/6 (INC. TAX). PKG. & CARR. 15/- EXTRA.

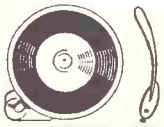
A LARGE RANGE OF TEST METERS IN STOCK

T.S.L. ELECTROSTATIC SPEAKERS

Type LSH75 ..... Price 12/6
Type LSH100 ..... Price 21/-
Type LSH518 ..... Price 17/6

LATEST B.S.R. MONARCH 4-SPEED AUTOCHANGER

Designed to play 12in., 10in., and 7in. Records intermixed in any order at 16, 33⅓, 45 or 78 r.p.m. Capacity 10 Records. New reversible, Dual Stylus Crystal Pick-up, for use on 100/250 v. 50 cycle A.C. mains, £9/15/- plus packing and postage 5/-. Deposit 25/- and 8 monthly payments of 25/-.



B.S.R. TU8 3-speed Record Player £4/12/6 plus 2/6 post and packing.

COLLARO A.C.4/564

4 speed single player with Studio "O" head. A.C. Main. 200/250 volts, 50 c/s. Suitable for record speeds of 16 33⅓, 45 and 78 r.p.m.

Special offer

£9 . 7 . 0

Carr. & Pkg. 5/-

LOUDSPEAKERS

ELAC ELLIPTICAL 7in. × 4in.	21/10
ELAC—8in. dia. Moving Coil 3 ohms imp	21/-
PLESSEY 8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) with Pentode Transformer	10/6
PLESSEY—8in. dia. Mains Energised, 3 ohms imp. (600 ohms field)	7/6
PLESSEY—2½in. dia. Moving Coil, 3 ohms Imp.	18/9
GOODMANS—Audiom 60 ..... Plus 5/- packing and carriage.	£9/2/0
GOODMANS—Axiom 150 ..... Plus 5/- packing and carriage.	£10/15/9
PLESSEY ELLIPTICAL—10 × 7	37/6

TUNING CONDENSERS (Miniature type)

2-gang .0005 mfd. 5/-.

METER RECTIFIERS

Miniature type with leads 1-5 mA. 5/-, post paid.

WEYMOUTH MINIATURE COIL PACK

Covering Med./Long/Short Wave Bands. Iron Cored Coils. Dimens.: Ht. 1¾", length 3¼", width 2¼in. Price 29/6.

TERMS OF BUSINESS:

Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-. 1/6 under 40/-. Unless otherwise stated.

PREMIER PERSONAL PAYMENTS PLAN ITEM	CASH PRICE	CREDIT TERMS DEPOSIT	CREDIT TERMS MONTHLY PAYMENTS	H.P. TERMS DEPOSIT	H.P. TERMS MONTHLY PAYMENTS
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Premier Bureau Cabinet	12 12 0	1 12 0	(8) 1 12 6	6 6 0	(8) 18 3
Premier Bureau de Luxe Cabinet	17 6 6	2 3 4	(8) 2 2 10	8 13 0	(12) 16 1
Rogers Amplifier and Pre-amp.	26 0 0	3 4 6	(8) 3 4 0	13 1 3	(12) 1 4 0
Mullard EAR/5/10	18 18 0	2 7 3	(8) 2 6 6	9 9 3	(8) 1 6 3
Mullard EAR/6/10P	24 3 0	3 0 6	(8) 2 19 5	12 2 0	(12) 1 2 4
Leak TL10	28 7 0	3 11 0	(8) 3 9 9	14 3 0	(12) 1 6 4
Garrard Transcription Type 301 less P/U	26 8 3	3 6 0	(8) 3 5 0	13 4 0	(12) 1 4 6
Garrard Changer Type RC80M AC/DC	26 3 5	3 5 5	(8) 2 10 1	13 1 9	(12) 1 4 3
Garrard Changer Type RC98H AC	19 17 7	2 9 1	(8) 2 9 0	9 19 4	(9) 1 4 6
Lenco-Transcription Unit Model F50-8 complete with P/U	21 16 2	2 14 6	(8) 2 13 3	10 18 8	(12) 1 0 2
Goodmans Axiom 102 Speaker	10 7 9	1 5 0	(8) 1 6 6	5 3 9	(6) 1 0 8
Goodmans Axiom 150 MK. 1	10 15 9	1 7 1	(8) 1 7 4	5 7 9	(6) 1 1 4

207 EDGWARE RD., LONDON, W.2.

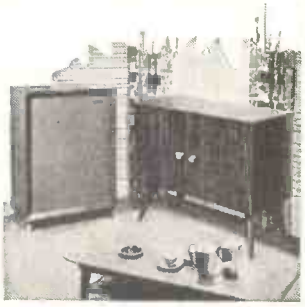
Tel: AMBassador 4033 and PADdington 3271

FACTS about the new Avantic DL7-35

This amplifier needs no "sales talk"—the specification speaks for itself

Announcing the Avantic 'GLYNDEBOURNE'

The DL7-35 with wide range speaker system can be supplied in two superb cabinets finished in natural mahogany at £144.5.0. net. Provision is made for any of the following items which can be fitted as optional extras: 4-speed single or automatic record player; Avantic vhf-fm or mw-am/vhf-fm radio feeder unit; Avantic tape player.
The Avantic loudspeaker system comprises a 12" diameter low frequency unit and two 2½" high frequency units. The frequency range of the system is 20—22,500 cps. and the peak power ratings are 40 watts (l.f.) and 10 watts (h.f.).



POWER AMPLIFIER

Push-pull distributed load output stage producing an output of 27 watts at ± 0.1% total distortion.
Frequency response: ± 1 dB 1 c/s. to 100 Kc/s.
Damping factor: 50. Sensitivity: 255 mV. for 27 watts output.
Hum & noise: —89 dB relative to 20 watts output.
Output impedances: 4Ω, 8Ω & 16Ω switch selected; automatic feedback adjustment. Built-in volume control and two audio input sockets.

PRE-AMPLIFIER CONTROL UNIT

Output: 200 mV. at 0.1% and 2.0V. at 0.2% total distortion.
Intermodulation distortion: power & pre-amplifier combined: 1% for 20 watts output.
Noise: —64 dB on radio or tape inputs; —53 to —56 dB on pick-up inputs.
Radio power outlet: 6.3V. 2.5A., 440V 30 mA. **Tape recorder outlet.**
8-inputs: Tuner (2 levels) Pick-up (3 levels) Tape & Auxiliaries (2 levels).
Controls: 8 position selector switch incorporating 5 record play-back characteristics.
Loudness control providing compensation for low level reproduction of high level inputs in accordance with Fletcher-Munson loudness curves.
Bass Control: —15 dB at 30 c/s. to +16 dB at 50 c/s.
Treble control: —15 dB to +15 dB at 10 Kc/s.
Low-pass filter: 3-positions: 20, 10 & 5 Kc/s. Slope: 12 dB/octave.
Rumble filter: 40 c/s. turnover frequency. Slope: 12 dB/octave.
Monitor/Record switch: 3 positions.
Price: Power amplifier and pre-amplifier control unit complete £55.

See and hear our products

1957 AUDIO FAIR

APRIL
12 · 13 · 14 · 15
★
Waldorf Hotel, London, W.C.2.

Avantic
HIGH FIDELITY REPRODUCERS MANUFACTURED BY
Beam-Echo Limited
Witham, Essex.
Telephone: Witham 3184. Telegrams: Parion, Witham

Wireless World

ELECTRONICS, RADIO, TELEVISION

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

APRIL 1957

In This Issue

VOLUME 63 No. 4

PRICE: TWO SHILLINGS

FORTY-SEVENTH YEAR OF PUBLICATION

Editorial, Advertising and Publishing Offices:
Dorset House, Stamford Street, London, S.E.1

Telephone:
WATerloo 3333 (60 lines)

Telegraphic Address:
"Ethaworld, Sedist, London".

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD. Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Iliffepres, Sedist, London." *Annual Subscription:* Home and Overseas, £1 12s. 6d. U.S.A. and Canada $5.00. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10 Corporation Street. *Telephone:* Coventry 5210. *GLASGOW:* 26B Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. OVERSEAS OFFICES: *U.S.A.:* 111 Broadway, New York, 6, N.Y. *Telephone:* Digby 9-1197. *CANADA.* 67, Yonge Street, Toronto, 1, Ontario. *Telephone:* Empire 6-0873

A service for all who need complete data on Mullard valves, tubes and semiconductor devices

The Mullard Technical Handbook is a loose-leaf publication, issued on a subscription basis and containing data sheets on all Mullard valves, tubes and semiconductor devices in current production.

From one to twenty pages are devoted to each type, data including: standard ratings, recommended operating conditions and performance figures for various applications, limiting values, characteristic and performance curves.

Subscribers receive supplementary or revised sheets automatically as they are issued and thereby have early intimation of new introductions.

At present the Handbook comprises four volumes with the following contents:—

VOLUMES I and IA
Data on current Receiving and Amplifying Valves. Cathode Ray Tubes. Crystal Diodes and Transistors. Photocells. Cold Cathode Tubes. Small Thyratrons. Miscellaneous and Special Tubes.

VOLUME 2
Data on earlier type Receiving and Amplifying Valves and Cathode Ray Tubes still in limited production for the maintenance of existing equipment.

VOLUME 3
Data on Power Valves for Transmitting and Industrial Equipment. Power Rectifiers. Large Thyratrons. Microwave Devices.

For full details of this service, including subscription rates and application form, write to the address below.

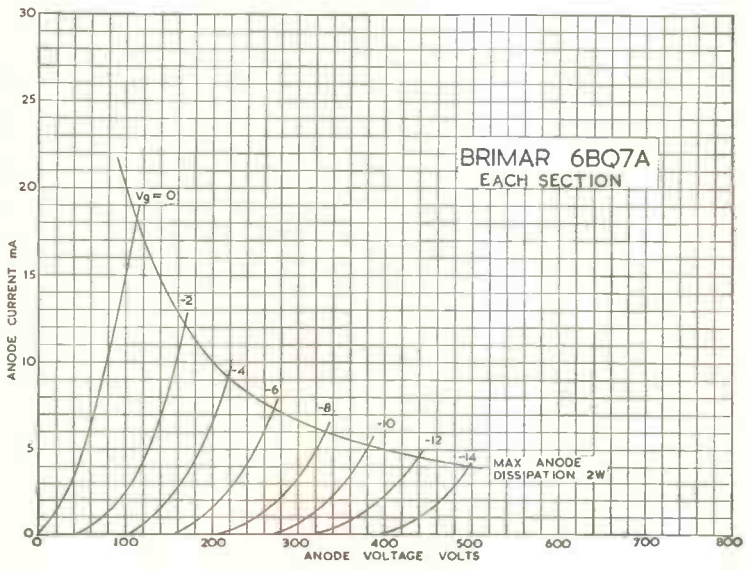
Mullard

Mullard Limited, T.S.D., Data and Publications Section, Mullard House, Torrington Place, London, W.C.1.

Mullard

BRIMAR 6BQ7A

The Brimar 6BQ7A is a double triode consisting of two independent high slope sections with similar characteristics. The valve is particularly useful as a cascode R.F. amplifier for television receivers and also as a combined oscillator and mixer for frequency modulation receivers. It can, of course, be used wherever high slope triodes are required, and features low interaction between the sections as an internal screen is provided which is brought out to a separate base pin.



Cut this out for further reference or write to the Publicity Department at Footscray for a data sheet.

Name .....

Address .....

.....

W.W.

TYPICAL CHARACTERISTICS

Anode voltage	150 volts
Cathode bias resistor	220 ohms
Anode current	9 mA
Mutual conductance	6.4 mA/V
Amplification factor	39
Anode resistance	6,100 ohms
Grid cut-off voltage (I_a — 10μA)	—10 volts approx.

"BELLING-LEE" NOTES

In a difficult position, the difference between the quality of these two pictures can be a distance of less than half a wave length, i.e., from one corner of a chimney to the other.

The band III and band I aerial story is coming to a head in Scotland.

The band III test transmitter is in position at Blackhill, near Kirk-o-Shotts, and it is expected that it will be "on the air" by very early March. There is, of course, a lot of interest; we are conducting a lecture tour in the service area with an automatic film strip in colour. This has been shown to three hundred dealers in Edinburgh, a hundred and fifty dealers in Stirling and five hundred in Glasgow. We have still to go to Dundee but this tour will have been completed by the time you read this.

It is only too obvious that dealers or aerial riggers seldom have the time to ensure that the aerial chosen is the best one for the location, or to ensure that it is placed in the optimum position; even if they had the time, only too few viewers would pay for it. It is because most of the aerial installation jobs we undertake, come into the V.I.P. class where results must be obtained regardless of cost, that we are able to give a satisfactory picture in the most unlikely places. It may be difficult to believe that moving an aerial half a wavelength can make all the difference in a difficult case, but it does. It is indeed fortunate that there are millions of aerials in use in areas of strong signal and where you can take tremendous liberties, but when up against a "sticky" job remember some of the things we have written about so often.

Probably the most important of these is the probing of the site to find the best picture. In the case of a reflecting object so close to the aerial that the delay is negligible, no displacement will be noticeable. The reflection can in fact add to the direct signal, giving an improved picture, or subtract from it, giving a poor, weak picture. The distance between the best position and the worst is less than half a wavelength.

There will be a lot of awkward spots within the service area of Blackhill. Try hard to get the test signal, that will give you direction, and from there build up knowledge and with knowledge comes confidence. If there is a good clean picture from the test transmitter, go ahead confidently, but if the picture is weak and noisy, go very carefully, there may be ghosts camouflaged in the noise, and they may become very obvious when the background noise disappears with the advent of increase of power.

We were asked why we claimed only 5½ dB for a three element array. Our answer was that the figure given was the average from many measurements. All our measurements are based on a dipole cut to the same frequency. This is the accepted method used by engineers, and the figure agrees with what you would expect in theory. We know the figure is correct, and that the aerial compares favourably with those of our competitors, and we really cannot enter into arguments about figures claimed by others.

If you are one of the fortunate people who receive an invitation to visit the Component Show at Grosvenor House in May, be sure to look us up. Owing to space restrictions we will only show a token aerial display—after all it is a components exhibition and most visitors are more interested in components than aerials. Nevertheless, if you have a private aerial problem, bring it to us. There will be someone around who will be glad to help you. We always feel that we learn a lot from questions on such occasions.

Vortexion

NEW MINIATURE 10-15 WATT AMPLIFIER

and versatile Pre-amplifier for tape (direct from heads), microphone, radio and gramophone.

It measures only 4½" x 5" over the front panel and projects 10½" to the rear.

These small dimensions are obtained by using "C" core material for the transformers, giving extremely low intermodulation distortion and less than 0.1% harmonic distortion at 10 watts output.

Low value grid leaks are used on the output grids to prevent runaway.

The main amplifier response is level 15 c/s to 50,000 c/s within 0.2 db. Separate inputs are provided for tape, microphone, radio and gramophone, and the 10 position selection switch also selects the right replay characteristic for different speeds of tape and different types of records. An extra low noise stage is provided for tape replay to permit working direct from all normal heads without additional amplification.

Extra power is available for a radio feeder, etc., of 50 **mA** at 300 volts and 6.3 volts at 2.5A balanced.

Other VORTEXION products at the Audio Fair

The well-known professional quality
TAPE RECORDERS types 2A and 2B

The type "B" recorder has an additional amplifier and head by which the signal recorded on the tape can be monitored a fraction of a second later, and compared by the turn of a switch with the pre-recorded signal. This saves time since the tape can be proved whilst the recording is in process without the need for a run through afterwards before performers depart.

It is also possible to listen to a previous recording and record additional commentaries on top of the first, or re-record the original a fraction of a second later to form an echo. The unit may be used as a high fidelity amplifier alone.

Both models have built-in microphone transformers for 30 ohm line and are loaded by 7 microvolts, which is approximately equal to normal voice at 20 feet from the microphone, the cable of which may easily be 440 yards in length of ordinary twin or twin screened cable. Radio/gram inputs are also provided and monitoring is by means of a meter which can be switched to read the level of bias. The accurate bias level ensures a response of plus or minus 1½ db with minimum distortion at all times and the metering may be used as a guide to mains voltage to to compensate for head wear after many thousands of hours' use.

A 50 cycle POWER PACK is available to operate the synchronous motor recorder from a 12 volt car battery and provides accurate tape speed.

VISIT OUR DEMONSTRATION ROOM

No. 145

See and hear our products at **THE LONDON**

1957 AUDIO FAIR

APRIL

12 · 13 · 14 · 15

Waldorf Hotel, London, W.C.2.

4-CHANNEL ELECTRONIC MIXERS 3-CHANNEL MIXERS and PEAK PROGRAMME METERS

Used by broadcasting and other studios, at home and overseas, these are known for their low noise, low distortion and freedom from break through.

AMPLIFIERS: 30, 50 and 150 watts

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 **Telegrams: "Vortexion, Wimble, London."**

Britain's finest Hi-Fi Equipment

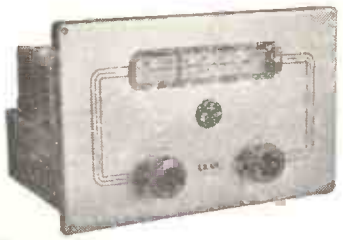
It was in 1945 that H. J. Leak revolutionised the performance standards for audio amplifiers by designing the original "Point One" series, and we became the first firm in the world to market amplifiers having a total distortion content as low as 0.1 per cent. This claim was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and since then hundreds of TL/12 amplifiers have been used by the B.B.C., and Commonwealth and foreign broadcasting authorities, and thousands have been used by recording studios, leading musicians and music-lovers throughout the world.

Further development work resulted in our producing, at a much lower price but with the same high performance standards, the TL/10 amplifier. The output of the TL/10 is ample for high fidelity home music systems, and the quality of reproduction obtained is equal in every respect to that of the TL/12. We always use the TL/10 amplifier and "Point One" pre-amplifier for our public demonstrations of high fidelity reproduction of gramophone records and radio. The TL/10 amplifier, when used with the best available complementary equipment, gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price. Even when the complementary equipment falls below that of the best obtainable the use of these amplifiers will enable one to obtain very marked improvements in reproduction.

An Important Test Report . . .

Independent laboratory tests of the Garrard 301 transcription turntable were recently carried out by Audio Instrument Company Inc., New York, U.S.A., under the direction of Mr. C. J. Lebel (Chairman of one of the groups which prepared the NARTB Standards). It was necessary that the pick-up and amplifier system should conform in response to the RIAA-New AES-New NARTB response curve within ±1 db, and in the tests of this excellent transcription unit the components selected for use were a Leak tone arm fitted with Leak cartridge and a complete Leak pre-amplifier and power amplifier Model TL/10.

The full test report appeared in the February, 1957, issue of "Wireless World," pages 22 and 23.



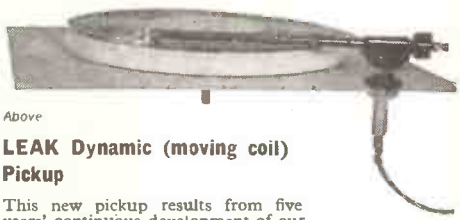
LEAK TROUGH-LINE F.M. Tuner, £25
plus 10 gns. P.T.

A Trough-line inductor and AFC eliminate drift. Very high sensitivity for fringe area listening. Quieting control plus high fidelity discriminator. Cathode-follower output. Self powered to operate with any amplifier.

LEAK TL/10 10-watt Amplifier, 17gns. and "Point One" Pre-amplifier, 10gns.

Prices made possible only by world-wide sales

Harmonic Distortion 0.1% 1,000 c/s, 7.5 watts output.



Above

LEAK Dynamic (moving coil) Pickup

This new pickup results from five years' continuous development of our first moving-coil design. Reports from users have justified our earlier belief that the pickup might earn recognition as the best in the world.

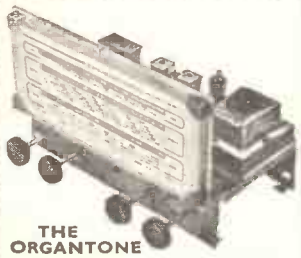
Leak dynamic pickup: Arm	**...£2/15/-**	**p.t. £1/3/1**
LP head with diamond stylus	**...£5/15/-**	**p.t. £2/8/4**
78 head with diamond stylus	**...£5/15/-**	**p.t. £2/8/4**
Mumetal cased transformer	**...£1/15/-**	

FREL is the trade name of the Leak Full-range Electrostatic Loudspeaker which will be available to the public in 1957. The design is original and has great theoretical and practical advantages over previously described electrostatic loudspeaker systems. It is the result of intensive research and development work carried out by H. J. Leak, M.Brit.I.R.E., and A. B. Sarkar, M.Sc., who are the authors of a paper, describing the basic design principles of this loudspeaker, which was published in the "Wireless World," October 1956. A reprint of this paper will be supplied on request.

LEAK . . . *the first name in High Fidelity*

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3, ENGLAND

Telephone: SHEpherds Bush 1173/4/5 *Telegrams: Sinusoidal, Ealux, London* *Cables: Sinusoidal, London*



THE ORGANTONE

5-Valve 3-wave band superhet covering long, medium and short wave.
Osram miniature valves are employed and low loss iron cored coils account for an excellent signal-to-noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages.
The output stage utilises variable negative feedback. A gram. position is provided and reproduction of records is particularly good.
Chassis size is 12×7×7in.—scale size is 10½×4½in. This receiver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results. Price £11/10/- carriage, etc., 7/6. Or £2 deposit and seven monthly payments of £1/10/-. Carr., etc., 7/6.

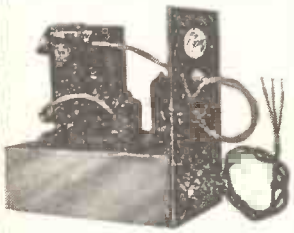
CHASSIS ASSEMBLY

Three-colour 3-waveband scale covering Standard, Long, Medium and Short wavebands, scale pan, chassis, punched for standard 5-valve superhet, pulley driving head, springs, etc., to suit. Scale size 14½×3½in. Chassis size 15×5×2in. deep. Price 15/- plus 1/6 post. Note: We can supply cabinet for this, 39/6 and 5/- p. and p.

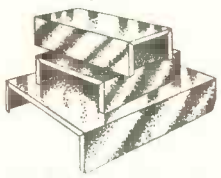
BAND III PRE-AMP

In difficult areas it will be necessary to increase the signal level and this is the ideal unit for this purpose. It is A.C. mains operated and is fitted with input and output coax. plugs. Price £4, post and packing 3/6.

E.H.T. GENERATOR



This is a made-up unit, power consumption (6.3 volt 8 amp. filament and approx. 59 mA. H.T.) Contains three BVA valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6½×4½×7in. Price 69/6, post, packing, etc., 5/-.



BLANK CHASSIS

18 S.W.G. Aluminium

7×3½×2	3/9	14×10×3 ..	7/9
9½×4½×2½ ..	5/-	16×10×3 ..	8/3
10×8×2½ ..	5/6	16×12×3 ..	8/8
10×5½×2½	5/-	19½×9×2½ ..	8/3
12×9×2½ ..	7/-		
14×9×2½ ..	7/6	20×10×3 ..	10/-

THE "CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:

- **Ferrite Rod Aerial.**
- **Low consumption valves (DK96 range).**
- **Superhet circuit with A.V.C.**
- **Ready built and aligned chassis if required.**
- **Beautiful two-tone cabinet.**
- **Guaranteed results on long and medium waves anywhere.**

All parts, including speaker and cabinet, are available separately or if all ordered together the price is £7/15/- complete. £1/15/- deposit and seven monthly payments of £1. Post and insurance 3/6. Ready built chassis 30/- extra. Instruction booklet free with parts or available separately 1/6.

RECORD PLAYER FOR £4/10/-.

3-Speed Induction Motor.

3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side.

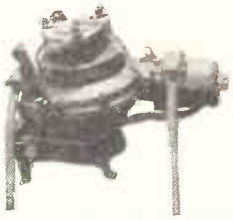
HI-FI PICK-UP

Using famous Cosmocord HI-G turnover crystal. Separate sapphire for each speed.

SPECIAL SNIP OFFER THIS MONTH

The two units for £4/10/-, or 30/- deposit and four payments of 18/-, post and insurance, 5/-. **Or fitted upon base, as illustrated,** £5/10/-, plus 7/6 post and insurance.

UNITS FOR CONTROLLED AUTOMATIC ROTATION



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

W.D. CIRCUIT DETAILS

Diagrams and other information extracted from official manuals. All 1/6 per copy, 12 for 15/-.

American Service Sheets	R.109 78 receiver
A.1134	76 receiver
BC.348	B28/ARC5
BC.312	R1116/A
R.103A	RA-1B
B.C.342	AB88D
RA-1B	AN/APA-1
R-208	78
R-1155	76
R-1124A	R.T.18
R-1132A/R-1481	CAY-46-AAM-RADAR
R-1147	A.S.B.-3.
R-1224A	Indicator 62A
R-1082	Indicator A.S.B.3
R-1355	Indicator 62
B.C.1206-A/B	Indicator 6K
B-455-A (or -B)	R.F. unit 24
B-454-A (or -B)	R.F. unit 26
B-453-A (or -B)	R.F. unit 25
Transmitter T1154/ B.D.J.N.	R.F. unit 27
Fifty-eight walkie-talkie	Wireless set No. 19
Frequency meter B.C.221.	Demobbed valves

T.V. Commercialising Outfit

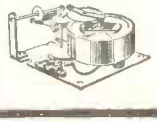
DO IT YOURSELF IT'S REALLY QUITE EASY

You will manage it in an evening and we guarantee

SUCCESSFUL RESULTS OR MONEY BACK

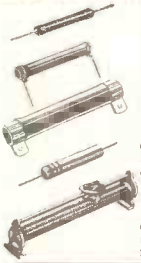
Our parcel contains: *I.T.A. Aerial, 36ft. I.T.A. Down Lead, I.T.A./B.B.C. Interference Eliminator, I.T.A. Converter.*

A special bargain price for all the above items if bought together is £8/10/-. Or £1/10/- down and 8 monthly payments of £1. Post and ins. 4/6. Full details with illustrations 1/6.



METER MOTORS

These are very small A.C. mains operated motors which have many applications for driving toys or other light loads. All are in good condition, but not new, having been stripped from electric light meters.
Price 8/6 each. Post and insurance 2/-.

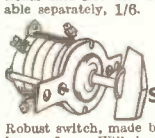


RESISTORS

High stability types from ¼-watt to 2-watt. Wire wound vitreous covered wire ended up to 20-watt. High powered types up to 150-watt mostly clip-in. Insulated and non-insulated carbon types preferred values. High and low powered variable types. Big stocks available — send details of your requirements.

MINI-RADIO

Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown Bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/10/-, plus 3/6 post. Constructional data free with the parts, or available separately, 1/6.



30 AMP ROTARY SWITCHES

Robust switch, made by one of our most famous firms. Will give lifetime of service. Price complete with pointer knob. 4 pole change over, 10/-. 6 pole change over, 17/6. D.P. on/off 15 amp., 4/6.

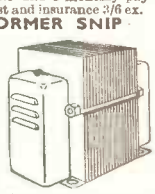
MULLARD AMPLIFIER "510"

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than .4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is £12/10/-. £1/10/- deposit and 6 monthly payments of £2, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

MULLARD PRE-AMP

In order to obtain the full output of the Mullard Amplifier a reasonably large input voltage is required. This voltage is available from crystal pick-ups but not from magnetic types nor is it available from most types of microphones. To overcome this, Mullard engineers have designed a Pre-Amplifier and this we are pleased to offer as a ready-made unit. It uses the low hum/noise high gain pentode type EF86. It takes its power supply from the amplifier and incorporates 2 switches to provide immediate compensation, for radio, microphone, L.P. and 78 records. The price of this unit is £4 or 15/- deposit and 8 monthly payments of 10/-. Post and insurance 3/6 ex.

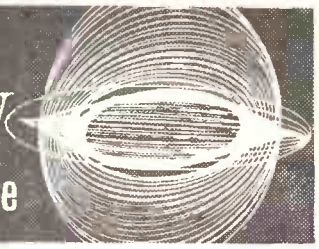
TRANSFORMER SNIP



Standard tapped mains input. Output 6.3 at 3 amp. 5 v. at 2 amp. and 350-0-350 at 80 milliamps. Ex-equipment but guaranteed perfect. 8/6 plus 2/6 post and packing. (Note this transformer is a half shrouded drop through type not stand up as illustrated.)

Champion High-Fidelity

unit equipment for the home



Champion proudly introduce the latest developments in HI-FI unit equipment

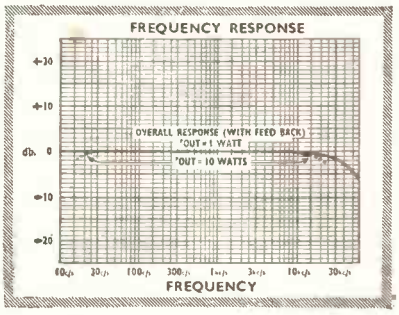
Model 853 Power Amplifier

The complete power amplifier for use with either of the 2 other models (853A or 854). It is supplied in a beautifully finished polished wood cabinet which can be placed on a side table or bookshelf and will blend harmoniously in any room.

TECHNICAL DETAILS

Maximum power output *11 watts.* Frequency Response: *at 1 watt within 1 db. 10 c/s —20,000 c/s—at 10 watts within 1 db. 30 c/s —15,000 c/s.*
Output impedance (Speech Coil): *15 ohm or 3.75 ohm.*
Mains Supply: *200-250 volts. 50-60 c/s A.C. or 100-130 volts. 50-60 c/s A.C.*

22 gns. NO TAX



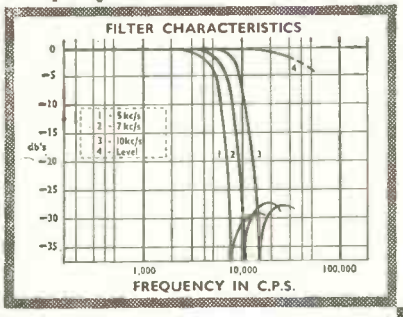
Model 853A Pre-Amplifier Control Unit

The Pre-Amplifier comprises a low noise, low distortion amplifier with tone controls and low pass filters. The first stage gives balanced compensation for five recording characteristics used by the leading recording companies in England and the U.S.A. This is effected by the use of frequency selective negative feedback. The tone control circuits give continuously variable control of both bass and treble frequencies.

TECHNICAL DETAILS

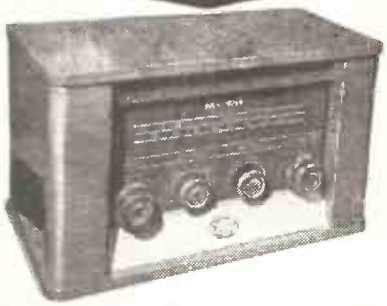
Input selector.
(1) *Tape/Radio Replay.*
(2) *R.I.A.A.*
(3) *A.E.S. and R.C.A. ORTHO.*
(4) *Col. L.P. and F.F.R.R.*
(5) *N.A.R.T.B. and H.M.V. L.P.*
(6) *British 78 R.P.M.*
(7) *Microphone.*
Treble and Bass Control.
Volume Control.
Low Pass Filter. *Switched 10 K c/s. 7 K c/s. 5 K c/s level.* Dimensions *15" x 4¼" x 4¼".*

18 gns. NO TAX



The new Champion High-Fidelity Equipment is designed to bring to every home where music is enjoyed and appreciated, a new conception of listening. In ultimate form High-Fidelity is reproduction exactly as the artist recorded it.

Model 854 Pre-Amplifier and F. M. Tuner



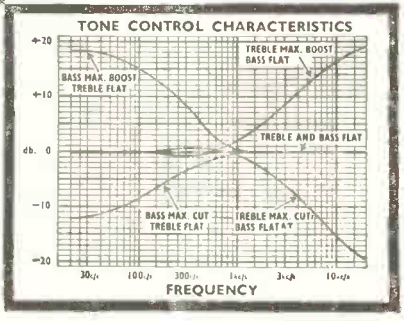
The Master Control comprises a low noise, low distortion tone control pre-amplifier and a sensitive VHF/FM tuner covering the frequency range 88-95 Mc/s, housed in a handsome polished wood cabinet matching the Main Amplifier Model 853.

TECHNICAL DETAILS

Input Selector.
(1) *Mains OFF Switches off mains to Power Supplies in Model 853.*
(2) *FM Tuner.*
(3) *L.P. Records,*
(4) *78 Records,*
(5) *Tape/Radio Replay,*
(6) *Microphone,*
Volume Control.
Treble and Bass Controls.
Tuning Control.
Tuning Indicator,
Magic Eye. Mullard EM 81. Dimensions *15" x 8½" x 9½".*

33 gns. INC TAX

£25.0.4 + £9.12.8 P.T.



1957 AUDIO FAIR

APRIL 12, 13, 14, 15
Waldorf Hotel,
London, W.C.2

Stand No. 50
Demonstration
Rooms 237, 238

With the Champion High-Fidelity you will become aware of a new excitement in music; surprised and delighted to hear with extraordinary realism your favourite works, which before lacked clarity.

Champion
ELECTRIC CORPORATION
London Office & Showrooms: 8 Eccleston Street, S.W.1
Works: Newhaven, Sussex

AMERICAN MULTI-RANGE TESTMETERS

1,000 ohms per volt, 400 microamp basic movement. Ranges as follows: A.C. and D.C. volts, 0 to 5,000 volts in 6 switched ranges. D.C. current, 1ma., 10ma., 100ma. and 1 amp. Resistance measurement from .1 ohm to 1 megohm. Decibels from −10 db to +15 db.
The instrument is housed in a polished wood case, complete with leather carrying handle, test prods and battery. Guaranteed perfect order and tested before despatch. Price **£5/19/6** each.

MAINS NEON PANEL INDICATORS. Chrome escutcheon. 200/250v. Red, amber or clear, **3/9** each.

460 kc/s B.F.O. UNITS. Brand new and complete with 1S5 valve, fully screened in aluminium case, only **8/6** each.

EDDYSTONE POWER UNITS. 200/250 volts input. Output 175 volts 65ma., and 6.3 volts 3 amps. Fully smoothed, 5Z4 rectifier, **32/6** each.

SMOOTHING CHOKES
ALL NEW AND UNUSED

G.B. 20h. 175ma., **10/6**; Parmeko 8H. 250ma., **10/6**; Parmeko 9h. 100ma., **7/6**; Parmeko 8h. 50ma., **5/6**; Parmeko C core, 4h. 22.5ma., **4/6**; Collins 8H. 100ma., **8/6**; Parmeko swinging choke, 3.6–4.2H. 250ma. 20H. no D.C., **10/6**; 15H. 60ma., **5/6**; STC 10H. 60ma., **4/6**.

MARCONI CRYSTAL CALIBRATOR
Frequency coverage 170/240 mc/s. Directly calibrated, accuracy .001%. Operation 200/250 volts A.C. Supplied complete with 5 mc/s crystal and spare set of 5 valves, in original transit case, brand new with instructions. **£4/19/6** each.

SURPLUS SPEAKER BARGAINS
All new and unused
Elac 5in. 3 ohm, **17/6**; Elac 6½in. 3 ohm, **17/6**; Elac 8in. 3 ohm, **19/6**; Elac 10in. 3 ohm, **27/6**; ROLA 7X4 elliptical 3 ohm, **18/6**; Plessey 2½in. 3 ohm, **16/6**; Plessey 10X7 elliptical 3 ohm, **27/6**; Goodmans 3½in. 3 ohm, **17/6**; Std. pentode o/p transformer, **4/6**.

A.C. MAINS BLOWER MOTORS

220/230 volt 300 watts. 1½in. diameter outlet. Housed in metal box and fitted with dust filter pads. Supplied complete with 4 spare filters, 2 way outlet adaptor and 2 lengths of hose. Brand new only **£4/19/6** each.

GERMANIUM CRYSTAL DIODES. ONLY **10d.** R.E.P. dual range crystal coil with circuit, **2/6**. .0005mfd. air spaced tuner, **3/6**. 2,000 ohm headphones, **12/6** pr.

ELECTROLYTIC CONDENSERS. All new stock
8mfd. 150v. **1/-**; 8mfd. 450v. **1/9**; 8X8mfd. 450v. **3/6**; 8X16mfd. 450v. **3/6**; 8X16mfd. 500v. **4/3**; 16mfd. 450v. **2/9**; 16mfd. 500v. **3/3**; 16X16mfd. 450v. **3/6**; 16X16mfd. 500v. **4/3**; 30mfd. 450v. **3/3**; 32X32mfd. 350v. **4/3**; 32X32mfd. 450v. **4/6**; 64X120mfd. 275v. **3/6**; 100X200mfd. 350v. **7/6**; 40mfd. 450v. **3/9**; 50X50mfd. 275v. **3/9**; 25mfd. 25v. **1/9**; 50mfd. 50v. **1/9**; 100mfd. 25v. **1/3**; 250X250 mfd. 6v. **2/6**; 500mfd. 12v. **1/3**; 6,000mfd. 6v. **3/6**; 1000+2000mfd., 6v. **3/6**; Ceramic/mica 1pf–.005mfd. **6d.** Paper .01mfd.–.1mfd. **9d.**; 25 **1/-**; .5 **1/3**.

TP-7 REPEATERS

Few only of the above equipment in stock in new condition. Enquiries invited.

AMERICAN ROTARY GENERATORS

Input 12 volt D.C. Output 250 volts 80ma. Fitted with blower attachment which can be easily removed if desired. Brand new **22/6** each. Ditto with 6 volt input **22/6** each.

EX-NAVY SOUND POWERED TELEPHONES

This type requires no batteries to operate. Fitted with hand generator for calling giving a high pitch note. Can be fitted anywhere. Ideal for factories, offices, field activities, etc. Only **45/-** each.

MODULATOR 67

These bargain instruments contain a COMPLETE A.C. MAINS POWER PACK, input 230 volts 50 cycles. Output 350 volts. 120ma. and 6.3 volts 5 amps. Choke and condenser smoothed and uses 5Z4 rectifier. (Transformer actually 200 ma.) Also included in the unit are 11 other valves, 5 SP61, 1 VR116, 2 EB34 and 3 EA50, and many other useful components, pots, resistors, switches, etc. Size of case 18 x 9 x 7in., which is finished in grey. Supplied brand new, **49/6** each.

EXPLODERS-CONDENSER-DYNAMO MK1

This unit was designed for detonating an explosive charge but can be used alternatively as a portable photo flash generator, the advantage being that no batteries are required. Operation is by hand generator supplying A.C. pulses, stepped up through a transformer, rectified by 2 J 50 recs and a final charge is developed across a 6mfd. paper condenser of 1,800 volts. A neon indicates when charged, press button to fire. Supplied brand new with circuit, **£3/19/6** each.

AMERICAN GEARED MOTORS

American 24 volt D.C. motors with built-in precision gearbox giving twin outputs 20 r.p.m. and 6 r.p.m. Will also operate on 12v. giving reduced outputs. Size 7in. x 1⅞in. Shaft dia. ¼in. Supplied brand new only **29/6** each.

AMERICAN BEACON TRANSMITTER/RECEIVERS

RT 37/PPN-2. Brand new and boxed, complete with instruction book. Equipment comprises transmitter/receiver with 9 valves (5 3A5, 3 1S5 and 1 1R5), with built-in 2v. vibrator power pack, spare vibrator, headset, connector leads and 10ft. collapsible aerial. Frequency coverage 214/238 mc/s. Price **72/6** each.

VARIAC TRANSFORMERS

Input 220/240 volt A.C. 50 cycles. Output variable 200/240 volts A.C. 7.5 amps. Price **92/6** each. Also 0-250 volts output 20 amps., **£25** each.

WANTED

COMMUNICATIONS RECEIVERS, TEST EQUIPMENT, VALVES ETC., highest cash prices paid.

3 cm. SIGNAL GENERATORS. Complete with 11 valves and klystron. Price **£6/19/6** each. For callers only.

MARCONI SIGNAL GENERATORS

Model TF390G. Frequency coverage 16-150 mc/s. 200/250 volt A.C. operation. Supplied brand new in original transit case, complete with calibration charts, **£25** each. Also TF-144 85kc/s-25 mc/s. Supplied fully overhauled, guaranteed, **£75**. Marconi Valve Voltmeters TF-428B. Brand new, **£25**. Marconi "Q" meters, fully overhauled, guaranteed, **£75**

P/O RELAYS AND KEY SWITCHES Extensive stocks available at "CHEAP" prices. All enquiries welcomed. Special American relay offer. Typel. 3,500 ohm coil, 1 pr. changeover contacts, 12v. 6ma., **5/6**. Ditto 6,500 ohms, 2ma., **6/6** each.

DEAF AID EARPIECES. Brand new, 30 ohm resistance, **3/6**. Leads **1/-**. 1 meg. pots w/switch, **1/-**. Output transformer, **2/6**.

AMERICAN MULTI-RANGE TESTMETERS

Precision series, fitted with the larger 4½" meter 1,000 ohms per volt. Ranges as follows: A.C. and D.C. volts 0-6,000 volts. D.C. current 0-12 amps. Resistance 0-10 megohm. Six output ranges and six DB ranges −12 to +78 DB. Supplied brand new in wooden carrying case complete with leads and instructions, **£8/19/6** each.

METER BARGAINS

0/100 μamp. 2½in. F.M.M.C.	39/6
0/1.5 amp. A.C./D.C. 2in F.M.M.I.	6/6
50 M/amps. 2in. F.M.M.C.	7/6
150 M/amps. 2in. F.M.M.C.	6/9
200 M/amps. 2½in. F.M.M.C.	9/6
1 amp. R.F. 2½in. P.J. T.C.	5/–
4 amp. R.F. 2in. F.M.T.C.	5/–
300 volt D.C. 2in. F.M.M.C.	10/6
300 volt A.C. 2½in. F.M.M.I.	25/–
500/0/500 microamp. 2½in. F.M.M.C.	25/–
20/0/20 amp. Lucas, car type.	8/6

ALL NEW AND UNUSED

2m/a meter rectifiers, S.T.C.	5/6

VALVE BARGAINS

Large stocks held. Few examples:
5V4 **8/6**, 6AG5 **3/6**, DK96 **9/6**, EY51 **10/6**, EF86 **12/6**, 6V6 **6/6**, DL96 **9/6**, EF80 **10/6**, EL84 **12/6**, 5U4 **8/6**, 6X5 **7/6**, PX25 **15/6**, DF96 **9/6**, ECF80 **12/6**, EZ81 **10/6**, 6H6 **1/9**, 6SN7 **6/6**, DAF96 **9/6**, ECF82 **12/6**, ECC83 **10/6**, 6J6 **3/6**, KT66 **12/6**, DF91 **7/6**, ECC84 **12/6**, ECL80 **11/6**, 2D21 **10/6**, VU111 **1/9**, EF39 **5/6**, ECH42 **10/6**, ECH81 **10/6**, EF37A **10/6**.
ALL NEW AND GUARANTEED

MUIRHEAD KEY SWITCHES. Brand new, 8 pole changeover, **4/6** each.

A.C./D.C. MAINS TESTMETER. 3½-inch moving iron meter in wooden box complete with leads, 0-300 volts, **29/6** each.

COSSOR DOUBLE BEAM OSCILLOSCOPES

Model 339A. 200/250 volt A.C. operation. Supplied in perfect working order **£27/10/0** ea.

POWER UNIT 234

A complete A.C. mains power unit in grey metal case for 19in. rack mounting. Input 200/250 volts A.C. Output 250 volts 150 m/a. and 6.3 volts 6 amps. Double choke and condenser smoothed. Fitted with 2½in. moving iron meter for measuring A.C. input and D.C. output volts. Price **69/6** each.

R.S.C. BATTERY CHARGING EQUIPMENT

ASSEMBLED CHARGER
6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads, Double Fused. Only **47/9**

Carr. 3/6.

ASSEMBLED CHARGERS

6 v. 1 amp.	19/9
6 v. or 12 v. 1 amp.	25/9
6 v. 2 amps.	29/9
6 v. or 12 v. 2 amps.	38/9
6 v. or 12 v. 4 amps.	59/9

Above ready for use. Carr. 2/9.

HEAVY DUTY KIT
12 v. 30 amp. Suitable for garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers. 2 Meters. 4 Fuses. 4 Terminals. 2 Rheostats and circuit. Only 9 gns. Carr. 15/-.

BATTERY CHARGER KITS
Consisting of Mains Transformer F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp.	22/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 4 amps.	53/9

BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

All for A.C. MAINS 200-250v., 50 c/s. Guaranteed 12 months

Assembled 6 v. or 12 v. 4 amps.
Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. **75/-** Ready for use with mains and output leads. Carr. 3/9.

SELENIUM RECTIFIERS

L.T. Types		6/12 v. 6 a. ..	19/9
2/6 v. ½ a.h.w.	1/9	6/12 v. 10 a. ..	25/9
6/12 v. ½ a.h.w.	2/9	**H.T. Type H.W.**	
F.W. Bridge Types		120 v. 40 mA.	3/9
6/12 v. 1 a. ..	4/11	250 v. 50 mA.	5/9
6/12 v. 2 a. ..	8/9	250 v. 80 mA.	7/9
6/12 v. 3 a. ..	11/9	250 150 mA. ..	9/9
6/12 v. 4 a. ..	14/9	300 v. 250 mA.	12/11

CO-AXIAL CABLE. 75 ohms. ¼in., 8d. yard Twin screened feeder, 11d. yard.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yd.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 6/9 doz. 2.5 v. 0.3 a. 3/9 doz.

ELECTROLYTICS (current production). NOT Ex Govt.

Tubular Types		Can Types	
8 mfd. 450 v. ..	1/9	16 mfd. 350 v.	1/11
8 mfd. 500 v. ..	2/6	16μF 450 v. ..	2/9
16μF 350 v. ..	2/3	16 mfd. 500 v.	3/9
16μF 450 v. ..	2/9	32μF 350 v. ..	2/11
16μF 500 v. ..	3/9	32 mfd. 450 v.	4/9
8-16μF 500 v.	4/11	100 mfd. 450 v.	4/9
25μF 25 v. ..	1/3	8-8μF 450 v. ..	2/9
50μF 12 v.	1/3	8-16μF 450 v.	3/11
50 mfd. 25 v. ..	1/9	16-16μF 450 v.	3/11
50μF 50 v.	1/9	32-32μF 350 v.	4/9
100 mfd. 12 v.	1/9	32-32μF 450 v.	5/9
100 mfd. 25 v.	2/3	100-100 mfd. 350 v.	5/9
3,000 mfd. 6 v.	3/9	64-120 mfd. 350 v.	7/6
6,000 mfd. 6 v.	3/11	100-200 mfd. 275 v.	6/11

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9, plus 2/9 post.

EX GOVT. METAL BLOCK PAPER CONDENSERS

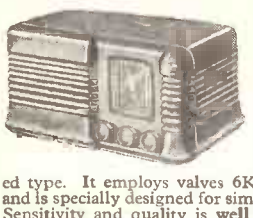
4 mfd. 500 v. ..	2/3	10 mfd. 500 v...	4/9
4 mfd. 1,000 v.	3/9	8-8 mfd. 500 v.	5/11
8 mfd. 500 v...	4/6		
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137, EA50, EB34, 11d.; SP61 2/3; VS110 1/11; 6J5 3/9; 6V6G, 5U4G 6/9; 35Z4, 6X4 5/9; EZ80, EF80 7/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G, etc., trans., L.F. choke, Rectifier, etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6.

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated above or walnut veneered type. It employs valves 6K7, SP61, 6F6G. and is specially designed for simplicity in wiring, Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

EX GOVT. MAINS TRANSFORMERS

All 230 v. 50 c/s. input	
120-0-120 v. 40 mA.	5/9
250-0-250 v. 60 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4½-3½-3in.	11/9
460 v. 200 mA., 6.3 v. 5 a.	22/9

HEAVY DUTY OIL FILLED MAINS TRANSFORMERS
Suitable welding or soil heating. With input of 200-250 v. 50 c.p.s., output is 12 v. 80-100 amps. Only £6/19/6, carr. 7/6.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-240-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a., 5 v. 3 a., 33/9. Drop through type 250-0-250 v. 70 mA. 6.3 v. 3 a., 11/9. Postage on either type 2/9.

EX GOVT. SMOOTHING CHOKES

250 mA., 5 H., 50 ohms.	12/9
250 mA., 3 H., 50 ohms.	8/9
150 mA., 10 H., 50 ohms.	10/11
100 mA., 10 H., 100 ohms, Parmeko	6/9
100 mA., 5 H., 100 ohms., Tropicalised	3/11
50 mA., 50 H., 1,000 ohms.	6/9
L.T. type 1 amp., 2 ohms.	2/9

EX-GOVT. CASE. Well ventilated, black crackle finished, undrilled cover. Size 14—10—8½ins. high IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.
SPECIAL OFFERS. Small 2 gangs .0005 mfd., 4/9. Electrolytics 32-32-32 mfd. 250 v. 2½ × 1⅜ins., 2/9 each or in lots of six, 2/3 each.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is avilable. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams, 39/9. or ready for use, 46/9.

Type BM2. Size 8 × 5½ × 2⅝in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T.2v.ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions 49/9 or ready for use 59/6.

MINIATURE MOTORS. 24/28 v. D.C. or A.C. Size only 2¾ × 1⅝ins. Spindle 1⅛ins. long, ⅛in. diam. Made by Hoover Ltd., Canada. Price only 9/9.
VIBRATORS. Oak 2 v. 7 pin. synchronous, 7/9.
M.E. SPEAKERS. 2—3 ohms R.A. 8in. Field 600 ohms, 11/9

T.V. CABINETS. For 15 16 or 17in. tube. Table model with doors, 79/6 carr. 7/6.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a. c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a. c.t., 5 v. 3 a., suitable 450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5. v. 3 a.	69/6
Williamson Amplifier, etc.	49/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517	36/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a. ..	5/9	0-2-4-5-6.3 v. 6.3 v. 2 a. ..	7/6
4 a.			16/9
0-4-6.3 v. 2 a.	7/9	6.3 v. 6 a.	17/6
6.3 v. 3 a.	8/11	12 v. 3 a. or 12 v. 1 a.	7/9
24 v. 1.5 a.			17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries:
0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9;
0-3.5-9-17 v. 3 a., 17/9; 0-9-15 v. 5 a., 19/9;
0-9-15 v. 6 a., 23/9.

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v., 250 mA.	9/11

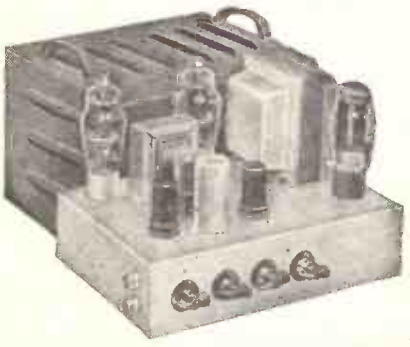
OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/6
Small Pentode 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Multi-ratio 40 mA. 30:1, 45:1, 60:1, 90:1, Class B Push-Pull	5/6
Push-Pull 8 Watts 6V6 to 5 ohms.	8/9
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms.	21/9
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type exact to spec.	85/-

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms.	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11

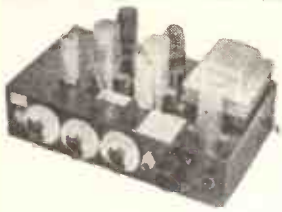
R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER



NEW 1956 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 30 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. Only **9** GNS. carr. 10/-. Or Factory built with 12 months' guarantee, 50/- extra. **TERMS ON ASSEMBLED UNITS** with extra input. **DEPOSIT** 28/9 and 9 monthly payments of 28/9. If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc. etc., can be simultaneously applied for mixing purposes. Extra cost of this 13/-. Cover as illustrated 17/6 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.** We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on terms with amplifiers.

EXPORT ENQUIRIES INVITED



R.S.C. TAI HIGH QUALITY TAPE DECK AMPLIFIER FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox, etc., or matched to low impedance erase heads as fitted latest COLLARO TAPE TRANSCRIPTOR. Chassis size 12-7-3in. Overall size 12-7-6½in. For 230-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response ± 3 D.B. 50-11,000 c/cs. Facilities for recordings at 15in., 7½in. or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST. LEAFLET 6d. **11** Ready for use GNS. Carr. 7/6.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. BRAND NEW. CARTONED. Only £3/19/6 (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down, 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v., 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with basplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-, carr. 3/6 or factory built 22/6 extra.

P.M. Speakers recommended for use with A7, A5 or L45 amplifiers.
Plessey 12in. 3 ohm, 29/11. 6½in. Celestion and Goodmans with high flux density magnet 19/9.

P.M. SPEAKERS. 2-3 ohm. 5in. Goodmans, 17/9, 7 × 4in. Elliptical, 19/6, 6½in. Goodmans wafer type 18/9. 8in. Rola, 19/9. 10in. R.A., 26/9. 12in. Plessey 15 ohms, 10 watts, 3 gns.

GARRARD 3-SPEED AUTOMATIC RECORD CHANGERS.
Latest Model Mixer Type RC110. Fitted high fidelity turnover crystal pick-up head with dual point sapphire stylus. Baseboard size 14 × 12½in., height above, 4in. Below, 2½in. For 200-250 v. A.C. mains. Limited number. Brand new cartoned. Only £8/17/6, plus 3/6 carriage.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with Garrard, B.S.R. or any other record playing unit, and most microphones. Total negative feedback 12 db. Separate Bass and Treble Controls. For convenience when mounted in cabinet, mains switch is incorporated in control. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size of unit only 6 × 5 × 5½in. high. Chassis is fully isolated from mains. Guaranteed 12 months. Only £5/19/6.

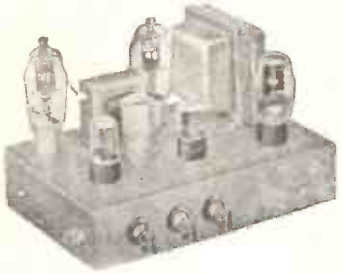
MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type, 50/-. Piezzo with heavy floor base and telescopic stem, £6/19/6.

ROTARY CONVERTERS. 200 watts. Input 12 v. D.C. Output 230 v. 50 c/cs. A.C. Only 7 gns. Carr. 7/6.

PLESSEY DUAL CONCENTRIC 12 in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker, of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A8 or any similar amplifier. Rating is 10 watts. Price only £5/17/6.

R.S.C. ULTRA LINEAR 12-WATT AMPLIFIER



NEW 1956 MODEL A8 HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL, PRE-AMP. STAGES

High sensitivity. Includes 5 valves (807 outputs), High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut"** Frequency response ± 3 db. 30-30,000 c/cs. Six negative feedback loops. Hum level 71 db. down. ONLY 70 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and practically all microphones Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied.

Unapproachable value at **£7/15/-** or factory built, 45/- extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6. Where an extra input socket with associated volume control is required for mixing purposes this can be provided for 13/- extra. **TERMS OF ASSEMBLED UNITS with extra input as mentioned above. DEPOSIT** 25/6 and nine monthly payments of 23/4.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. Mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs, and outputs for 3 and 15 ohm speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Carr. paid. Send S.A.E. for leaflet.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance, £4/10/9. Please state whether 3 ohm or 15 ohm required.

SUPERHET RADIO FEEDER UNIT

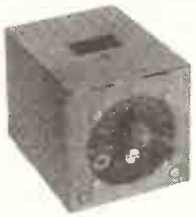
Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F., and double Diode Second Detector. Delayed A.V.C. Ae./Grid F/C Coupling is by bottom end Condenser Coupling giving freedom from alignment troubles when Ae. of varying lengths and capacity are used. Both Frequency Changers and I.F. valves are A.V.C. controlled from the very low distortion Double Diodes so arranged that very high Percentage modulation of the Transmitter can be handled without distortion. The Feed for the delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W., Ch., and Vol. Output will load most Amplifiers requiring 500 M.V. input depending on Ae. location. Only 250 v. 15 mA. H.T., and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-point wiring diagrams and instructions, 2/6.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1 Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m.

There is always a fine selection of equipment a



BEACON RECEIVER BC1206A

Covering 200–400 kc/s. Valve line up: 6K7 RF; 6SA7 frequency changer; 6SK7 I.F. amplifier; 6SQ7 det; 28D7 O/P.

This was designed to run on 24/28V d.c. HT/LT. Excellent basis for car radio; size 6in. x 5in. x 4in. Good working order. £3/5/– each, plus 5/– carr.

APQ.2. RADAR/JAMMING UNIT

Freq. 450–710 Mc/s. Containing 931a Photo Multiplier Cell complete with resistance network and light proof box. Wide band amplifier 2 6AC7, 1 6AG7, 2 388a. This unit is similar to the A.P.Q9 Jamming Unit. Brand new £5 plus 10/– carriage.

AN/APN.1 TRANSDUCER

This Unit consist of Magnet, and Coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. Mounted on a Ceramic cover which sits over the diaphragm is a form of 2-Gang capacitor which has a swing from 10-50 pF.

The above unit is used as part of Wobbulator described on page 252 of the June "Wireless World." PRICE 7/6 p.p.

DESYNN TYPE Antenna or Beam position indication

This comprises a Transmitter unit and Indicator which will operate on 12 or 24 volts D.C. and will indicate with instantaneous and smooth pointer movement. The Transmitter is a specially designed potentiometer and will operate the Receiver on a simple three-wire system and the receiver in this instance is calibrated in Gallons but dial could be easily altered to indicate a 360 Deg. sweep. Transmitter and Receiver with full instructions. Price 12/6 post paid.

TRANSMITTER Type T1131-L

Frequency 100 to 156 Mc/s. Output 50 W. Crystal controlled. 200-240 v., 50 c.p.s. Power supply. Housed in 6ft. standard on 19in. rack. In new condition complete with valves.

Send for full details

MINIATURE I.F. STRIPS

Size 10¾ x 2½ x 3in. Frequency 9.72 Mc/s. 2 EF.92s and 1 EF.91 I.F. amps. EB.91. DET/AGC. EF.91 AGC. Amp. and EF.91 Limiter. Circuit supplied.

Price 8/- less valves. Post paid.

WAVEMETER TYPE W.1310

Coverage 155 to 230 Mc/s. continuous, complete with Test Prod. Input 230 v. 50 cycles. New condition, £3/10/–, plus 7/6 carr.

STUD SWITCHES

20 segment 5/16in. studs, base 5in. square with handle and housing. New and boxed, 5/– each, plus 1/6 p.p.

SPECIAL OFFER—MALLORY VIBRATOR PACKS
12 volt, 150 volt 40 mA. Brand new and boxed, size 5½ x 5½ x 3in. 12/6 p.p.

ALTITUDE SWITCHES

(U.S. manufacture) containing a one pole 11-way 2 bank switch (Yaxley type) and 14 2.5 K ohms 1 watt resistors 10% contained in metal box 3in. dia. by 5in. long by 1¾in. skirted pointer knob. Brand new and boxed 4/– p.p.

3 cm. TEST SET

TYPE 263

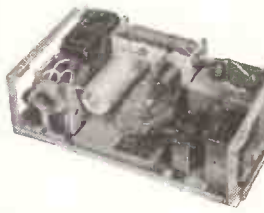
Containing transmission type w/meter complete with detector unit 9280–9480 Mc/s, attenuator unit, 2 coaxial to waveguide feeders, impedance matching unit, medium power dummy load, standing wave indicator with lock using CV.263 indicator valve, metered indicator unit, various connectors. Suitable for testing medium and low power radar installations. Price £20 carriage paid.

EDDYSTONE 358

COMMUNICATIONS RECEIVERS (B34)

Range 40 kc/s to 31 Mc/s covered with 10 plug-in coils; only 4 c available covering 1250–2100 kc/s, 2100–4500 kc/s, 4500–9000 k 9000–22000 kc/s. Selectivity: 2 kc/s at 2.5 db down; 5 kc/s at 35 down; 150 c/s. at 4 db down. Supply required: 6V 1.4 A; 175/20 65 mA. CIRCUIT: variable mu pentode H.F. Amplifier, Triode-Hex frequency changer, two I.F. Amplifiers (450 kc/s), A.V.C./Detector/A Amplifier, output stage, B.F.O. Valve check Meter.
£8/10/– with power supply. Plus £1 packing and carriage.

POWER UNIT Type 173



24 volt D.C. input, 120 v,. 60 mA. output. Containing Vibrator Transformer, 12 volt Vibrator, two 120 volt Selenium Rectifiers. Chokes and Condensers. Size 10½in. x 6in. x 3in. Price 12/6 post paid.

THE PERFECT BEAM ROTATOR

Cowl Gill Motors. These motors have a 4 stage (600 to 1) reduct gear. Tapped field. Size 12in. x 3¼in., drive end ½in. splined. Pr 25/– each p.p.

POST OFFICE COUNTERS

500 ohm, 4 figure no reset; size 5 x 1½ x 1in. 5/– each, p.p.

2in. MAGSLIPS

50 v. 50 cycle transmitter and receiver units. Accurate to 1/10th Guaranteed good working order, 35/– a pair, plus 3/– p.p.

R.F. UNITS

R.F. 24 20–30 Mc/s. Switched Tuning. Valved ..... 9/6 each

R.F.25 40–50 Mc/s. Switched Tuning. Valved ..... 9/6 each

R.F.26 50–65 Mc/s. Variable Tuning. Valved. Damaged dials .. 20/– each

Perfect dials ..... 25/– each

Packing and postage 3/– each type.

COMMUNICATION RECEIVER CG.46116

(General Electric U.S.A.) Highly sensitive receiver 1500 to 9000 (200–232 metres) continuous coverage with overlaps in 4 chan 3 .IF. stages, 2 R.F. stages and I.F. break-through trap. B.F.O. O/P. Valve line up: 5 12SK7s, 12K8, 12SR7, 12A6. Neon stat antenna circuit.
Fully valved £8/10/–, plus 10/– pack. and carr.

All these fine offers are on display at ➔

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1

MUSeum 5929/0095
(50 yards only from Tottenham Court Road Tube)
All post orders please to:—24-26, HAMPSTEAD RD., LONDON, N.W.1
EUSton 5533/4/5

THE JASON FM TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in m/cs., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. × 5in. Chassis 7in. × 4¼in. × 1¼in. Complete standard kit **£6/15/-** plus 2/6 P. & P. Fringe area kit **£7/15/-** plus P. & P.

FM POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is 37/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 × 4 × 1¼in. Optional extra for power pack. Bulgin Octal Plug 2/3.

THE T.S.L. FM TUNER!
We can now supply this FM/VHF adaptor either in kit form or fully assembled, wired and tested. Our price for the ready-built unit which incorporates its own power supply is **£13/15/-** only, tax paid, plus 5/- P. & P. or H.P. terms. Magic eye tuning indicator, just plug in, 19/- extra. Or the kit complete as specified **£10/19/6** plus 3/6 P. & P. The booklet "FM TUNER CONSTRUCTION" (32 pages) with full technical data and point-to-point wiring diagrams together with our separately priced parts list is available at 2/6 post free.

THE T.S.L. AM/FM CHASSIS! 1957 Model!
9-valve Superhet with F.M./VHF Band (4 wavebands). Push-pull output. Slow motion tuning drive. Full provision of Automatic Volume Control. Sockets provided for Aerial, Earth, Gram, Pick-up and Extension Speaker. Connections provided to Gram. Motor controlled by Chassis On/Off switch. The tone controls have been given an extra wide range to embrace all types of recordings. A.C. 200/250 volts, 50 cycles only. CASH £27/6/-. Packing and carriage 7/6. H.P. terms available. Demonstrations at 18 Tottenham Court Road.

INTRODUCING THE NEW T.S.L. FM TUNER UNIT
This compact unit with built in power supplies has been designed by craftsmen to standards which will satisfy the most critical enthusiast. Brief specifications: Valve line up: ECC85, 2-EF89, EABC80, 6X4 and EM80. Overall size: 10¼in. W. × 5¾in. H. × 6¼in. D. Dial size 10¼in. × 5¾in. Attractive plastic dial in Black and Gold with easy-to-read calibration. Controls: Switch, OFF FM & GRAM. and tuning. Pre-set gain control at rear of chassis. Connections: Co-axial output socket, 300 ohm aerial input socket and pick-up input socket on rear of chassis. Price **£17/10/-** plus 5/- P. & P.

THE DULCI FM TUNER. Incorporates own power supply, suitable for use with any amplifier. Valve line-up: ECC85, two EF89, EABC80, 6X4 and EM80 indicator! Overall size: 9 × 6 × 5¼in. high. Pre-Budget price **£16/16/-** plus 5/- P. & P. Illustrated leaflet available, also H.P. terms.

ANNOUNCING OUR NEW F.M. TUNER KIT! (printed circuit)
This is our printed circuit version of the Osram 912 F.M. Tuner—using T.C.C. printed circuit and condensers, incorporating 5 valves and two germanium diodes. Attractive black and gold dial, with gold escutcheon plate. Dial aperture only 5 × 2in. Osram F.M. booklet plus our additional instructions and individually priced components list—2/6 post free or the Kit absolutely complete at £3/8/- plus 2/6 P. & P. Alignment service available if required. We are demonstrating at 18 Tottenham Court Road!

TELEVISION TURRET TUNERS 12 CHANNEL—"TELENG"
We have six types now available from stock, to cover Bands I and III—fully illustrated and descriptive leaflet available on request. Each unit is fully aligned and thoroughly tested before despatch. Valves employed are PCF80, PCC84 for AC/DC and ECF80 and ECC84 for AC. Price complete **£7/7/-**, 2/6 P. & P. All channels available.

Type Sound	MC/s	Vision MC/s	Heater
TT34S	38.0	34.5	Series
TT34P	38.0	34.5	Parallel
TT16S	19.5	16.0	Series
TT16P	19.5	16.0	Parallel
TT13S	10.5	14.0	Series
TT13P	10.5	14.0	Parallel

We have a large selection of in-built converters for all areas from 92/6; also aerials, low-loss co-axial cable at 9d. per yd. Are you on our mailing list?

ANOTHER CABINET BARGAIN—EXCLUSIVE!
This cabinet as illustrated below was originally manufactured for Decca, Ltd., at a price well in excess of our selling price! Originally intended for Projection T/V, lends itself to any conversion. Will accommodate all your equipment, up to 12in. P.M., record storage, and even cocktail cabinet! Handsome dark walnut veneer, two doors open in front. Measurements: 44in. high, 29in. deep, 19in. wide. Our price for strictly limited quantity is **£11/19/6** plus 20/- insurance, packing and carriage. H.P. terms available.

SPECIAL PURCHASE! MANUFACTURER'S SURPLUS
Owing to favourable purchase we can offer strictly limited quantity of these handsome chassis. AC/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line-up: U107, N108, DH107, W107 and X109. Overall chassis size 12 × 5¾ × 7¼in. high. Attractive bronze dial with gold and cream lettering. Dial size 11½ × 4½in. Scale length 7½in. Logging scale provided. Price **£7/19/6** only, tax paid, plus 3/6 P. & P. H.P. terms, £4 deposit plus four monthly payments of 22/-.

Splendid unrepeatable offer !! Dulci F.3 Radiogram chassis

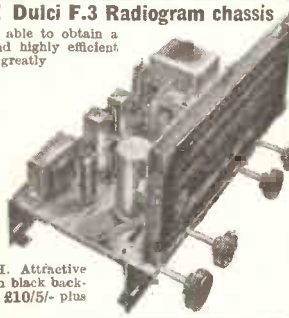
We have been very fortunate in being able to obtain a limited quantity of this well known and highly efficient chassis which we are able to offer at a greatly reduced price. **Definitely the last few!**
Specification:

Three waveband: long 1,000-2,000 metres; medium 187-540 metres; short 16-50 metres. Valve line-up: X79, 6BA6 or W7A7, 6AT6 or DH77, EL84 or N709, 6X4 or U78.

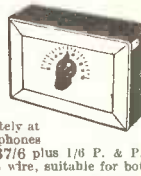
Four controls, tone/on-off.

Volume wavechange.

Tuning: output 4 watts matched to 3-5 ohms. Incorporates latest Ferrite Rod Aerial. Pick-up sockets and mains supply for Gram motor. Overall dimensions: 12in. L. × 7in. D. × 7¼in. H. Attractive dial with red, gold and green lettering on black background. Size 11½in. × 4½in. Price only **£10/5/-** plus 3/6 P. & P.



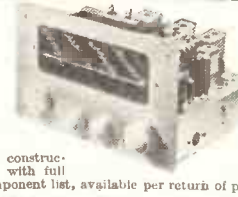
JUST RELEASED ! ! !
THE NEW R.C. TRANSISTOR/CRYSTAL RECEIVER KIT
This receiver, covering medium waveband, which can be assembled in about 1 hour, will give amazing volume and tonal quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For headphone reception.
Included with the kit of parts is a handsome plastic case in black and white, measuring 4¾ × 2¾ × 1¾in. This case accommodates the complete receiver, including battery.
PRICE OF COMPLETE KIT: 25/- plus 1/3 P. & P.
Lightweight high resistance headphones can be supplied separately at 15/- pair. If, however, the kit is purchased complete with headphones this will be supplied at a **SPECIAL INCLUSIVE PRICE OF 37/6** plus 1/6 P. & P.
Optional extra. 100ft. coil single 7/36 coloured P.V.C. covered wire, suitable for both aerial and earth. 2/6 only.



TRANSISTORS ! ! ! Now available, manufacturers' surplus transistors. Suitable for use in Audio stages, etc., and for experimental purposes. P.N.P. type. Only 10 each, post free. Blue spot type available for R.F. up to 1.6 Mc/s., 15/- each.

AM/FM KIT

Introducing the JASON AM/FM KIT for medium waves and F.M.!
As illustrated this is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at **£15/5/-**. Also less output stage but with own built-in power pack at **£13/19/6** only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of p at 2/- post free. Both plus 3/6 P. & P.



DULCI H4T AM/FM TUNER

Designed for Quality Reproduction and built to the highest technical standards. Own power supplies. Four wavebands: VHF 87-101 mc/s. Short, 16-50 metres. Medium, 187-540 metres. Long: 1,000-2,000 metres. Intermediate Frequencies: 10.7 mc/s. and 471 Kc/s. Full A.V.C. on all A.M. Bands and amplitude limitation on F.M. Band. Controls: ON/OFF, Volume, Tuning and Wavechange. Valve line-up: ECC85, ECH81, EF89, EABC80, EM80 and EZ80. Attractive dial in Black with Red, Green and Gold lettering, size 11½in. × 5¾in. Chassis size (overall) 12in. W × 7¾in. H. × 8¾in. D. A low impedance of 47K ohm output makes matching to amplifier non-critical. Price is **£20/17/-**, plus 5/- P. & P. H.P. terms.

DULCI AM/FM CHASSIS H4

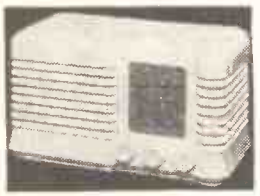
Illustrated leaflet available. L., M. and Short Waves plus F.M. This is a quality chassis 6 latest B.V.A. Mullard Valves, including magic eye. High Q inductances throughout, also Ferrite rods. Price is **£24/6/6** cash—or H.P. terms.

THE R.C.3/4 WATT AMPLIFIER KI
Compare the advantages!
Treble, bass AND middle controls! crystal or magnetic pick-up! A.C. Ma 200/250 v. Valve line-up: 6V6GT, 6 metal 6X5GT. Negative feedback. B on stove enamelled steel chassis, measur only 8in. × 4in. × 1¾in. Four engra cream knobs are included in the price the complete kit with all necessary practi and theoretical diagrams at £4/5/- o plus 2/6 packing and post or Instr tion Book fully illustrated for 1/-. Post free! This amplifier can be supplied assembled, tested, and ready for use at **£5/5/-** plus P. and P. Hearing is believing.

Our advantageous H.P. terms are available on any single item over £5. Let us have your enquiries.

Please add postage under £1, or Cash with order. C.O.D. charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry but we close 1 p.m. on Saturday.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7 and 6V6. Chassis ready drilled. Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later. Plus 2/6 packing and carriage for complete kit.



THE "SUPERIOR FOUR" KIT. Our superior four-valve receiver. A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components as supplied. Valve line-up: 2 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for complete kit, £6/9/6! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch, dial, pointer, drum pulleys drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage. N.B.—Our kits are even supplied with sufficient solder for the job.

N.B.—All our T.R.F. Kit circuits now include specially wound Denco "Max-Q" coils on polystyrene formers, improved performance! Price remains the same.

SURPLUS BARGAINS—METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3½in.	M.C.	F.R.	95/-
100 microamp	D.C. 2½in.	M.C.	F.R.	45/-
200 microamp	D.C. 2in.	M.C.	F.R. (Tropicalised)	30/-
200 microamp	D.C. 3½in.	M.C.	F.R.	65/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq.	22/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1954 manufacture by Elliott)	25/-
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
500 mA.	D.C. 2½in.	M.C.	F.R.	10/-
.5 amp.	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	10/-
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.P.	45/-
1 amp.	R.F. 2½in.	Thermo	R.P.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
300 volt	A.C. 2½in.	M.C.	F.R.	35/-
300 volt	A.C. 3½in.	M.I.	F.R.	30/-

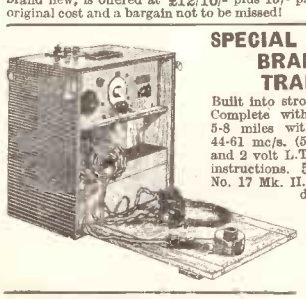
SPECIAL U.S. 0-1 mA. 2½in. taken from equipment but perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

METER RECTIFIERS. 1 mA. by G.E.C. at 6/6, also 5 mA. by G.E.C. at 6/6.

METER SPECIAL. We have a limited quantity of aircraft electrical thermometers. Brand new, by Weston, 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full scale deflection is approximately 150 microamps! Price 12/6 each only, plus 1/-. P. & P.

SPECIAL PURCHASE!!
LIMITED QUANTITY ONLY.

A.A. PREDICTOR MK. I—OSCILLOSCOPE No. 11. This ex Govt. unit readily lends itself economically to conversion to oscilloscope for domestic use. For 115 volt or 230 v. 50 cycle A.C. mains—comprising 2½in. C.R.T. Type ACR10—4-EF91, EBC33, 6J5, 6X5GT, SU2150A and EA50. Continuously variable and stepped attenuator on Y amplifier. Internal X and Y shifts. Brightness and focus controls. Time base speeds can be increased by simple modification to cover 3 kc/s to 30 kc/s. Details are supplied. Overall measurements of chassis as illustrated are 7in. high, 15in. deep and 19in. long. This unit, which is of recent manufacture and absolutely brand new, is offered at £12/10/- plus 15/- packing and carriage. This is a fraction of original cost and a bargain not to be missed!



SPECIAL PURCHASE from Ministry BRAND NEW No. 17 Mk. II TRANSMITTER/RECEIVER

Built into strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Frequency coverage: 44-61 mc/s. (5-7 metres). Uses standard 120 v. H.T. and 2 volt L.T. batteries. Complete with full operating instructions. 59/6, plus 3/6 C. & P.

No. 17 Mk. II. as above, but secondhand, in good condition and complete, 45/-, plus 3/6 C. & P.

CONTINUITY TESTER.
Comprising: well made polished wooden carrying case 8¾in. × 5¾in. × 3¾in., with hinged lid and web carrying strap, 50 ma. 2½in. flush wound meter (unscaled), mounted on paxolin panel with 10 ohm. wire wound "zero set" pot, complete with leads, heavy duty test prod., and battery compartment. Ideal for conversion to multi-range test meter. In new condition. Only 17/6 plus 1/6 P. & P.

MAINS TRANSFORMER—SPECIAL
Removed from chassis but clean and guaranteed. 200/240 v. Input. 350-0-350 at 250 m/a. 6.3V. 8 amps. 6.3V. at .6 amps. 5 at 3 amps. Only 30/- plus 1/6 P. & P.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT
Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green adds to the very imposing appearance of this model which is housed in attractive cream and grey leatherette covered attache-case type cabinet, measuring only 9in. × 7in. × 5½in. Weight less batteries 4½lb., with batteries 6½lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 10/-. Also L.T. 1.5 v. A.D. 35 at 1/6.

RAMBLER MAINS UNIT! At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6 plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 2½in. × 1¼in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 L.T.

THE R.E.P. 1-Valve RECEIVER. All-dry battery operation, for use with headphones. The complete kit is available at 42/-, less batteries plus 2/- P. & P. or full instructions at 9d. post free.

COIL PACKS. Manufacturers' Surplus. Miniature size, only 2½in. × 2½in. × 1¼in. deep. Iron-cored. For L., M. and S.W. with gram. position. Switch has 2in. spindle. Absolutely brand new, complete with circuit. Price only 27/6 plus 1/6 P. & P. A snip!

RECORDER AMPLIFIER
(Well known manufacturer's surplus.)

This is a brand new amplifier designed for use with a famous wire recorder. A simple modification is all that is required to make this unit ideal for use with any Tape Deck, being very compact it is particularly suitable for inclusion in portable equipment. Specifications: valve line-up: 7C5, 12AU7, 6BR7, 6BR7, 6X4. Neon Record Level Indicator. Controls: Volume/Record Level, Tone Control, Record/Playback Switch. High and Low level inputs for Mike and Radio. External Speaker Socket. Built-in 5in. Loudspeaker with High Flux magnet. Separate Power Pack. Dimensions: Amplifier 5½in. H. × 11¼in. W. × 2½in. D. Power Pack: 6¼in. × 6in. × 5in. High (overall). Full modification details are supplied. Price £8/19/6. P. & P. 3/6.

ANOTHER WINNER!!! SMALL PORTABLE GRAM AMPLIFIER. This little amplifier is built around a PRINTED CIRCUIT and employs the very latest highly efficient valve type ECL82. It is ideal for use where space is limited. Although of such small size, 7in. × 5¼in. × 2in. (overall) with a control panel 3¾in. × 1¼in., reproduction is excellent. A wide range tone control is provided. Output approx: 3 watts. For use on A.C. mains 200/250 v. NOTE THE PRICE: 59/6 plus 2/- p. & p.

VALVES: We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection of brand new imported valve types, fully guaranteed. P.T. paid.

EABC80	10/-	DAF96	10/6	PL81	13/6
EAF42	10/-	DF96	10/6	PL82	10/6
EB41	7/6	DK92	10/6	PL83	11/6
				PY80	9/-
EB91	7/6	DK96	10/6	PY81	10/-
EBC41	10/-	DL96	10/6	PY82	9/-
EBF80	11/6	or3/6 per		PY83	11/6
ECC81	9/-	set of four		UBC41	10/6
ECC82	9/-	DM70	9/-	UCH2	11/6
ECC83	9/-	EL41	10/6	UF41	10/6
ECC84	13/6	EL42	10/6	UL41	10/6
ECC85	10/-	EL84	11/6	UY41	9/-
ECF82	13/6	EM80	9/-	6AQ5	8/6
ECH42	11/6	EY51	11/6	6AT6	8/-
ECH81	11/6	EY86	13/6	6AU6	9/6
ECL80	11/6	EZ40	8/6	6BA6	8/6
ECL82	12/6	EZ80	8/6	6BE6	8/6
EF41	10/6	EZ81	9/6	6BW6	8/6
EF80	9/-	PCL82	12/6	6X4	6/6
EF85	10/6	PCF80	12/6	35W4	7/6
EF86	12/6	PCF82	12/6	50B5	10/-
EF89	10/-	PCC84	12/6	50C5	10/-

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list!

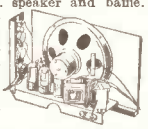
LOOK ! ! ! A first-class SIGNAL GENERATOR that YOU can afford. The "Weyrad" type S.G.M.1 covers 100 kc/s to 70 mc/s in 6 bands, on Fundamentals, with an accuracy better than ±2%. Switched Audio Mod.: 500 c/s. For use on A.C. Mains 100/250 v. 50 cycles. Fully illustrated leaflet available. Price ONLY £12/10/- plus 2/6 P. & P. H.P. available.

GRAMOPHONE MOTORS are in SHORT SUPPLY!

COLLARO AC.3/554: Three speed, single player for A.C. mains 200/250 v., cream finish, complete with turnover crystal pick-up, incorporating the well-known high output "T" type head. Strictly limited quantity at £6/19/6 plus 3/6 p. and p.

FOUR-SPEED CHANGERS! The new B.S.R. 4-speed auto-changer in attractive cream and gold finish now available from stock at £8/15/- only, plus 3/6 p. and p. H.P. terms available.

THE "R.C. STALLION." This is the latest addition to our range of gramophone amplifiers and is supplied complete with high flux 8in. P.M. speaker and baffle. Incorporating three octal-type valves, 6Q7, 6V6 and 6X5, this robust and well made unit is ideal for use in the larger type of record player or radiogram, and is equally suitable for use in conjunction with a radio feeder unit. Separate bass and treble controls are provided; also provision is made for an extension speaker and mains supplies to gram. motor. Output approx. 4 watts. Size overall: 13in. × 4in. × 9in. high. For use on A.C. mains 100/200/250 v. Price £5/19/6, plus 2/6. P. & P. This amplifier will fit our portable cabinet type "G" without modification. Cabinet price 85/-, plus 6/6 P. & P. Will also accommodate any standard Record Changer!



RECORD PLAYERS CABINETS—to suit all types of single record and auto-changer units. Priced from 45/-. Send stamp for fully illustrated list.

PRE-SET TUNER UNIT
(Manufacturer's surplus.)

This is a two valve (TH41, VP41) superhet tuner unit covering, in original stage, two pre-set stations: Light and Home Service, with provision for adding a third station. Station selection is by means of an attractive illuminated Perspex knob. A small modification, the addition of a Germanium diode, is all that is required to enable this unit to be used in conjunction with any amplifier or tape recorder capable of supplying the necessary power: 200 v. D.C. at 20 m/a. 4 volts at 2 amps. heaters. Alternatively built-in power supplies may be added. This is an exceptionally well made unit producing a "clean," good quality output. Dimensions of Tuner: 9in. L × 3½in. W. × 7½in. H. Overall. Unit only 45/- plus 2/6 P. & P. We can also supply all the components for built-in power pack with full modification details at 20/-.

CLYNE RADIO LTD.
18, Tottenham Court Road, London, W.1.

AMPLIFIERS
PRE-AMPLIFIERS

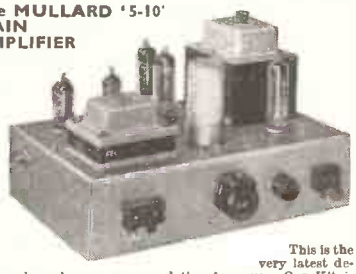
HIGH FIDELITY FOR THE HOME CONSTRUCTOR

TUNING UNITS
RADIO RECEIVERS

—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—

QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST

The MULLARD '5-10' MAIN AMPLIFIER



This is the very latest design and needs no recommendation from us. Our Kit is complete to Mullard's specification, including the latest GILSON ULTRA LINEAR OUTPUT TRANSFORMER and the entire MULLARD Valve line up. ALL SPECIFIED COMPONENTS are supplied.

PRICE OF COMPLETE KIT OF PARTS (Plus 5/- carr. and ins.). **£11/11/0**

STERN'S "fidelity" PRE-AMPLIFIER TONE CONTROL UNIT

"A design for the music lover"

Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL. (b) STEEPCUT FILTER; (c) Continuously variable BASS and TREBLE CONTROLS and a variable OUTPUT CONTROL which enables its use with any type of Amplifier.

PRICE OF COMPLETE KIT OF PARTS **£6/6/0**
WE ALSO OFFER IT ASSEMBLED READY FOR USE, £8/-/- (Plus 5/- carr. and ins.).

A COMPLETE KIT OF PARTS STERN'S "HIGH QUALITY" 8-10 WATT AMPLIFIER

Has power supply available for Radio Tuning Unit.

Price of COMPLETE KIT OF PARTS (plus 5/- carr. and ins.). **£7/10/0**

WE ALSO OFFER IT ASSEMBLED and READY FOR USE for (plus 5/- carr. and ins.). **£9/10/0**

This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The Complete SPECIFICATION and BUILDING INSTRUCTIONS are available for 1/6.

"Wire-to-Wire" Diagrams are included and all Components are available separately.

THE full SPECIFICATION and BUILDING INSTRUCTIONS for these three Units are available for 1/6 each. THEY include COMPONENT PRICE LISTS and simple "wire-to-wire" PRACTICAL DIAGRAMS.

SPECIAL PRICE REDUCTIONS . . . FOR PURCHASERS OF A COMPLETE "Hi-Fi" AMPLIFIER

WE WILL SUPPLY (a) COMPLETE KIT OF PARTS to build THE MULLARD "5-10" MAIN AMPLIFIER and the STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for £16/16/- or we will supply THE TWO UNITS MADE UP and READY FOR USE for £19/19/-. Terms: Deposit £9/19/6 and 12 monthly payments of 18/7, or £5 Deposit and 9 monthly payments of £1/16/7.

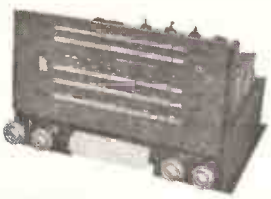
"MODERNISE YOUR OLD RADIOGRAM"

IT IS MUCH CHEAPER THIS WAY!!

THE LATEST DESIGN OF COMBINED AM/FM REPLACEMENT RADIOGRAM CHASSIS and a NEW 4-SPEED RECORD PLAYER

STERN'S NEW "Fidelity" COMBINED AM/FM RADIOGRAM CHASSIS

A genuinely hand-made chassis providing really high quality on both Radio and Gram.



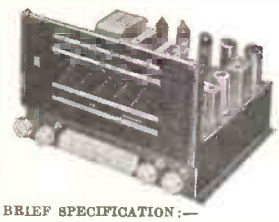
PRICE
£26/15/0
(Plus 7/6 carr. and ins.).

TERMS: Credit Deposit £6/14/- and 9 monthly payments from £2/9/-. H.P. Deposit £13/7/6 and 12 monthly payments of £1/4/10.

BRIEFLY IT HAS:—
An 8 valve line up incorporating the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM waveband plus the SHORT, MEDIUM and LONG waves. ● Has EL84's in Push-Pull, with negative feedback of 6 watts output. ● Employs "Piano Key" Selector Switch and a Variable Tone Control. ● Contains Gram input socket for both Crystal and Magnetic Pick-ups. ● Provides for use of either 3 or 15 ohm Speakers. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. × 9½in. × 8in. high, Dial size 11½in. × 5¼in.

THE NEW ARMSTRONG P.B.409 AM/FM RADIOGRAM CHASSIS

A "de luxe" Chassis for those who want the highest possible quality



PRICE
£29/8/0
(Plus 7/6 carr. and ins.).

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/-. H.P. Dep. £14/14/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION:—
A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Key" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Two Gram Inputs are provided, one for Crystal Pick-ups and the other for Magnetic types. ● Dimensions 13in. × 9½in. × 8in. high, Dial size 11½in. × 5¼in.

STERN'S "SUPER SIX"

6 Valve 3 Waveband Superhet

Provides good selection of stations and really good reproduction on both RADIO & GRAM.

PRICE ONLY £14.0.0 *(Plus 7/6 carriage and ins.)*

CREDIT TERMS: Deposit £3/10/- and 9 monthly payments of £1/5/8. H.P. TERMS: Deposit £7 and 10 monthly payments of 16/-.

BRIEF SPECIFICATION . . .
- ★ Delayed AVC on all wavebands
- ★ Preselection feedback
- ★ Modern valve line-up: 12AH8, 6BA6, 6AT6, two 6AQ5s and 5Z4 (or OCTAL VALVE equivalents)
- ★ Push-pull output gives approx. 6 watts
- ★ Connections on chassis for extension speaker, gram. and mains supply to gram.
- ★ Coverage 18-50 metres, 190-560 and 800-2,000
- ★ Overall size 11 × 7½ × 8½in. high, dial 8½ × 4½in.
- ★ A bronze dial escutcheon is available for 4/6.

SEND S.A.E. IF FURTHER INFORMATION IS REQUIRED ON THESE CHASSIS.

To complete a GENUINELY HIGH QUALITY RADIOGRAM . . . we recommend THE NEW COLLARO MODEL 456 4-speed Autochanger, and if a LOUDSPEAKER is required . . . we recommend THE 8- or 10-inch W.B. STENTORIAN "Hi-Fi" MODELS. We have SPECIALLY REDUCED PRICES for purchasers of a CHASSIS and RECORD PLAYER (and SPEAKER if required). SEND S.A.E. FOR DETAILS.

CASH ONLY OFFER!!

This latest B.S.R. MONARCH 4-SPEED AUTOCHANGER

£8/15/0 (Plus 5/- carr. and ins.).

● These units will autochange on all three speeds, 7in., 10in. and 12 in.

● They play MIXED 7in., 10in. and 12in. records of same speed.

● They have spearate sapphires for L.P. and 78 r.p.m., which are moved into position by a single switch.

● Minimum baseboard size required 14 × 12½in., with height above 5½in., and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

109-115 FLEET ST., LONDON, E.C.4.

Phone: FLEet Street 5812-3-4.

RECORD PLAYERS

THE VERY LATEST MODELS ARE OFFERED AT GREATLY REDUCED PRICES

● TRANSCRIPTION UNITS. ● 3- and 4-SPEED AUTOCHANGERS ● AUTOCHANGERS with MANUAL CONTROL POSITION. Send S.A.E. for ILLUSTRATED and DESCRIPTIVE LEAFLET.

PORTABLE CASE

Ideal for Record Players

Price Only £3.3.0 (Plus 3/- Carr. & ins.)

Attractively finished in High Grade Rexine and Robustly constructed with initial measurements at 13½in. × 15½in. high. It will be seen therefore that it will accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

FOR CALLERS ONLY We have in stock various KITS OF PARTS including F.M. Tuners, AM/FM Tuners, Midget Battery Portable and Mains Units, etc., etc. . . . We also have the most comprehensive stock of WIRELESS and ELECTRICAL COMPONENTS.

SPECIAL CASH ONLY OFFER!!

A PORTABLE AMPLIFIER CASE

A good quality 2 Stage (plus Rectifier) GRAM AMPLIFIER together with a 6½in. P.M. Speaker and this attractive PORTABLE CASE.

ALL FOR ONLY £8.7.6. The Amplifier incorporates the latest B.V.A. Valves, types ECC83, EL84, with EZ80 Rectifier and has separate BASS and TREBLE CONTROLS. The CASE is attractively finished in Rexine, maroon and grey, and has space for almost any make of Autochanger. We also sell the two separately:

(a) AMPLIFIER and 6½in. SPEAKER £4 12 6
(b) PORTABLE CARRYING CASE £3 17 6

Best Buy at Britain's

TEST METERS
American multirange, in handsome polished wooden case with leather carrying handle. Size 6in. x 6¼in. x 3¾in. 400 microamp basic movement. A.C. and D.C. volts 0-2.5, 10, 50, 250, 1,000, and 5,000. (1,000 ohms per volt.) D.C. current 0-1, 10, 100 m/Amps., and 1 Amp. Ohms 0-500, 100 K., and 1 Meg. Decibels —10 to +69. Complete with test prods, leads, circuit, instructions, and battery. New condition, tested. **£5/19/6.**

INSULATION TESTERS by Record Electric. 0-50 MegOhms. Test voltage 500. In perfect working order. Complete in leather carrying case. **£9/19/6.**

OUTPUT POWER METERS. Ex-W.D., No. 3, Mk. 2 (Windsor 150 A.). Impedance ranges 2.5 to 20,000 Ohms in 40 steps. Power ranges 0-5, 50, 500, milliWatts, and 0-5 Watts. Also scaled in dB. 3¼in. M/C. meter. In oak case, 10¼in. x 8in. x 5¼in. In good condition. Tested. **£15.**

AVO TEST BRIDGES. Capacity 5 pFd. to 50 mFd. Resistance 5 Ohms to 50 MegOhms. Inductance can be measured against external standard. Balance is indicated on a meter, which can also be used a valve voltmeter, from .1 to 15 volts. Has leakage test and Power Factor control. For A.C. mains operation 220-240 v. Good condition. Tested. **£8/19/6.**

AVO VALVE TESTERS in Good Condition, with panel. For CALLERS only.

MARCONI SIGNAL GENERATORS
TF390G. 4-32 and 50-100 Mc/s.... **£25 0 0**
TF390G. 16-150 Mc/s..... **£27 10 0**
TF517F. 18-58 and 130-260 Mc/s. **£35 0 0**
All complete with Instruction Book, spares, Calibration Charts, etc. In original transit cases. Brand new. We have large stocks of similar quality Laboratory type equipment available to callers at very reasonable prices.

VIBRATOR PACKS. Input 6 v. D.C. Output approx. 100 v. at 30 m/Amps. D.C., fully smoothed and RF filtered. Size 6¼in. x 5in. x 2in. Fitted with Mallory 629C Vibrator. Brand new, boxed, **12/6.**

HEAVY DUTY BLOWERS. For A.C./D.C. mains 200-250 v. 300 watts. 1¾in. diam. outlet. Suitable for industrial use, forges, etc With spare filter pads and brushes. Brand new. **£4/19/6.**

HEAVY DUTY LT TRANSFORMERS. 230 v. A.C. mains input. Secs. 5-0-5 v., 5-0-5 v., and 5-0-5 v., all at 5 amps., each winding. 5, 10, 15, 20, 25, or 30 v. at 5 amps., or other possible combinations. 4¾in. x 4¼in. x 6in. high. Wt. 12lb. BRAND NEW, **29/6.** ANOTHER, 230 v. A.C. mains input, two separate secondary windings, each 14 v. C.T. 12 amps., 7, 14, 21, or 28 v. at 12 amps., or other possible combinations. Wt. 24lb. Ex Admiralty. Brand new **42/6.**
U.S.A. potted type, input 210/220/230 v., 5 secondaries, 7.5 v. 4 a., 7.5 v. 4 a., 7.5 v. 8 a. and 2.5 v. 5 a., ALL centre tapped, and 6.3 v. 4 a. These can be connected to give many useful voltages up to 31 v. 4 a. Size 6in. x 5in. x 4in. Wt. 14½lb., price **35/–.**
G.E.C. 200-250 v. A.C. mains input. 30 v. (tapped at 10 v.) 36 amps. output. 5¼in. x 6in. x 7in. high. Wt. 24lb., **55/–.**

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. input 45 v. R.M.S. D.C. output 30 v. 10 amp. **47/6** each.

HEAVY DUTY SLIDER RESISTORS. 250 watts. Rated to carry 25 amp. .4 ohm resistance. For charging boards, etc. Worm drive. On metal stand 9in. x 4in. x 6in. high. BRAND NEW **7/6** each. ANOTHER, 12 amps., 1 ohm, 150 watts, **6/6.** ALSO 14 ohms, graded 1 to 4 amps., **7/6.**

FIELD TELEPHONES. Army type D, Mk. 5. Buzzer calling. Ideal for building sites, farms, workshops, etc. Complete with handset and batteries. Tested, **39/6** each.
CRYSTALS. 200 Kc/s American GEC, **10/–** each. 100 Kc/s R.C.A. bars, **19/6** each.
5FT. P.O. TYPE 19in. RACKS. "U" channel, heavy angle base. **59/6.**

TOP BAND R1155 L's!

Superior version of the R1155 with super slow-motion drive. 200 kc/s to 18.5 mc/s. in 5 ranges, covering the 100-200 metre trawler and shipping bands. Although not packed in original transit cases, these are in every way equal to BRAND NEW, and are fully guaranteed. Never before available at the low-price of ONLY **£12/19/6.** Carriage 10/6.
R1155A equal to new and fully guaranteed. **£10/10/–.**
ALL R1155's are supplied with free booklet, re-aligned, and tested before despatch, and gladly demonstrated. Send S.A.E. for details of receivers and power packs, or 1/3 for 14-page illustrated booklet.
A.C. MAINS POWER PACKS WITH OUTPUT STAGE. Just plug in, NO modifications. Heavy duty quality job, guaranteed 6 months. Type A, **£4/10/–.** Type B, with 6½in. speaker, **£5/5/–.** Type C, in specially designed black crackle steel cabinet, with 8in. speaker de luxe, **£6/10/–.**
SAVE £££s. DEDUCT 10/– WHEN PURCHASING R1155 AND POWER PACK TOGETHER.

WIRELESS SET No. 19, Mk. 2.
Two transmitter-receivers and an intercomm. amplifier in one case. "A" set covers 2-8 Mc/s. R/T and CW, and "B" set 240 Mc/s R/T only. Complete with dynamotor for 12 v. D.C. operation, 6 K7G, 2 6K8G, 2 6V6G, 6B8G, 807, EF50, EB34 and 500 microamp check and tuning meter. S.A.E. for full details and specification. Technical data available. Made in Canada, in first-class condition, **£5/10/–** plus 15/– Carr. and Pkg. Or less dynamotor, **£4/19/6.**

METER BARGAINS

RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-100	59/6
100 Microamp	D.C. M/C	2½in.	Flush circ., scaled 0-1,500	39/6
500 Microamp.	D.C. M/C	2in.	Flush circular	17/6
500-0-500 Microamp.	D.C. M/C	2½in.	Flush circular, scaled 100-0-100 V.	25/-
1 Milliamp.	D.C. M/C	2in.	Flush square, Fe/NFe	22/6
100 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
150 Milliamp.	D.C. M/C	2in.	Flush square	7/6
200 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
1 Amp.	Thermo-couple	2¼in.	Projecting circular	6/9
4 Amp.	Thermo-couple	2in.	Flush square	6/9
20 Amp.	D.C. M/C	2in.	Projecting circular	7/6
30-0-30 Amp	D.C. M/I	2in.	Proj. circ., car type	5/-
15 Volts	A.C. M/I	2½in.	Flush circular	8/6
300 Volts	D.C. M/C	2in.	Flush square	10/6

METER RECTIFIERS. Full wave bridge. Brand new. Salford 1/m A. 6/6. 5 m/A., 6/6. STC 2 m/A., 5/6.

RUNNING TIME METERS. For life testing and process timing any A.C. mains apparatus. 200-250 v. 50 c/s. Indicates 1/10 to 10,000 hours on 5 scales. 4½in. diam. Good condition, tested, **35/–.**

RCA AMPLIFIERS

MODEL MI-11220. Employs 2 6L6G, 4 6J7, and 1 5U4G. Output 12 watts at 5-7.5-15-600 ohms. For 190/250 v. A.C. mains. In grey crackle case, 17 x 11 x 9in. Wt. 38lb. Brand new and boxed. Price, less valves, **£9/19/6.** Circuit supplied. OR, ready converted for use with pick-up or microphone, with tone control, £2 extra. Set of new boxed valves **59/6.**

CALLERS CORNER

VCR97's from .. 2/6
Indicator chassis 5/-
10 mfd. paper .. 2/6
8 mfd. paper 3/-
8 mfd. 500 v. Elec. 1/3
EF50's, from .. 2/6
EA50's, NEW .. 6d
EB34's, NEW .. 6d
12H6's, NEW .. 6d
Eddystone 358 Rx's 79/6
Meters, from 6d

R109A RECEIVERS. 8 valve superhet using 5 x ARP12's and 3 x AR8's covering 2-12 Mc/s. Contains vibrator pack and 3½" speaker and operates from 6 volt battery, consumption 1¼ amps. Housed in metal case 13" x 12" x 11". Complete with valves and circuit. Aerial tested and in very good condition. **£4.7.6.** Carr. paid.

MEDIUM WAVE COMMAND RECEIVERS. 550-1,500 Kc/s. Ideal for car radio. These have not been on the market for years! Few available. First class condition. ONLY **79/6.** Still available, BC453 (Q5'er), **59/6,** and BCXXX (Top band) 1.5-3 Mc/s. NEW, BOXED, **75/–.** FREE CIRCUIT WITH EACH RECEIVER.
TRANSMITTERS. Complete with 1626, 1629 and 2 1625's and crystal. BC457 4-5.3 Mc/s., **22/6.** NEW ditto, **29/6.** BCZZZ 2.1-3 Mc/s., unboxed, **29/6.**

PYE 45 Mc/s IF STRIPS. Complete with 7 valves and CIRCUIT. New. ONLY **39/6.**
MINIATURE 9.72 Mc/s IF STRIPS. Only 10¾ x 2¼ x 3in. Ideal for FM conversion. 2 EF92's and 1 EF91 IF Amps., EB91 Det/AVC, EF91 AVC Amp., and EF91 noise limiter. Brand new, with circuit, **45/–,** or less valves **7/6.**

RF UNITS. ALL BRAND NEW AND BOXED. RF24 **10/–,** RF25 **12/6,** RF26 **25/–.** Post 2/6.

RT37/PPN2 BEACON TRANSMITTER-RECEIVER. 214-234 Mc/s Size 13in. x 10in. x 5in. Contains 5 3A5, 3 1S5, 1 1R5 and 2 2 v. synchronous vibrators. Operates from 2 v. accumulator via 2 built-in vibrapacks. Complete with telescopic mast antenna system (9¼ft.), lightweight headphones. Technical Manual, super quality carrying haversack, cords, co-ax. cables, plugs, etc. Total wt. 28lb. BRAND NEW, boxed, American equipment, **72/6.**

TWO-WAY MORSE TRAINING SETS, W/T Mk. 3. Consists of 2 valve oscillators (ARP12's) (one with pitch control), for 1 or 2 operators. Has provision for creating "atmospherics." In polished oak case 12¼in. x 10in. x 8in., wt. 16lb. Complete with valves, leads, 2 keys, 7-way terminal board, circuit and instructions, but less batteries and phones. Ideal for Cadets, Scouts, etc. SNIP, **19/6,** Carr. **7/6.**

COMMUNICATIONS RECEIVER CR100. Covers 60 Kc/s to 30 Mc/s in 6 ranges. 2 RF's and 3 IF's, variable selectivity, B.F. Osc., etc. Operates from 210-250 v. A.C. mains. Size 16in. x 12¼in. x 16¼in. deep, wt. 82lb. S.A.E. for illustrated details. Overhauled, first class condition, **£21.** CR100/2 with side-tone facility, superb condition, **£25.** Plus £2 carr. and pkg. (£1 refund when pkg. case returned.)

INDICATING UNIT 277. Contains 1in. C.R. Tube type VCR522 (same as used in G.E.C. "Miniscope"), 4 EF50, 2 EA50, and a host of useful components. Has 'Focus" and "Brightness" controls, etc. Size 5¼in. x 7in. x 12in. deep All Tubes tested. **39/6.**

INDICATOR UNIT 62A. Has VCR97 with Mu-metal screen, 12 EF50, 3 EA50, 2 EB34, 4 SP61, Muirhead SM Drive, and a host of pots, switches, etc. On double-deck chassis. Ideal for 'scope. In wooden transit case. Brand new condition. **59/6.**

METAL RECTIFIERS. 250 volt, 100 m/A 5/-. 230 volt, 60 m/A **3/6.** Many other types.

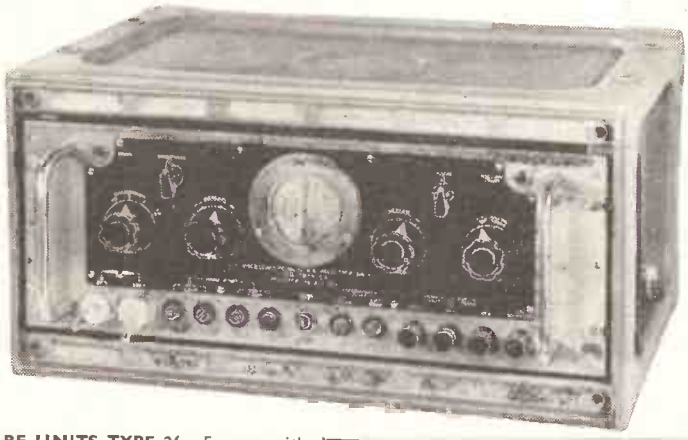
PLEASE ADD POSTAGE OR CARRIAGE ON ALL ITEMS

CHARLES BRITAIN (Radio) Ltd.

11 UPPER SAINT MARTIN'S LANE, LONDON, W.C.2. TEMple Bar 0545

One minute from Leicester Square Station (up Cranbourn Street)

Shop Hours: 9-6 p.m. (9-1 p.m. Thursday). *Open all day Saturday*



OSCILLOSCOPE No. 11

Made for Anti-Aircraft Command, and just released by Ministry of Supply. Manufactured by A. C. Cossor in 1952, this is a First Grade L.F. Oscilloscope incorporating a Hard Valve Time Base, with existing speeds of 1-5-40 milliseconds, but is easily converted at a cost of a few shillings to produce speeds of 3 cycles per second to 30 kc/s. Has High Class Amplifier with Fine and Coarse gain controls, plus Brightness and Focus controls, and X and Y shifts. Conservatively rated Mains Power Pack is for nominal 115 v. and 230 v. input, and is adequately fuse protected in all circuits. Tube employed is 2½in. ACR.10. Will make up into an ideal workshop or servicing oscilloscope. Has grey and black engraved front panel size 19in. x 7in., depth of unit being 12in. Illustrated in heavy steel transit case, in which it can be used, or removed for standard 19in. rack mounting. Complete with leads and suggested modification data. BRAND NEW IN MAKER'S PACKING CASES. ONLY **£12/10/-** (carriage 15/-).

RF UNITS TYPE 26. For use with the R.1355 or any receiver with a 6.3 v. supply. This is the variable tuning unit which uses 2 valves EF54 and 1 of EC52. Covers 65-50 Mc/s. (5-6 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY **25/-** each.

MARCONI BAND III CRYSTAL CALIBRATORS. Frequency range 170-240 Mc/s. Incorporates 5 Mc/s. crystal for better than .001 per cent. accuracy. Directly calibrated dial, internal A.C. mains pack. Complete with spare set of valves and instruction manual in maker's transit cases. BRAND NEW. ONLY **£4/19/6.**

CLASS D WAVEMETER
Another purchase of this famous crystal-controlled wavemeter which has been repeatedly reviewed and recommended in the "R.S.G.B." Bulletin as being suitable for amateur transmitters. Covers 1.9-8.0 Mc/s., and is complete with 100/1,000 kc/s. crystal, 2 valves ECH35, two 6-volt vibrators and instruction manual. Designed for 6 v. D.C. operation, but simple mod. data for A.C. supplied. BRAND NEW IN MAKER'S TRANSIT CASES. ONLY **£5/19/6.** Transformer for A.C. modification, **7/6.**

A.C./D.C. BLOWERS. 220/250 volts, 300 watts. 1½ in. diam. outlet. Complete with filter pads. BRAND NEW. ONLY **£4/19/6.**

INSULATION TESTERS (MEGGERS). Read up to 20 megs. at 500 volts pressure. Overhauled, and in perfect order. With leather carrying case. ONLY **£9/19/6.**

POWER UNIT TYPE 3. Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA. and 6.3 v. 4 amps. Fitted with H.T. current meter, and voltmeter. For normal rack mounting and has grey front panel size 19in. x 7in. ONLY **90/-** (carriage, etc., 7/6).

EHT TRANSFORMERS. 5.5 kV. (Rect.) with 2 v. 1 a., **79/6.** 7 kV. (Rect.) with 2 v. 1 a., **89/6.** 2.5 kV. (Rect.) with 2-0-2 v. 1.1. a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), **42/6** (postage 2/- per trans.).

159 RECEIVER UNIT. Contains 1 each valve, types EF50, EA50, SP61, RL37 and 24 v. selector switch. ONLY **7/6.**

TRAWLER BAND R 1155s.

The latest version of this famous Communications Receiver to be released by the Air Ministry. Covers 5 wave ranges: 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 3.0-1.5 Mc/s., 1.5 Mc/s-600 kc/s., 500-200 kc/s. As used by Coastal Command, Air-Sea Rescue Launches, etc. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Have had slight use, but are in excellent condition. ONLY **£12/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE, in black metal case, enabling the receiver to be operated immediately, by just plugging in without any modification. Can be supplied as follows: WITH built-in 6½in. P.M. speaker, **£5/5/-,** LESS speaker, **£4/10/-.** With 8in. P.M. speaker, **£6/10/-.**
DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.
Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver.
Add carriage; 10/6 for Receiver, 5/- for Power Unit.

FREQUENCY METERS TYPE L.M.

The United States Navy version of the BC221. Frequency range 125-20,000 kc/s with better than 0.01% accuracy. Contains a Crystal Controlled Oscillator, a Heterodyne Oscillator, and an Audio Frequency Amplifier. Can be used as Signal Generator, having CW-MCW control. BRAND NEW and UNUSED. Quotation on request.

METERS

F.S.D.	SIZE	AND TYPE	PRICE
50 microamps D.C.	2½in.	Flush circular	59/6
100 microamps D.C.	2in.	Proj. circular	35/-
250 microamps D.C.	2in.	Proj. circular	30/-
500 microamps D.C.	2in.	Flush square.....	27/6
500-0-500 micro D.C.	2½in.	Flush circular	27/6
1 m/a D.C.	2in.	Flush square.....	22/6
2 m/a D.C.	5½in.	Flush circular	45/-
5 m/a D.C.	5½in.	Flush circular	40/-
10 m/a D.C.	2½in.	Flush circular (blank scale)	10/6
150 m/a D.C.	2in.	Flush square.....	7/6
200 m/a D.C.	2½in.	Flush circular	12/6
8 amps A.C.	3in.	Flush square moving iron	25/-
10 amps D.C.	3½in.	Proj. circular	20/-
20 amps D.C.	2in.	Proj. circular	7/6
40 amps D.C.	2in.	Proj. circular	7/6
15-0-15 amps D.C.	3½in.	Flush square.....	25/-
30-0-30 amps D.C.		Car type moving iron ...	5/-
15 volts A.C.	2½in.	Flush circular moving iron	8/6
300 volts A.C.	2½in.	Proj. circular	25/-
2 Kilovolts A.C.	2½in.	Proj. circ. electrostatic ..	22/6
300 volts D.C.	2in.	Flush square.....	10/6

WIRELESS SET NO. 19 MK. II. The famous Army Tank Transmitter-Receiver. Incorporates "A" set (TX/RX covering 2.0-8.0 mc/s., i.e., 37.5-150 metres); "B" Set (VHF TX/RX covering 230-240 mc/s., i.e., 1.2-1.3 metres), and Intercomm. Amplifier. Complete with 15 valves as follows: 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, and 1 ea. 6B8G, 6H6, E1148, EF50, 807, and booklet giving circuits, notes, etc.
Size 17½in. x 8½in. x 12½in. Magnificently made by famous American firms.
IN BRAND NEW CONDITION. ONLY £4/19/6 (carriage, etc., 10/6).

MARCONI SIGNAL GENERATORS TF-390G
Frequency coverage 16-150 Mc/s. BRAND NEW IN MAKER'S ORIGINAL TRANSIT CASES, with instruction manual. For normal A.C. mains operation. A unique opportunity to acquire Laboratory Equipment at a fraction of original cost. ONLY **£27/10/-.**

L.T. HEAVY DUTY TRANSFORMERS. Ex-Admiralty, with 230 v. 50 cycles primary. 1. Secondaries 5, 10, 15, 20, 25, 30 volts at 5 amps. ONLY **29/6.** 2. Secondaries 7, 14, 21, 28 volts at 12 amps. ONLY **42/6.** (Postage on either 2/9.)

100-0-100 VOLTS METERS by Sangamo Weston. 2½in. circular, basic movement being 500-0-500 microamps. A really first-class centre zero meter for hundreds of uses. BRAND NEW IN MAKER'S CARTONS. ONLY **27/6.**

POCKET VOLTMETERS. Not ex-Govt. Read 0-15 v. and 0-300 v. A.C. or D.C. BRAND NEW AND UNUSED ONLY **18/6.**

WALKIE TALKIE TYPE 18. Covers 6.0-9.0 Mc/s. Transmitting and receiving units in metal case, complete with valves. In excellent condition. ONLY **79/6.**

TRI196 TRANSMITTER SECTION, complete with valves EL32, EF50, CV501, and all components. BRAND NEW. Price ONLY **12/6.**

TRANSFORMERS. H.T. Fully shrouded upright, mounting, 250-0-250 v. 60 mA., 6.3 v. 3 a., 5 v. 2 a. ONLY **21/-.** 250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. ONLY **37/6.** 350-0-350 v. 180 mA. 6.3 v. 5 a., 5 v. 3 a. ONLY **37/6** (postage 2/- per trans.).

Cash with order please, and print name and address clearly

PLEASE ADD POSTAGE OR CARRIAGE COSTS ON *ALL* ITEMS

U.E.I. CORPORATION

Radio Corner, 138 Gray's Inn Road, London, W.C.1. *Phone :* TERMINUS 7937

Open until 1 p.m. Saturdays. We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1 : 1.25 giving a 25% boost on Secondary.

2 volt	10/6 each	
4 volt	10/6 each	with Tag
6.3 volt	10/6 each	Panel and
10.8 volt	10/6 each	Solder Tags
13.3 volt	10/6 each	
Ditto with mains primaries	12/6 each.	

Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.3 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 220/240 volts. Output 2-2½-2½-2½-3 volts at 2 amps. With Tag Panel 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. receivers having series connected heaters.

RESISTORS. All values. 10 ohms to 10 meg., ¼ w. 4d.; ½ w., 6d.; 1 w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w. 1%, 2/-. All preferred values 100 ohms to 10 meg.
5 watt, 10 watt, 15 watt } WIRE-WOUND RESISTORS 25 ohms—10,000 ohms ..... { 1/3 1/6 2/-
15,000 ohms—50,000 ohms, 5 w., 1/9; 10 w..... 2/3
WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC. Pre-set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K. 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-. Standard size Pots., 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K, 6/6. W/W EXT. SPEAKER CONTROL 10Ω, 3/-.
O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 6/6. Tapped small pentode, 3/9. Hygrade Push-Pull 7 watts, 15/6.
L.F. CHOKES 15/10 H. 60/85 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H., 120/150 mA., 12/6; 5 H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a. 5 v. tapped 4 v. 2 a., ditto 250-0-250 80 mA., etc., 21/-.

I.F. TRANSFORMERS 7/6 pair

465 Kc/s Slug tuning Miniature Can 2½ × 2in. × 2in. High Q and good band width. By Pye Radio. Data sheet supplied.

Wearite M800 IF Transformers 465 kc/s 12/6 pair.

HEATER TRANS. Tapped 200/250 v. 6.3 v. 1½ amp., 7/6.
ALADDIN FORMERS and cores. ½in. 8d.; ¾in., 10d. .3in. FORMERS 5937/8 and Cans TV1/2. ½in. sq. × 2½in. and ¾in. sq. × 1¾in., 2/- complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v. 16/9.
SOLON MIDGET IRON. 25 w. 24/-.
MIKE TRANS. Ratio 50 : 1, 3/9 ea. new and boxed.
MAINS DROPPERS. 3 × 1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms, per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos

Precision engineered. Size only 1¼ × 3/16in. Bargain. Price 6/6. No transformer required.

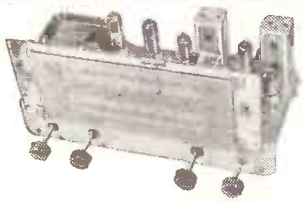
LOUDSPEAKERS P.M. 3 OHM. 2½in. square 17/6. 5in. R.A. 17/6. 7in. × 4in. Goodmans 21/-. 3½in. Square Elac., 21/-. 8in. Elac, 22/6. 6½in. Goodmans, 18/6. 10in. R.A. 30/-.
TSL TWEETER LSH75, 8/6. 12in. Plessey 30/-.
8in. M.E. 2.5 k. field tapped O.P. transformer, 24/6.
CRYSTAL DIODE. G.E.C., 2/-. GEX34, 4/-.
CRYSTAL SET CONSTRUCTION. Kit 12/6. Book 1/-.
H.R. HEADPHONES. 4,000 ohms, brand new. 16/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. midget, 1½in. × 1½in. × 1¾in., 10/-. .0005 Standard with trimmers. 9/-; less trimmers, 8/-; soiled, 2/6; 3-gang 500 pf., 7/6.

SUPERHET COIL PACK 27/6

Miniature size 2½ × 2½ × 1¼in. High Q dust cored coils. SHORT, MED., LONG. GRAM switching with connection diagram and circuit.

VALVE HOLDERS. Pax int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/-. **MOULDED** Mazda and Int. Oct., 6d., B7G, B8A, B8G, B9A, 9d., B7G with can, 1/6, VCR97, 2/6. B9A with can, 2/6. **CERAMIC,** EF50, B7G, Int. Oct., 1/-. B7G with can, 1/9.
SPEAKER FRET. Gold Cloth 18in. × 25in., 5/-. 25in. × 36in., 10/-. Expanded metal, Silver 15½ × 9½in., 2/- each. 14½in. × 12in., 3/- each. Tygan 4ft. 6in. wide, 10/- ft; 2ft. 3in. wide, 5/- ft.
WAVECHANGE SWITCHES.
2 p. 2-way 3 p. 2-way, short spindle..... 2/6
5 p. 4-way 2 wafer, long spindle..... 6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle..... 3/6
3 p. 4-way, 1 p., 12-way, long spindle..... 3/6
Wave change "MAKITS," 1 wafer 8/6; 2 wafer 12/6; 3 wafer 16/-; 4 wafer 19/6.
TOGGLE SWITCHES. S.P., 2/-. D.P. 3/6. D.P.D.T. 4/-
NUTS BOLTS. 12 of each, 2, 4 or 6BA..... 1/-

KNOBS GOLD ENGRAVED. Walnut or Ivory. 1¼in. diam., 1/6 each. "Focus," "Contrast," "Brilliance," "Brilliance—On/Off," "On-Off," "Volume," "Volt-On-Off," "Tone," "Tuning," "Treble," "Bass," "Wavechange," "Radio Gram," "S.M.L. Gram," "Record-Play," "Brightness," ditto, not engraved, 1/-.



1957 RADIOGRAM CHASSIS

THREE WAVEBANDS FIVE VALVES
S.W. 16 m.—50 m. LATEST MULLARD
M.W. 200 m.—650 m. ECH42, EF41, EBC41,
L.W. 800 m.—2,000 m. EL41, ELZ40
12 month Guarantee. A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13¼in. × 5¼in. × 2¼in. Glass Dial 10 × 4¼in. horizontal or vertical available. 2 Pilot Lamps. Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

T.S.L. Tweeter supplied free.

BRAND NEW £10.10.0 Carr. 4/6.
TERMS: Deposit £5/5/- and 6 monthly payments of £1.

A.M./F.M. RADIOGRAM CHASSIS

Measurements 13in. × 6in. × 7in. high. Dial cut-out required only 10¼in. × 2¼in. 5 valve plus metal rect., gram. socket, piano key wavechange, tone control, med., long and V.H.F. wavebands. Valve line-up: ECC85, ECH81, EF89, EABC80, EL41. For A.C. mains 100-250 v.

PRICE **£16.19.6** Carriage 10/6
MATCHED SPEAKERS FOR ABOVE CHASSIS 8in., 19/6; 10in., 25/-; 12in., 30/-.

Collaro Autochanger RC531 for 78 R.P.M. 10in. and 12in. Records. Brand new in maker's boxes! High impedance, lightweight pickup with sapphire needle, will match any amplifier or radio. Less than half price. Terms: deposit £2/15/- and 6 monthly payments of 10/-. **5 GNS.** Post free. No. C.O.D.

B.S.R. MONARCH 4-SPEED AUTOMATIC RECORD CHANGERS

1957 MODELS
Brand new and fully guaranteed 12 months.

NOT JOB LINE REJECT STOCK

Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. Lightweight Xtal pick-up, turnover head, two separate sapphire styli, for Standard and L.P. each plays 2,000 records. Voltage 200/250 A.C.

OUR PRICE **£8.15.0** each. Post free.
Terms: Deposit £5 and 5 monthly payments of £1. Space required 14in. × 12½in. 5in. above and 3in. below.

TRANSISTORS

JUNCTION TYPE (Red-Spot) (P.N.P.)

Suitable for use in Amplifiers, Signal Tracers, Local Station Receivers, Radio Control, Oscillators, Transistor Voltmeters, Baby Alarms, Microphone Pre-Amplifiers, etc. A.F.800 Kc/s.

BRAND NEW 10/- EACH

These Transistors may be used in place of Mullard OC71.

B.S.R. MONARCH. 3-speed Motor and Turntable with selecting switch for 33, 45 and 78 r.p.m. records 100-120 v. and 200-250 v. A.C. 50 c.p.s. Also B.S.R. MONARCH Lightweight Pick-up with Acos Xtal turnover head, separate Sapphire stylus for L.P. and standard records. SPECIAL OFFER, THE TWO £4/12/6, post 2/6. 14 × 12½in. Cut Out board 6/-.

Teletron Band III Converter

London, Midland and Northern for all T.V. Makes. T.R.F. or Superhet

Ready wound coils, two EF80 valves, all components, punched chassis, circuit diagram, wiring plans. COMPLETE KIT for mains operation. 200-250 v. A.C. £3/10/-.
AS ABOVE less POWER PACK. Requires 200 v. 20 mA. H.T. 6.3 v. 0.6 a. L.T. £1/5/-.

ALLDRY UNIT POWER PACK. Replaces Battery B114, etc., 69 v. plus 1½ v. Size 4½in. × 3¾in. × 1¾in. 4-pin Socket. Same as battery. Only 1/- a year to run on A.C. 200-250 v. FAMOUS MAKE. LIST PRICE 65/-. OUR PRICE 39/6. Ready for use.

T.V. PRE-AMP. (MoMICHAEL)
Will amplify output of your Band 3 Converter. Tunable Channels 1 to 5. Midget size. High gain fringe model. B.V.A. Valve. Full instructions supplied. READY FOR USE. (H.T. 200V., L.T. 6.3V., .3 amp. required). PRICE 25/- each. BRAND NEW. SPECIAL MAINS POWER PACK for above, 25/- extra.

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.
No. Sw. S.P.Sw. D.P.Sw.
3/- 4/- 4/9
Lin or Log Tracks

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated ¼in. dia. Stranded core. Ideal Band III. 9d. yd. Losses cut 50%

STANDARD ¼in. Coaxial.... 8d. yd.

COAXIAL PLUGS 1/- DOUBLE SOCKET 1/3
SOCKETS 1/- OUTLET BOXES 4/6

BALANCED TWIN FEEDER per yd., 6d. 80Ω or 300Ω. **TWIN SCREENED BALANCED FEEDER** 1/- yd., 80 ohms.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9.

ALUMINIUM CHASSIS. 18 s.w.g. Plan, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides. 7 × 4in., 4/6; 9 × 6in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in., 12/6 and 18 × 16 × 3in., 16/6.

CHROMIUM PEN TORCHES with battery and bulb, 2/6.
BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 10 colours, single or stranded, 2d. yd.
5in. **RADIO SCREWDRIVERS,** 4½d. each.
NEON MAINS TESTER SCREWDRIVERS, 5/6.
MULTICORE SOLDER 60/40, 18 s.w.g., 3d., 16 s.w.g. 4d. yd.

PURETONE RECORDING TAPE, 12/6

1,200ft. on standard fitting 7in. Plastic reels
Brand new, boxed, 12/6.
Spare Spools 5in. metal, 1/6. 7in. Plastic, 4/3.
FERROVOICE PLASTIC TAPE 25/-
First Quality. Highly Recommended. Brand new. 1,200ft. on 7in. plastic Reels, 25/-.

SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 5/-; K3/40 3.2 kV., 7/-; K3/45, 3.6 kV., 7/6; K3/50 v. 4 kV., 8/-; K3/100 8 Kv., 14/6.
MAINS TYPE, RM1, 125 v.; 60 mA, 5/-; RM2, 100 mA., 6/-; RM3, 120 mA., 8/-; RM4, 250 v. 275 mA., 16/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 ma., 8/6; 250 v. 85 ma., 9/6.
COILS. Wearite, "P" type, 3/- each. Osmor Midget "Q" type adj. dust core, 4/- each. All ranges.
TELETRON. L. & Med., T.R.F., A/HF., 7/- pair.
H.F. Chokes RFC4 2/6 each.
M.W. XTAL COIL HAX, 3/-, L.W. 3/6.

JASON F.M. TUNER COIL SET. 22/6. H.F. coil, aerial coil, Oscillator coil, two I.F. Transformers 10.7 Mc/s., Detector transformer and heater choke. Circuit and component book using four 6AM6, 2/-. J.B. Chassis and Dial, 19/6. Complete Kit, £5/18/6. With Jason superior calibrated dial, £6/15/-.

CONDENSERS. New stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto 20 kV., 9/6; 100 pf. to 500 pf. Micas, 6d.; Tubular 500 v. .001 to .01 mfd., 9d.; .05, .1, 1/-; .25, 1/6; .5, 1/9; .1/350 v., 9d.; .1/600 v., 1/3; 1 mfd., 2,000 v., 4/-.
CERAMIC CONDS. 500 v., .3 pf. to .01 mfd., 10d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf. 1/3. DITTO 1% 1.5 pf. to 500 pf. 1/9; 515 pf. to 5,000 pf., 2/-.

NEW ELECTROLYTICS. FAMOUS MAKES.

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	100/25 v.	3/-	8+16/450 v.	5/-
2/450 v.	2/3	8+8/500 v.	4/6	16+16/500 v.	6/-
4/450 v.	2/-	16+16/500 v.	6/-	6,000 mfd. 6 v.	6/6
8/450 v.	2/3	CAN TYPES		32+32/350 v.	4/6
8/500 v.	2/9	Clips	3d.	32+32/450 v.	6/6
16/450 v.	3/6	16/450 v.	3/6	64+120/275 v.	7/6
16/500 v.	4/-	32/350 v.	4/-	60+100/350 v.	11/6
32/450 v.	5/6	64/350 v.	5/6	100+200/257 v.	10/6
25/25 v.	1/9	100/275 v.	5/6		
50/25 v.	1/9	50+50/350 v.	7/-	1,000+1,000/6 v.	6/6
50/50 v.	2/-	500/12 v.	3/-		

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ amp. 13/6; 4 amp., 21/-.
All BERNARDS books in stock.
VALVE EQUIVALENTS MANUAL, 5/- each.
ACID HYDROMETER. New ex. Govt. Unbreakable. Packed in metal case 7 × 1¼in., 4/6.

VALVES

All Boxed			New & Guaranteed	
8/6	5/6	1/6 EA50	6/6	10/6
1R5	6B8	954	6AL5	5Z4
1T4	9D2		6J5	12AT7
1S5	EF50	2/6	6K6	EBC41
3S4	Equip.	E1148	6K7G	ECL80
3V4	8P61	EB34	EB91	ECH42
5U4	8P41	3/6	HVR2	EF41
6AM6	EF92	(near)	(near)	EF80
6AT6		6D6	EF36	EL41
6K8		6H6M		EL84
6SL7	7/6	7/6	7/6	EZ40
6SN7	6BE6	6V6G	EL32	MU14
6V6GT	6BW6	6X4	HVR2A	12Q7
EBC33	6F6	6X5	PEN25	PY18
EF50	6K6GT	807	VP23	35Z4
Sylv. Red		EF39		6Q7
EF91	11/6			X79
EZ80	EY51.—U25 PL81			

We have no connection with any other firm. Please address all Mail Orders correctly as below.

RADIO COMPONENT SPECIALISTS

307 WHITEHORSE RD., WEST CROYDON
OPEN ALL DAY—(Wed. 1 p.m.) *10-page list 3d.*

Tel. THO 1665. Buses 133 or 68 pass door. S.R. Stn. Selhurst. **48-hour postal Service.** P. & P. 1/-, £2 orders post free (Export extra.) C.O.D. Service 1/6

PUBLICATIONS, ETC.

No. 134. F.M. Tuner Construction 2/6
No. 138. How to Make Aerials for TV (Bands 1 and 3) and V.H.F. (Band 2) 2/6
No. 135. All-dry battery Portable Construction 2/6
No. 100. A Comprehensive Valve Guide, Book No. 1 ..... 5/-
No. 121. A Comprehensive Valve Guide, Book No. 2 .. 5/-
No. 103. Radiofolder "A" .. 1/6
No. 114. Radiofolder "E" .. 2/6
No. 128. Practical Transistors and Transistor Circuits 3/6
No. 140. TV Servicing for Beginners 4/6
No. 142. Modern TV Circuitry and General Fault Finding Guide 4/6
Servicing the Modern Radio Receiver 1/6
(Please include 4d. postage per copy.)

"Loudspeakers," by G. A. Briggs. The why and how of good reproduction 7/6
Mullard High Quality Reproduction 3/6
"Wearite Manual of the Tape Deck" 3/6

TWO HIGHLY INFORMATIVE PUBLICATIONS

The G.E.C. Nine One Two Plus, 4/-. The FM plus Tuner for the Nine One Two, 2/6.

T.S.L. HIGH STABILITY FM/VHF TUNER, with visual tuning indicator. 6 valves. Send for full descriptive leaflet, £17/10/-.

Belling Lee cross over boxes. Diplexers, 13/- each.

Spencer West Pattern Remover, 25/- each.

Aerialite 153 outlet box. 4/6 each.

Cinch Paxolin Duodecal C.R. Tube Sockets, 9d. each.

THESE AND MANY OTHER COMPONENTS ARE LISTED IN OUR CURRENT CATALOGUE. SEND A 1/- FOR YOUR COPY.

CYLDON TURRET TUNER Conversion to I.F. (no patterning). Nine versions covering three major I.F. Bands, 10 mc/s, 16 mc/s., 38 mc/s., and 3 valve heater supplies (6.3 v., 100 M/A., and 300 M/A). Send for full descriptive leaflet, £7/7/- each.

OSMOR COIL PACKS. Type HO 52/6, Type MTS 52/6. HF stages for above 21/- each. Circuits, etc., supplied with each unit.

JACKSON BROS. TYPE U101/SS CONDENSERS. Split stators available, 3/10 PF, 3-8-27 PF, 4-35 PF, 4-43 PF. 10/9 each.

T.S.L. Lorenz LPH 65 Treble Speakers, 39/6 each.

ELSTONE MAINS TRANSFORMERS. All to full specification.
MT/3M for Mullard 3 watt amplifier, 35/-.
MT5/10 for Mullard 5/10 watt amplifier, 36/-.
MT/MU for Mullard 5/10 watt amplifier, with FM tuner and pre. amp., 42/6.
MT/912 for G.E.C. amplifier 912 Plus, 40/6.
MT/912 AFM for G.E.C. FM or AM Tuner units, 29/6.
ELSTONE OUTPUT TRANSFORMERS.
OT/3 for Mullard 3 watt amplifier, 21/-.
OT/6 for Mullard 5/10 amplifier low loading, 45/- each.
OT/8 for Mullard 5/10 amplifier, normal loading, 45/- each.
OT/912 for G.E.C. 912 Plus Amplifier, 45/- each.
MT/M1 for T.S.L. FM Tuner Unit, 29/6 each.

MAINS TRANSFORMER. TE6, 200/250 volts. Secondary 250 v., 40 M/A., 6.3 v. 1.5 a., 15/- each.

3 WATT AMPLIFIER. A.C. mains. NEG feed back. Tone and vol. controls. Fully wired and ready for use. 82/6 each.

TYANA SOLDERING IRON. 4 oz. Heats up in 3 mins., 200/220 volts or 230/250 volts, 16/9 each.

JUST RECEIVED
The New Bernards "At a Glance" valve equivalent book. Over 3,000 valves listed, 5/- each. Post 4d.

RECTIFIERS

RM4	16/6	RM1	4/6
RM2	5/6	RM3	7/6

RESISTORS ASSORTED
½, ¼ and 1 watt 12/6 per 100. Brand new.

Portable Cases 8½in. × 8½in. × 4½in., complete with chassis, dial, etc.. 35/- ea. Post 2/6.
As above size 11½in. × 8½in. × 4½in., 25/- each. Post 2/6.
2 gang condensers, miniature 7/6.
I.F. Transformers 9/- pair.

Twin Ribbon Feeder cable 300 ohms impedance. 6d. yard.
Osmor Band I filter (rejects B.B.C. signal, easy to fit). 10/- each.
Aerialite 3 Element add on Band III aerials. 30/- each.
Aerialite 5 Element add on Band III aerials. 41/- each.

CONTACT COOLED RECTIFIERS

Half Wave	Full Wave
125 v. 80 m/a 5/- ea.	250 v. 75 m/a 9/-
250 v. 50 m/a 9/- ea.	250 v. 125 m/a 11/6.
250 v. 85 m/a 10/- ea.	

PENCIL RECTIFIERS
K3/25 5/-, K3/40 7/-, K3/45 7/3, K3/50 7/9, K3/60 8/9, K3/100 11/-.

STC RECTIFIERS
RM1 4/6. RM2 5/6. RM3 7/6. RM4 16/6. RM5 20/-.

WESTINGHOUSE RECTIFIERS
14A97 13/6 ea. 14A100 19/6 ea. WX6 2/9 ea.

HEATER TRANSFORMERS
All 230/250 volt input.
2 v 3 a. 8/3 ea. 4 v. 1.5 a. 5/6
4v. 3 amp. 10/- ea.. 5 v. 2 a. 10/- ea.
6.3 v. 1.5 a. 6/9. 6.3 v. 3 a. 10/- ea.
12 v. .75 a. 5/9 ea.

WAVE CHANGE SWITCHES
3 pole 4 way 2/9 ea. 4 pole 3 way 2/9 ea.
4 pole 1 way 1/9 ea. 1 pole 12 way 2/9 ea.
2 pole 6 way 2/9 ea.
All have long ¼in. spindles.

MAINS TRANSFORMERS

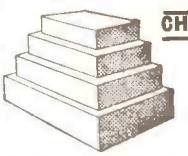
3-way Mounting Type

MT1
Primary: 200-220-240 v.
Secondaries: 250-0-250 v. 80 M/A, 0-6.3 v. 4 amp., 0-4 v. 2 amp., both tapped at 4 v., each 19/6

MT2
Primary 200-220-240 v.
Secondaries. 350-0-350 v. 80 M/A. 0-6.3 v. 4 amp., 0-5 v. 2 amp., both tapped at 4 v., each 19/6

MT3
Primary: 200-220-240 v.
Secondary: 30 v. 3 amp. Taps at 3 v., 4 v., 6 v., 8 v. 9 v., 10 v., 15 v., 18 v., 20 v. 24 v., each 19/6

2/- Packing and Post on above transformers.



CHASSIS

Aluminium undrilled with reinforced corner. Available in the following sizes.

	Each		Each
6×4×2½in.	4/6	12×8×2½in.	8/6
8×6×2½in.	6/3	14×3×2½in.	6/-
10×7×2½in.	7/3	14×9×2½in.	12/-
12×3×2½in.	5/9	16×6×2½in.	8/6
12×5×2½in.	6/9	16×10×2½in.	14/-

All are four-sided—ideal for radio receivers, amplifiers, power packs, etc.

CONTROL KNOBS IN MODERN STYLING
Tastefully and clearly engraved in gold. These mouldings are available in two colours: walnut and ivory. They are suitable for use with ¼in. spindles and are simply and firmly held by means of a grub screw and locking nut.
Prices: Type "A" 1/6 each. Type "B" 1/2 each.

PIFCO ALL-IN-ONE RADIO METER. A.C. or D.C., L.T. and H.T. tests. M/A tests. Many uses. 32/6 each.

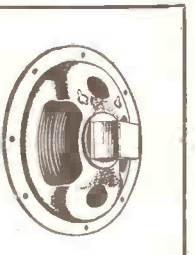
COSMOCORD MICROPHONES.
Type MIC 33-1, 50/- each.
Type MIC 35-1, 25/- each.

SOLON SOLDERING IRONS.
65 watts, oval bit. All voltages. 29/-.
65 watts, pencil bit. All voltages, 30/9.
All spares for these irons available from stock, 25 watts instrument iron 24/- each.

LOUDSPEAKERS

ALL P.M. TYPES LESS TRANSFORMER

Waterhouse 5in. unit	17/6 ea.	Lectrona 5in. unit..	17/6 ea
Plessey 6½in. unit..	18/6 ea.	Goodmans 6½in. unit	18/6 ea
R. & A. 8in. unit..	19/6 ea.	Goodmans 8in. unit	19/6 ea.
Plessey 12in. unit..	35/- ea.	Goodmans 4 × 7in. unit	19/3 ea
R. & A. 6½in. unit, mains energised, 600 ohms field			17/6 ea.
Plessey 8in. unit, mains energised, 600 ohms field			21/- ea.
Goodmans or Lectrona 8in. unit with output transformer			21/6 ea
Elliptical Speaker 10in. × 6in. 25/- each. Baker Selhurst 12in. Heavy Duty Unit 15.Ohms. Speech Coil, 20 watts, £5/5/-.			

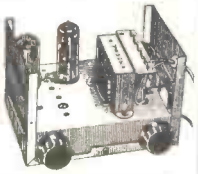


COMMERCIAL TELEVISION CONVERTER

SUITABLE ANY T.V. using lower side band

NO ALTERATIONS TO SET

Complete with built-in power supply, 230-250 v. A.C. mains. Case 5½in. long, 3½in. wide, 4½in. high. Incorporating gain control and band switch.

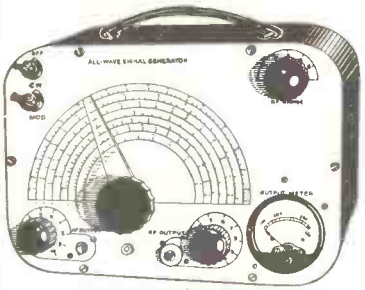


£3/19/6 Plus Post & Packing 2/6.

Illustrated with cover removed.

COMPLETELY BUILT SIGNAL GENERATOR

Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale, 6½in. × 3½in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation or 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F., output continuously variable 100 milli-volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

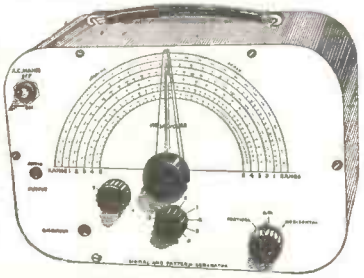


£4/19/6

or 34/- deposit and 3 monthly payments 20/-. P. & P. 4/6 extra.

SIGNAL & PATTERN GENERATOR

Coverage 7.6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning, audio output, 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ± 1%. A.C. mains 200-250 v.,



£6/19/6

P. & P. 5/6.

Or £3 deposit, P. & P. 5/6 and 3 payments of 30/-.

TRANSISTORISED MEDIUM & LONG WAVE CRYSTAL SET KIT

In plastic cabinet comprising transistor, tuning condenser, iron-cored coil, etc., **19/6** P. & P. 1/6.

Point to point wiring diagram **1/-**. Free with kit.

A.C. MAINS 3 VALVE CHASSIS

Comprising chassis, tuning condenser, coils, valves, valve holders, volume control, resistors, condensers, **19/6**

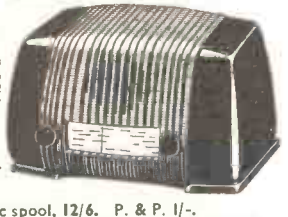
Point to Point wiring diagram **1/-**, Free with kit. plus 2/6 P. & P.

BATTERY CHARGER 6 or 12 v. 4 amp.

A.C. Mains 200-250 v. Fitted ammeter, selector switch, fuses battery clips, indicator lamp. Incorporating G.E.C. Metal Rectifier. Ready for use. In grey hammer finish case. Wall fixing, **59/6.** P. & P. 3/6.

T.R.F. KIT IN PLASTIC CABINET

3 valve plus metal rectifier, A.C. mains 200-250 v. Medium and long waves. In pastel blue or brown. Valve line-up: 2 VR65S and VT52. Size 15½in. long by 9in. high by 7in. deep.



£3/19/6 P. & P. 4/6.

A point-to-point wiring diagram, 1/6. Free with complete kit.

All parts supplied separately.

1,200 ft. Recording tape on plastic spool, 12/6. P. & P. 1/-.

Mains transformer, Primary 110-250. Secondary 0-120-180-200 v. 60 mA, 6.3 v. 2 amp., 10/6. P. & P. 2/-.

8 mfd. 450 wkg. can. size 2" × 1". 1/3 each. 12/- doz.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

23 ACTON HIGH STREET, LONDON, W.3

GOODS NOT DISPATCHED OUTSIDE U.K.

RADIO-GRAM CHASSIS

5 VALVE SUPERHET, LATEST B.V.A. MIDGET SERIES VALVES

3-WAVEBANDS:—*L.W. 800m-2000m, M.W. 200m. 550m, S.W. 16m-50m.* Chassis size 13½ × 5½ × 2½in. Attractive Glass Dial 10 × 4½in. edge lit by 2 pilot lamps. Horizontal or Vertical Station Names and 4 control knobs, walnut or ivory to choice, 4 position W/C switch, L.M.S. and Gram. P.U. sockets. Modern circuitry, all coils adjustable, dust cored and only quality components used throughout. Delayed A.V.C. and neg. feedback. A.C. mains 200-250 v. Double wound transf. isolates chassis from mains. Aligned and calibrated ready for use.

BRAND NEW & GUARANTEED £9.19.6 Carr. and ins. 4/6

8" and 10" speakers suitable for this chassis available.

7-Valve De Luxe, push-pull version 7 watt output £12.10.0. Carr. & ins. 5/-

MULLARD "3—3" QUALITY AMPLIFIER

An ideal companion unit to the JASON Tuner. A really first-class 3-valve 3-watt Amplifier giving Hi-Fi quality at a reasonable cost. Mullard's latest circuit Valve line up: EF86, EL84, EZ81. Extra HT and LT available for Tuner Unit addition.

Variable treble cut and bass boost controls sensitivity 100 MV for 3-watt output. Frequency response + or — 1 db, 40 c/s to 25 kc/s.

Complete amplifier wired and tested with quality sectionalised output transformer to Mullard specification (less speaker) **£8 . 8 . 0** Carr and ins 4/6.

ELECTROLYTICS *Leading Makes New Stock*

TUBULAR		CAN TYPES	
25/25 v., 50/12 v.	1/9	8+8/450 v.	4/6
50/50 v. 4/500 v.	2/-	8+16/450 v.	5/
100/25 v.	1/9	8+16/500 v.	5/6
8/450 v.	2/3	16+16/450 v.	5/6
8/500 v.	2/9	16+16/500 v.	6/-
8+8/500 v.	4/6	16+16+8/350 v.	5/6
8+16/450 v.	5/-	32+32/350 v.	5/6
16/450 v.	3/6	32+32/275 v.	4/6
16+16/450 v.	5/6	50+50/350 v.	6/6
32/350 v.	4/-	60/350 v.	6/6
32/500 v.	5/-	60+250/275 v.	12/6
32+32/350 v.	5/6	64+120/275 v.	11/6
32+32/450 v.	6/6	100+200/275 v.	12/6
		100/270 v.	6/6

CONDENSERS.—Mica, Silver Mica. All pref. values, 3 pf. to 1,000. 6d. each. Ditto ceramics 9d. each. Tubulars, 450 v. Hunts and T.C.C. .001 mfd.-.01 and .1/350 v., 9d. each. .02-1/500 v., 1/- each. .25 Hunts, 1/6. .5 Hunts, 1/9.

80 ohm CABLE CO-AXIAL

SPECIAL.—Semi-air spaced polythene standard ¼in. diam. Stranded core. Feeder losses cut 50%. 9d. yard.

Standard ¼in. Grade A, 8d. yard.

COAX PLUGS 1/2. SOCKETS 1/-.

COUPLERS 1/3. OUTLET BOXES 4/6

BALANCED TWIN FEEDER per yd., 6d.

Special 300 ohm. TWIN FEEDER 8d.

TWIN SCREENED FEEDER per yd., 1/3.

50 OHM COAX CABLE 8d. per yd., ½in.

ATTENUATORS 6db, 12db, etc., from 4/6. Band 1-3 Cross-over filter unit from 7/6.

SPEAKER FRET.—Expanded Bronze anodised metal 8 × 8in., 2/3; 12 × 8in., 3/-; 12 × 12in., 4/3; 12 × 16in., 6/-; 24 × 12in., 8/6, etc.

TYGAN FRET (Murphy pattern) 12in. × 12in., 2/-; 12 × 18in., 3/-; 12 × 24in., 4/-, etc.

JASON F.M. TUNER UNIT 87-105 m/cs

Kit of parts to build this modern and highly successful unit complete with drilled chassis and J.B. dial, wound coils and screening cans, 4 BVA miniature valves and all necessary quality components, etc., for only £6/10/- post free. Superior dial calibrated mc/s. edge lit by 2 pilot lamps, 12/6 extra, as illustrated. Power Pack components kit including double wound mains transformer, £2/5/- extra.

Tested and approved by "Radio Constructor," etc. Illustrated handbook with full details, 2/-, post free.

RESISTORS

Carbon type. Pref. values 10 ohms-10 megohms, 20% Tol. ½ w. 3d.; ½ w. 5d.; 1 w. 6d.; 2 w. 9d.; 10% Tol. ½ w. 9d.; 5% Tol. ½ w. 1/-; 1% Hi-stab. ½ w. 2/-.

WIRE WOUND TYPES

Wire ends. Silicone coated. 25 ohms-10,000 ohms, 5 w., 1/3. 10 w. 1/6, 15 w. 2/-.

LINE CORD .3a, 60 ohms per ft., .2a. 100 ohms per ft., 2 way 6d. per ft., 3 way 7d. per ft.

LOUDSPEAKERS

P.M. 3 OHM, 5in. Celes., 17/6; 6in. Celes., 18/6; 7 × 4in. Goodman's Elliptical 18/6; 8in. Elac., 20/-; 10in. R. and A. 25/-; 12in. Plessey, 35/-; 12in. Plessey, 16/6; Goodman's 12in. Audiom 50, 15 ohms, £4/15/0.

S.T.C. RECTIFIERS

E.H.T. types, K3/25 2 kV., 5/-; K3/40 3.2 kV., 6/9; K3/45 3.6 kV., 7/3; K3/50 4 kV., 7/9; K3/100 8 kV., 12/9, etc. Mains types. RM1 125 v. 60 mA., 4/6; RM2 125 v. 100 mA., 4/9; RM3 125 v. 120 mA., 6/9; RM4 250 v. 250 mA., 16/-. RM4B type 250 v. 275 mA., 17/6. LT types F/W bridge 6-12v. 1½ a., 8/9; 4 a., 15/6: 4 a., 18/6: 6 a. 24/6 each.

PRE-SET W/W POTS

T.V. knurled slotted knob type. 25 ohms to 30,000 ohms, 3/-; 50,000 ohms 4/-; 50,000 ohms to 2 Megohms (carbon). 3/-.

VOLUME CONTROLS

Midget log type, long spindles, all values 10,000 ohms to 2 Megohms. Less sw., 3/-; S.P. sw., 4/-; D.P. sq., 4/9. Linear types all values 10,000 ohms to 2 Megohms less switch 4/-. Guaranteed 12 months.

TRS RADIO COMPONENT SPECIALISTS

70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Phone: THO 2188. Hours 9 am.—6 pm., 1 pm. Wed. Open all day Saturday. By THORNTON HEATH STATION. BUSES 130A, 133, 169, 166, 190.

Terms: C.W.O. or C.O.D. Kindly make cheques, P.O.s, etc., payable to T.R.S. Post & Packing up to ½lb. 7d., 1lb. 1/1, 3lb. 1/6, 5lb. 2/-, 10lb. 2/9. Bargain Lists, 3d.

Career opportunities in industrial electronic control

Electrical Engineers! If you have an interest in the electronic field but are without this type of experience your application will be welcomed since special training may be arranged for selected personnel.

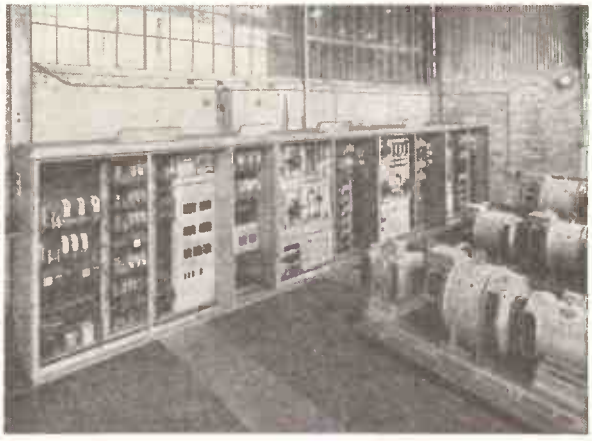
A career with a difference awaits you with Britain's leading manufacturers of *industrial* electronic equipment. Be in the forefront of the drive to supply industry with the automatic control equipment for the needs of today—and tomorrow!

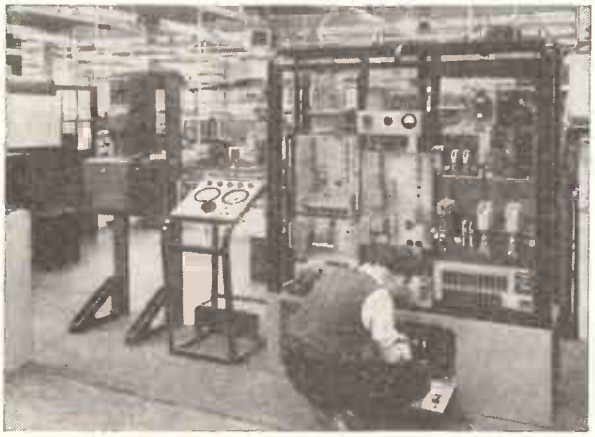
Positions at both senior and junior levels are available for :

- **DESIGN ENGINEERS**
- **DEVELOPMENT ENGINEERS**
- **TECHNICAL WRITERS**
- **APPLICATION ENGINEERS**
- **SALES ENGINEERS**
- **SERVICE ENGINEERS**
- **TEST ENGINEERS**
- **DRAUGHTSMEN**

Apply to Reference NDA at the address below

Equipment currently produced and under continuing development includes: control equipment for electrical machines of all types, specialised drives, regulators, machine tool controls, servo amplifiers and systems, process control equipment, photo-electric equipment, resistance welding controls, computer power supplies, protective and supervisory equipment and a wide range of specialised equipment to meet specific industrial requirements.





LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD

RUGELEY, STAFFORDSHIRE, ENGLAND

Manufacturers of Britain's widest range of industrial electronic equipment

One of the Lancashire Dynamo Group of Companies

ASSISTANT CHIEF ENGINEERS REQUIRED WHO WILL BE RESPONSIBLE FOR DEVELOPMENT TEAMS WORKING IN THE FOLLOWING FIELDS:

1. T.V. components design and circuit application.
2. Transistor and computor circuit components.
3. Low power and audio frequency transformers.
4. R.F. and I.F. components and filter design.
5. Component design with special reference to ferrite application.

Applicants should have several years' experience as team leaders in at least one of these fields with general qualifications to B.Sc. level. An attractive salary will be offered to selected candidates. Please reply, in confidence, giving full details of qualifications and experience to **Box No. 6434.**

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

requires an ASSISTANT DESIGN ENGINEER in the Engineering Services Division, for design and specification of SMALL TRANSFORMERS.

Qualifications: Recognised engineering apprenticeship or equivalent training: H.N.C. or equivalent and good Drawing office experience. Experience in transformer design or manufacture an advantage.

Salary: £795-£1,210.

Send POST CARD for further details and an application form, which must be returned by April 15th, 1957, to **Establishment Officer, A.E.R.E., Harwell, Berks,** quoting: **725/45.**

MARCONI INSTRUMENTS LTD.

TECHNICAL PERSONNEL REQUIRED

SENIOR AND JUNIOR ELECTRICAL DESIGN ENGINEERS

SENIOR AND JUNIOR MECHANICAL DESIGN ENGINEERS

DUTIES: To undertake the design of Test Equipment covering practically the whole electronic field, including Telecommunication, Guided Weapons and Nucleonics. Considerable personal responsibility and freedom is given and there are no set rules regarding the number of people engaged on a project, the allocation of project leaders, etc.

QUALIFICATIONS: The ability to design equipment, and aggressively progress a project through to the stage where a model is made and the information is available for a production drawing office. Senior engineers are usually of B.Sc. standard with practical experience in measuring techniques, while Junior Engineers are often Graduate Members of one of the Professional Institutions, or, have similar qualifications, but this is in no way mandatory. The ability to progress the project through to a satisfactory conclusion is the prime requirement. Due to expanding activities men with drive and initiative can be sure of progressive advancement.

Comprehensive pension and assurance schemes are in operation and Canteen and Social Club facilities are provided. On well-served transport routes.

HOLIDAY ARRANGEMENTS MADE CAN BE MAINTAINED

Write for interview to:—

DEPT. C.P.S., 336/7, STRAND, W.C.2

or call any day including Saturday mornings at:—

MARCONI INSTRUMENTS LTD., LONGACRES, HATFIELD ROAD, ST. ALBANS, HERTS

MARCONI INSTRUMENTS Ltd.

This Company has an immediate vacancy at St. Albans in their Technical Literature (Telecommunications) Section; the applicants should have electrical engineering qualifications and/or experience in the design or development of electronic equipment; the duties are varied and interesting and the post provides a permanent and pensionable position in a well-established Company. Apply Marconi Instruments Ltd., Longacres, Hatfield Road, St. Albans, Herts., quoting Ref. WW 2976A.

MICROWAVE DEVELOPMENT DEPARTMENT

Excellent opportunities exist for engineers with experience in the following aspects of multi-channel and Television link development.

Waveguide components.
Intermediate Frequency Amplifiers.
Modulators and Demodulators.
Multi-channel carrier techniques.
Installation and overall system testing.

Applications, giving full details of qualifications and experience to the

Personnel Manager, Pye Telecommunications Ltd., Ditton Works, Cambridge.

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF ELECTRICAL ENGINEERING

SENIOR ELECTRONICS TECHNICIAN REQUIRED, to take charge of a new electronics workshop for constructing and maintaining laboratory equipment. Salary within the scale £560 to £660 per annum. Good prospects of promotion. Form of application and conditions of appointment from Mr. H. Pickbourne, Registrar.

SENIOR DRAUGHTSMEN

Due to expansion of the Electronics Division of The Plessey Company Limited, there are several vacancies for experienced men in the following fields:

1. Design of a wide range of electronic equipment, including work to service requirements.
2. Mechanical design of precision mechanisms for quantity production.

These vacancies carry attractive salaries and long-term prospects in reward for hard work and offer good staff conditions, including superannuation and insurance schemes. Applications, which will be treated in confidence, should be addressed to:

THE PLESSEY COMPANY, LIMITED, VICARAGE LANE, ILFORD, ESSEX

Ferranti Limited, Edinburgh

require an

ELECTRONIC ENGINEER

with Radar experience.

for their Trials Division to take charge of a small team of Engineers who will be engaged on the Field Evaluation Trials of an experimental C.W. Radar installation. Although primarily based at Edinburgh, this post will require the applicant to spend approximately 18 months, after initial training at Base, in the South West area. Applicants should possess the Higher National Certificate in Electrical or Electronic Engineering, or suitable equivalent, and have had at least 3 years' experience in Radar systems. Please apply to the Personnel Officer, Ferranti Limited, Ferry Road, Edinburgh 5, quoting Ref. EE/TID.

Wireless World Classified Advertisements

Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day May 1957 issue, Thursday, March 28th. No responsibility accepted for errors.

WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

EPIGRAM model 3-3-3, transistor 3-speed fully portable record reproducer.
EPIGRAM fully portable amplifier with built-in power supply, independent of the mains.
FOR details and nearest dealer, write to W.W., Penco Products, Kings Langley, Herts, England. [6728

SHIRLEY LABORATORIES, Ltd., 3, Prospect Place, Worthing, Sussex. Tel. 30536.
THE TWA/1515 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts O/P each channel, 96gns; TWA/15 tape recording and reproducing amplifier, 13watts O/P, for Wearite and Collaro decks, 45gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier, exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

BEFORE buying that replacement chassis we suggest you send for literature; save yourself money by buying direct from us; our chassis have separate channels for AM and FM, variable N.F.B. tone control; 4-position w/c switch FM, Med. Long, Gram; trade enquiries invited; 2½d stamp for leaflets.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [6820

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

R.1155, power pack, speaker; bargain £8.—Griffiths, 354, Ilford Lane, Ilford. Ilf. 1197. [6854

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

R.F. Unit No. 2 for Receiver R.209, comprises compact unit approx. 6½×7½×7½ deep with RF stage (IT4) Osc. (IT4) and mixed stage (IR5) covers 4 bands 1-20mgs with super tuning drive (calibrated) and band spread dial marked 0-100 degrees; stabilized oscillator supply; the ideal front end for any communication receiver; complete with valves and brand new in makers packing; this unit could be easily altered for a.c. supply using 2-Z77 & X78 valves; complete as above 69/6 & 2/6 post & packing; or complete with stabilizer but less valves 39/6 plus 2/6 post and packing.
WALTONS WIRELESS STORES. 46, 47 & 48, Stafford St., Wolverhampton. [0146

"WIRELESS World" 7-valve F.M. tuner, unused, with cathode follower, magic eye, and power supply for use on 200-250 volts A.C., fitted with latest type F.M. components of the highest grade including specified temperature compensating capacitors; price £14/15 including 7 valves; accurately aligned and tested ready for use; approx. half original price, exceptionally good reproduction, ideal for use with all high fidelity amplifiers and recorders; as above but including high-grade cabinet 14½in×9½in×9in, £18/10, limited number; bargain; above are despatched by passenger train in boxes lined with foam rubber to ensure safety in transit.—Box 5084. [6741

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

BRIDGE connected rectifier units (large), 12 and 24V charging auto cut-outs, 300 amp starter relays, 12 and 24V working, heavy duty starter pushes; please see advert of October's "Wireless World," page 175.
T. W. PEARCE, 66, Great Percy St., W.C.1. [0012

TEST EQUIPMENT—SURPLUS AND SECOND-HAND

SALE: Instruments unused.
HOMELAB pattern generator type 4, 200/250v; offered £6/10.
AVO electronic test meter, No. 6088, list £40; offered £30.
AVO signal generator mains model 230v, 50w; list £30; offered £22/10.
E.I. & M.R., Ltd., 23, Brook St., Huddersfield. [6841

TEST EQUIPMENT—SURPLUS AND SECONDHAND

TELEVET 877 by Airmec, as new, unpacked, cost £66; accept £46; ill-health; genuine bargain.—Bond, 11, Ashbridge Rd., Coventry. [6863

ADVANCE type E.1 signal generator, £10; Taylor multimeter 88A, £10; Wayne Kerr component bridge B101, £16, or nearest offers. —Cookson, 34, Bridge End Place, Brighouse, Yorks. [6880

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0056

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic 6/4), still in steady demand by Hams and Sound Engineers; guaranteed newly made and boxed; 15/6 post free.—Radio-Aids, Ltd., 29, Market St., Watford. [0169

COMPONENTS—SURPLUS AND SECOND-HAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188.
ELECTROLYTICS: Capacity, voltage, size, type of mounting, price post paid, 25, 25v, ⅝×1¾, W/E, 1/3; 500, 12v, ¾×¾, W/E 2/1; 1,000+1,000, 6v, 1×3, clip, 3/3; 1,000, 6v, 1×2, clip, 2/3; 1,000+2,000 6v 1×3, clip, 3/9; 100, 12v, ⅝×1¾, clip, 1/9; 2,000, 12v, 1⅜×2, clip, 3/6; 50, 25v, ⅝×1¾, clip, 1/9; 100, 25s, ¾×1¾, 2/-; 1,000, 25v, 1×3, clip, 4/-; 3,000, 25v, 1⅜×4½, 5/-; 5,000, 25v, 1¾×4½, 6/6; 2,500, 50v, 1¾×4½, 6/6; 5, 150v, ⅝×1¼, W/E, 1/3; 8, 150v, ⅝×1¼, clip, 1/3; 40+40, 150v, 1×2, clip, 2/9; 100, 275v, 1⅛×3, clip, 3/-; 60+250, 275/350v, 1¾×4½, clip, 6/-; 16+24+8, 450/525v, 1¾×2, clip, 5/-; 20+10, 450v, 1×3, clip, 4/-; 8, 500v, 1⅜×2¾, clip, 2/3; 32+32+8, 350/425v 1¾×3, clip, 5/-; 32+32, 350/425v, 1¾×2, clip, 4/-; 100, 350/425v, 1¾×3, clip, 4/-; 2, 350v, ⅝×2, 1/3; 16+16, 275v, 1×2, clip, 3/-; 32+32+8, 275v, 1¾×2, clip, 4/3; 100+200, 350v, 1¾×4½, clip, 7/-; 50+50, 350v, 1⅛×3, lug, 4/6; 200, 250v, 1⅜×3, clip, 3/6; 16+8+4, 275v, lug, 3/-; 200+250+250, 275v, 2×4½, clip, 8/6; 32, 450v, 1⅛×2, W/E 3/9; 60+100, 350v, 1⅝×4½, clip, 6/6; 50+50+50, 350v, 1¾×3, lug, 5/6; all ALI cans, some with sleeves, all voltages WKG, surve V where marked, all new stock guaranteed.
TELEVISION chassis, cadmium plated steel; size 14×13×2¼in. complete with 13 valve holders (9-B9A Pax, 1-B9A Cer, 2-B7G Cer, 1-Int. Oct. amph), 20 various tag strip cut away for metal rect., line trans., etc., 9/11 each, post paid.
FRONT and rear tube mounts to fit above chassis, 3/- pair post paid.
P.M. focus rings, wide angle, tetrode tube, fully adjustable, 9/11, post paid.
SCANNING coils, wide angle, with mounting lugs 19/6, post paid.
T.V. metal rect. 250v 250mA, H.W. size 2¼×4in, 12/6, post paid.
C.T.V.IF's 34Mc/s, 2nd, 3rd, 4th, vision cans 13/16×13/16×2½, slug tuned, set of three 5/6 post paid.
100Ω w/w pots, 3w, 1in spindle; 2/6.
RADIO CLEARANCE, LTD., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport St., London, W.C.2. See our displayed advertisement, page 177.
MAGSLIPS at low prices, fully guaranteed, 3 in Resolver No. 5 (AP 10861), 50v; 50c/s, unused, each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

NEW GRAMOPHONE AND SOUND EQUIPMENT

TRANSISTOR Hi-Fi Amplifiers, 4 watts, shortly; Reflectograph Tape Decks, £33; Hi-Fi R./P. Amplifiers, 6 watts, U./L. output, 25gns.
COLLARO Mk. III decks £22, Amps. 23 and 25gns. 'Phone Gladstone 1770.
HARDING ELECTRONICS, 120A, Mora Rd., Cricklewood, London, N.W.2. [0032

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice versa.—Victor Morris, 406, Argyle St., Glasgow, C.2. [0201

RECORDERS by Ferrograph, M.S.S., Brenkell, Leevers Rich; unrivalled Mastertape, as used in our studio; extra-play tape, mics., disk recorders, blank disks, de-fluxers.
TAPE/DISK service, especially L.P.: full studio and mobile facilities.
"EROICA" RECORDING SERVICES (1949), Recorder House, Peel St., Eccles, Manchester. Ecc. 1624. Director: Thurlow Smith, A.R.M.C.M. [0122

CINE-VOX disc recording equipments, type C7J, for high-quality recordings from existing microphone equipment; price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7 for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Tel. Braunton 224. Callers by appointment only.

NEW GRAMOPHONE AND SOUND EQUIPMENT

TAPE recorders, Ferrograph, 76gns; Reflectograph, £87; Brenell, 48gns; tape decks, Wegrite, Collaro, Truvox, microphones, Reslo, STC, Acos amplifiers, Leak 27gns, Quad £42; high fidelity tape to disc service. LAMBDA RECORD Co., 4, Kimberley Ave., Liverpool, 23. [6884

ALL Hi-Fi enthusiasts please note! We are supplying the Collaro tape transcriptor complete with pre-amplifier and power pack ready to plug into any amplifier, for only 36gns. making it one of the lowest priced quality tape recorders on the market! A vast experience in tape recorders is at your disposal; all other makes in stock; easy terms available.—Sound Tape Vision (Dept. W.W.), 71, Praed St., London, W.2. Pad. 2807. [0211

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

E.M.I. high fidelity disc recording equipment, portable, little used, priced £180; offers over £100 invited.—Box 6424. [6830

PAM public address equipment, 15watt, twin 5in speakers, microphone; £10 or near offer.—U.M.C.A., 35, Great Peter St., Westminster, S.W.1. Abbey 2284. [6898

GRAMOPHONE AND SOUND EQUIPMENT—WANTED

CONNOISSEUR disc cutter wanted.—Alb. 4016. [6862

SECONDHAND Ferrograph or comparable tape recorder, perfect condition.—Watson, Eagle House, Sandhurst, Camberley. [6889

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 175. [0224

VALVES WANTED

NICE looking discarded radio valves for targets; quantities cheaply.—Frank, 4, Bookham St., London, N.1. [6864

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. [4485

WANTED, EXCHANGE, ETC.

WANTED, receivers A.P.R.4, also T.N.16, 17, 18, 19, etc., and any radio test gear. LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

WANTED, Hartley Turner 215 speaker.—Metcalfe, 121, Whitegate Drive, Blackpool. Tel. 24920. [6853

WANTED, electronic mixer, minimum 4 channels, 30 ohm inputs, self-powered, good specs. and condition essential.—Box 6876. [6872

EX Air Ministry accumulator capacity testing sets, universal type 5A/2181, serial No. 349, six wanted, good price paid.—Box 6117. [6773

WANTED, HRO coils, Rxs., etc., A.R.88s, BS348s, S27s, etc.—Details to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

CASH on the spot for second-hand tape recorders, amplifiers and Hi-Fi equipment, top prices paid.—Sound Tape Vision (Dept. W.W.), 71, Praed St., London, W.2. Paddington 2807. [0214

SPOT cash ready for purchase of surplus and bankrupt stocks of new valves and components; we sell plain valve cartons; list on request.—R. H. S., Ltd., 155, Swan Arcade, Bradford. [0190

WANTED, BC610 Hallicrafters, E.T.4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above; best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [6479

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638 Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [6059

WANTED, signal generators, types TF144G, TF762A, TF867, frequency meters types BC221, TS174, TS175, also receivers types R1359 and R1294.—Send price and details to Hatfield Instruments, Ltd., Crawley Rd., Horsham, Sussex. Tel. Horsham 3232/3. [0037

PROMPT cash for the purchase of surplus stocks of televisions, tape recorders, radios, amplifiers, and domestic electrical appliances of every description; substantial funds available.—Spears, 14, Watling St., Shudehill, Manchester. Blackfriars 1916. Bankers Midland Bank, Ltd. [6696

ALL U.S.A. V.H.F. test and communication equipment; TS174, TS175, TS47, B.C.221 freq. meters; receivers 1294, 1359; Hallicrafters S.27, S27CA U.S.A.; APR4 and tuning units TN16, 17, 18 and 19, RCA AR88D-LF, Hallicrafters SX28; valves 707A-707B, 2K28, 2K39, 2K33, 2K41; highest offers given by return.—Ger. 8410 and 4447.—Universal Electronics, 22, Lisle St., Leicester Sq., London, W.C.2. [0229

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification. MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed. F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0113

MAINS transformers, E.H.T.s, chokes, field coils, etc., promptly and efficiently rewound or manufactured to any specification. LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., London, N.W.10. [0222

REPAIRS AND SERVICE

USE Jefco coil winder, cheapest machine on the market.—Details, 170, London Rd., Southend-on-Sea. [0174

TRANSFORMER rewind service mains, E.H.T. transformers and chokes, prompt delivery, range of replacement types ex-stock or manufactured to your specification. METROPOLITAN RADIO SERVICE Co., 75, Kilburn Lane, London, W.10 Ladbroke 2296.

D. C. BOULTON for repairs to any loudspeaker; specialists on heavy and P.A. types; cone assemblies, field coils, repair accessories, pressure units, microphones; transformers rewound and to specification; motor rewinds.—134, Thornton Rd., Bradford, 1. Tel. 22838. [0171

MISCELLANEOUS

TAPE to disc; 12/6.—Mobile Recording Services, 5, New Brown St., Manchester. [6555

TAPE to disc.—Write, call or phone Queensway Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings. [6816

METALWORK, all types cabinets, chassis, racks, etc., to your own specification; capacity available for small milling and capstan work up to 1in bar. PHILPOTT'S METAL WORKS. Ltd., Chapman St., Loughborough. [0208

LYSONA Multi-Winder type Model 4, good working order, reel carrier requires attention; cost £1,250; bargain £495.—Apply Magneto Winding Co., Ltd., 75/77, Penrhyn Rd., Kingston. Tel. Kin. 4413. [6868

TAPE/DISC for connoisseurs, use Britain's oldest full-time transfer service; 30 min. 42/-; special prof. qual. tape, 25/- and 21/-.—Sound News Productions, 59, Bryanston St., W.1. Amb. 0091. [0192

TAPE to disc transfers, high quality microgroove; 45's from 15/-, 33's from 25/-; vari/g, c/b., etc., if required.—Write or call p.m. only, Laurel Disc Co., 5, Lonsdale Rd., W.11. [6801

NOTICES

BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J Houlgate, A.M.I.E.E., 12. Strongbow Rd., Eltham, S.E.9. [0031

AGENTS WANTED

PROGRESSIVE electronic manufacturer and D.O. requires free-lance agents with connections in industry to obtain business; exclusive territory arranged.—Box 5846. [6701

CAPACITY AVAILABLE

FACTORY Capacity available for the following categories:
PLASTICS Injection Moulding (3 oz).
ALUMINIUM Die-Casting.
LIGHT Engineering.
ELECTRONIC & Electrical Assembly. Location Wiltshire.—Box 0077. [0114

WORK WANTED

WORK wanted, P.T.F.E. supplied and machined, A.I.D. approved.—Bel Sound Products, Marlborough Yard, London, Archway, N.19. [0187

SITUATIONS VACANT

CANADA.

YOUNG, alert technician who likes hard work and is planning to emigrate soon required by small electronic service company in Niagara Peninsula; varied work, including Decca marine radar, industrial control, television, mobile and antenna erection; starting pay $60; 44-hour week; generous profit-sharing plan; an unusual opportunity with a rapidly growing firm; interviews U.K. early April; full particulars, photograph if possible, and telephone number please.—Box 6881. [6874

MURPHY RADIO, Ltd.

ELECTRONICS Division.
VACANCIES exist in a design laboratory for a senior and a junior engineer to work on the development of aerials for fixed, mobile and airborne use.
CANDIDATES should preferably have experience in the field, coupled with necessary mathematical ability.
POSTS are pensionable, sports club and other recreational facilities are available.—Applications should be addressed to: Personnel Department (E.35), Murphy Radio, Ltd., Welwyn Garden City, Herts. [6802

CENTRAL ELECTRICITY AUTHORITY

HEADQUARTERS
REQUIRE Engineers in the electronics and instruments section at the Research Laboratories, Leatherhead, Surrey, to assist in experimental and development work in the laboratory and in the field. Candidates should have a degree or equivalent qualification. Experience in one of the following an advantage: (a) Noise vibration, and harmonic measurement; (b) Field strength and voltage measurement at radio frequencies. Ability to calibrate equipment and analyse experimental data is also desirable. Salaries £735-£910 p.a. according to ability.—Applications to D. Moffat, Director of Establishments, Winsley St., London, W.1, by 18th April, 1957. Quote Ref. WW/82. [6866

SITUATIONS VACANT

ASSISTANT Foremen (Instruments).

VACANCIES exist with the Operations Branch of the Industrial Group of the United Kingdom Atomic Energy Authority at Dounreay Works, Thurso, Caithness, Scotland.
DUTIES.—To be responsible to the group engineer for the maintenance of physical and electronic instruments used for controlling chemical and nuclear reactor processes and services. The posts entail shift duty.
QUALIFICATIONS and experience.—Applicants must have served a recognised engineering apprenticeship or have had equivalent training in electronics. They must be skilled in the practice of instrumentation and have an aptitude for job instruction.
POSSESSION of an Ordinary National Certificate or equivalent may be an advantage.
SALARY.—£645 (at age 26)—£795 per annum. A contributory pension scheme is in operation.
HOUSES for renting by the Authority's staff are in course of erection at Thurso and hostel accommodation may be available for single and unaccompanied married persons; financial assistance towards removal expenses may be given in certain cases, as well as towards legal expenses incurred in private purchase.
SEND a postcard asking for an application form and quoting reference 1765 to the Recruitment Officer, U.K.A.E.A., I.G.H.Q., Risley, Warrington, Lancs. Closing date April 5, 1957. [6865

CENTRAL ELECTRICITY AUTHORITY

HEADQUARTERS
REQUIRE an Instrument Engineer in the electronics and instruments section at the Research Laboratories, Leatherhead, Surrey. Duties include the maintenance, calibration and repair of a wide variety of physical, chemical and electrical instruments. Experience in electronics or nucleonic equipment an advantage. Candidates should have H.N.C. or equivalent qualification. Salary £520—£695 p.a. —Applications to D. Moffat, Director of Establishments, Winsley St., London, W.1, by 18th April, 1957. Quote Ref. WW/83. [6867

NON-DESTRUCTIVE testing techniques.

ATTRACTIVE and responsible positions are offered in the development of new techniques for the non-destructive examination of materials.
SENIOR and junior staff are required with qualifications or experience in the fields of physics or physical metallurgy with particular reference to the non-destructive examination of materials or industrial instrumentation and measurement.
SALARIES commensurate with qualifications and experience will be paid.
APPLICATION should be made in writing in the first instance giving full details of qualifications, previous experience, age and salary required, and be addressed to Personnel Department, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [6722

NON-DESTRUCTIVE testing techniques.

TWO attractive positions are offered which will involve hard work and extensive travelling in the United Kingdom and Europe, the successful applicants will be concerned with the development and industrial application of modern non-destructive testing techniques, they must have the following qualifications:—
1. INITIATIVE
2. EXPERIENCE in the industrial application of modern electronic techniques and/or mechanical design; it is desirable that they should also have adequate academic qualifications.
3. AGE 23 to 30 years.
SALARIES will be commensurate with the candidate's qualifications and experience.
APPLICATION should be made in writing in the first instance giving full details of qualifications, previous experience, age and salary required, and be addressed to Personnel Department, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [6723

TECHNICIANS (Aeradio) Grade I required by EAST AFRICA high Commission Directorate of Civil Aviation on probation for pensionable employment; salary scale (including inducement pay) £813 rising to £1,173 a year; outfit allowance £30; free passages; liberal leave on full salary after each tour 30/36 months; candidates not over 38 years of age, should preferably possess C and G. Certificate in Telecommunications Principles or Radio Part III or equiv.; they must have had at least three years' experience in erection and maintenance of ground station transmitters, radio and radar navigational aids and aerial systems and should have up-to-date knowledge of workshop practice; knowledge of teleprinter and perforator equipment servicing or diesel electric power plant maintenance an advantage.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/42197/WF. [6894

TECHNICAL High Fidelity salesman required for new dept.; salary by arrangement.—Apply Staff Controller, B. B. Evans & Co. Ltd., 148-162, Kilburn High Rd., N.W.6, or 'phone for appointment, Mal. 4831. [6888

TRANSFORMER design engineer (senior) required for small factory in West London area; permanent executive position, to take sole charge of engineering staff of 10 persons; state salary required to Box 6875 [6870

SITUATIONS VACANT

INSPECTORS of Police, Grade II, required by NYASALAND Government for service in the signal section of the communication branch for one tour of 2-3 years with prospect of permanency; salary scale £705 rising to £1,200 a year; commencing salary according to experience; outfit allowance £50; uniform allowance £18 a year; free passages; liberal leave on full salary; candidates must be between 20 and 30 years of age, of good education and physique, not below 5ft 8in height, and have normal vision without glasses; essential to have at least four years' experience of telecommunications work with a radio firm, Government department or H.M. Forces; a knowledge of diesel and/or petrol electric sets would be an advantage.—Write to the Crown Agents, 4, Millbank, London, S.W.1; state age, name in block letters, full qualifications and experience and quote M1/45302/WF. [6893

APPLICATIONS are invited for pensionable posts as
EXAMINERS in the
PATENT Office
TO undertake the official scientific, technical and legal work in connection with Patent applications.
AGE at least 21 and under 35 years on January 1, 1957, with extension for regular Forces' service
CANDIDATES must have (or obtain in 1957) 1st- or 2nd-class Honours in Physics, Organic or Inorganic Chemistry, Mechanical or Electrical Engineering or in Mathematics, or an equivalent qualification or have achieved a professional qualification, e.g., A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. For a limited number of vacancies candidates with 1st- or 2nd-class Honours degrees in other subjects—scientific or otherwise—will be considered. Exceptional candidates otherwise qualified by high professional attainments will be considered.
STARTING pay for five-day week of 42 hours in London between £605 and £1,120 (men) according to post-graduate (or equivalent) experience and National Service. Maximum of scale £1,345. Women's pay above £605 slightly lower but is being raised to reach equality with men's in 1961. Good prospects of promotion to Senior Examiner rising to £2,000 (under review) and reasonable expectation of further promotion to Principal Examiner
APPLICATION form and further particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting S128/57 and stating date of birth. INTERVIEW Boards will sit at intervals, as required. Early application is advised. [6890

SCANNERS, Ltd., Gateshead, 10, Co. Durham, have a number of vacancies for:—
RADAR Engineers.
TECHNICAL Assistants.
RADAR Technicians/Mechanics.
APPLICANTS should have recent practical experience of Service radar equipment and must be willing to travel; early duties will include installation testing, tuning and trials of a series of modern ground radar equipments on sites in U.K.
GOOD starting salary dependent on ability and experience will be augmented by overtime and liberal subsistence rates; prospects of advancement to senior pensionable posts in factory or development laboratories.—Apply, quoting G5/IMM, with summary of qualifications and experience, to the above address. [6892

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge.
HAVE a number of vacancies for sales engineers, interesting work including systems planning for VHF multi-channel, Microwave TV Links and Aeradio, some vacancies cover survey and installation work in the field at home and abroad; excellent salary and prospects.—Apply in writing giving details and quoting ref. CET to the Personnel Manager. [6661

NOTTINGHAM and District Technical College, Shakespeare St., Nottingham.
APPLICATIONS are invited for the post of Assistant Grade B for Electrical Engineering (Light Current).
SALARY in accordance with the Burnham Technical Scale of Assistants Grade B viz., £650×25—£1,025 per annum plus degree allowance of £75 per annum (or £125 for good honours degree) and up to 3 increments of £25 for training in approved cases. Commencing salary may include incremental allowance for industrial experience after age of 21, and for war service.
THE policy of the College is to encourage staff and students to undertake research work, an appreciable amount being in progress at the present time.
FURTHER particulars and form of application may be obtained from the Principal. Completed forms should be returned as soon as possible. [6850

SALFORD ELECTRICAL INSTRUMENTS, Ltd., Chestergate Works, Stockport, Cheshire.
HAS Rectifier Development vacancies in rapidly expanding department; engineers and physicists required with degree or H.N.C.; salaries dependent on experience up to £1,000.
SEND full details to Personnel Manager at the above address. [6856

TECHNICAL sales representative required for well-known progressive manufacturers of High Fidelity equipment; excellent prospects. —Please write in confidence, Box 6956. [6887

SITUATIONS VACANT

W. H. SMITH & CO., ELEC. ENG., Ltd., Shepley Industrial Estate, Audenshaw, Manchester.
REQUIRE a limited number of experienced engineers for testing, planning, and prototype work for:—
ELECTRONIC control gear.
SERVICES radar equipment.
F.M. radio equipment.
THESE are staff appointments with superannuation scheme available.
APPLY in writing with full details of experience to the above address.
VACANCIES also exist for wiremen for the above equipments. [6842

ASSISTANTS (Scientific).—The Civil Service Commissioners invite application for pensionable posts.
AGE at least 17½ and under 26 years of age on 1st January, 1957, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.
CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject; at least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:—
(i) Engineering and physical sciences.
(ii) Chemistry, bio-chemistry and metallurgy.
(iii) Biological Sciences.
(iv) General (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
STARTING pay £340 (at 18) up to £460 (women £431) at 25; men's scale maximum £635; women's scale being raised to reach equality with men's by 1961; somewhat less in provinces; opportunities for promotion and for further education.
FURTHER particulars, from Civil Service Commission, Scientific Branch, 30, Old Burlington St. London, W.1, quoting No. S59/57.
INTERVIEW Boards sit at intervals, as required; early application is advised. [6840

ELECTRONIC engineers required for work on transistor circuitory and other projects, the minimum qualification for senior post, H.N.C. or equivalent.
FOR Junior Post, O.M.C. but consideration would be given to advanced student of special ability; north London district; quote reference S.B.E.—Box 6968. [6895

ROYAL Military College of Science, Shrivenham, Berkshire.—The Civil Service Commissioners invite applications from men for the following posts under the War Department:—
(a) SENIOR Lecturer or Lecturer in Radar and Telecommunications or Electronic Instrumentation (2 posts).
(b) ONE Senior Lecturer or Lecturer in Engineering Physics.
(c) SENIOR Lecturers or Lecturers in Mathematics (2 posts).
(d) A NUMBER of posts, normally tenable for 3 years, as Demonstrators in Mechanical Engineering or Electronics or Electrical Engineering or Instrumentation.
APPOINTMENTS to a Senior Lectureship will depend on age, qualifications and appropriate experience. Posts are unestablished but candidates appointed to posts (a) to (c) will be considered for established (i.e., pensionable) posts as they occur and unestablished service will, subject to the normal rules, count for superannuation purposes under the Superannuation Acts (which also provide gratuity for unestablished service lasting for more than 7 years).
FOR posts at (d) provision is made under F.S.S.U.
TEACHING work is at University level and candidates must have an appropriate degree (at least 2nd Class Honours) or equivalent. Research, for which there are excellent facilities, is encouraged.
PARTICULAR qualifications required as follows. For post (a) specialization in electronics, telecommunications, radar or missile guidance. For (b) specialization in servo-mechanisms, computing or missile control. For (c) some research or teaching experience in pure or applied mathematics.
AGE: Senior Lecturer at least 26 on 1st January, 1957. Appointment to Senior Lecturer at lower age may be made exceptionally. Lecturers and Demonstrators at least 21 and under 28 on that date, with extension for regular Forces service and for permanent service in the Experimental Officer class.
INCLUSIVE salaries: Senior Lecturer £1,075 to £1,265; Lecturer £565 to £995; Demonstrator £600 to £725. In assessing starting salaries of Lecturers credit will be given for approved post-graduate experience and National Service. For other posts consideration will be given to special circumstances.
SECONDMENT from, and transfer to, Scientific Civil Service may be arranged.
THE College is residential; houses available at economic rents for married men and quarters in residential officers' mess at reasonable charges for single men.
SUCCESSFUL candidates to take up duty in October, 1957, or as soon as possible.
FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S4672/57/13. Application forms should be returned by 10th April, 1957. [6885

SITUATIONS VACANT

TWO vacancies exist for Temporary Civilian Instructors, Grade III, to teach Line and Telegraph Technicians up to Class III standard. APPLICANTS should have served an acceptable apprenticeship, be fully experienced in the trade and capable of teaching subjects in these trades.
THE possession of City and Guilds Intermediate Certificate or Ordinary National Certificate, or equivalent qualification in Mathematics and Physics is desirable.
APPOINTMENTS will be made after testing and interview by a Board of Officers and will be subject to six months' trial.
SALARY: £716 (at age of 28), rising by annual increases, subject to satisfactory service, to £833 for a 5-day week of 44 hours.
APPLY in writing to: Commandant, Army Apprentices School, Harrogate, Yorks.
CLOSING date for receipt of application is 15th April, 1957. [6886

AUDIO Engineers required for progressive positions in expanding organization; men with experience of development test and service work apply to Personnel Manager, E.A.R., Ltd., The Square, Isleworth. Tel. Hou. 6256. [6881

DRAUGHTSMEN. Vacancies exist in our industrial electronics group for draughtsmen with experience in electronic equipment design, preferably with H.N.C. or equivalent standard.
HOUSING assistance will be given to successful applicants from the London area.
APPLICATION, which will be treated in confidence, giving full details of education and career, to: W. H. Sanders (Electronics), Ltd., Gunnels Wood Rd., Stevenage, Herts. [6751

FIRST-CLASS TV engineer required for Bush, Murphy, Pye dealers, good wages and conditions, must be able to drive, permanency to right man.—Garlicks, Northallerton, Yorks. [6707

TEST engineers for AM/FM radio production, alignment and fault finding, permanent jobs at top rates for experienced men.—Apply The Dulci Co., Ltd., 97, Villiers Rd., N.W.2. WIL. 6678. [6900

TELEVISION Engineers, able to drive, required by leading Murphy dealers; permanency, first-class salary and conditions.—Singer's, 211, Kilburn High Rd., N.W.6. Mai. 6403. [6222

TELEVISION engineer required, must be experienced and able to drive; we hold all main agencies and are an old established firm in South Wales; we have accommodation and pay good wages.—Apply giving full particulars and also wages required to Box 5940. [6721

ELECTRONIC engineer required to be trained to supervise production and maintain automatic R.F. plastic welding plant in N.W. London; excellent prospects in rapidly expanding factory.—Previous experience and present salary to Box 6969. [6891

DRAUGHTSMEN required for Civil Service base near Bletchley; salary £460-£885 per annum according to qualifications; opportunities for further education and eventual establishment; accommodation available for single men.—Box 6933. [6882

TELEVISION engineer, must be experienced with good technical knowledge, for main dealer holding all leading agencies; good prospects for right man, accommodation available.—Apply, stating full particulars and salary required.—A. E. Hughes & Sons, 28, Clarence Place, Newport, Mon. [6899

PYE, Ltd., Radio Works, Cambridge, invite applications for positions as technical authors to compile maintenance handbooks dealing with radio equipment; applicants must possess command of English and some technical knowledge.—Applications in writing to Personnel Officer. [6843

SERVICE Mechanics required, in the London area, for the maintenance of public address and similar equipment in factories and hospitals; permanent, superannuated and well-paid position to conscientious and skilled mechanics; our present staff have been informed of these vacancies; write giving details in confidence to—Box No. 6443. [6835

MURPHY RADIO, Ltd., have vacancies in the Radio and Television Laboratories for experienced engineers; these posts offer excellent prospects of advancement; applications, giving full details of experience and qualifications, should be addressed initially to—Personnel Department (R6), Murphy Radio, Ltd., Welwyn Garden City, Herts. [6568

DE HAVILLAND PROPELLERS, Ltd., need new technicians to work on the electronic, servo or instrumentation aspects of guided weapons; men with the ambition to secure a good position in this type of work are invited to write to the Personnel Manager (Ref. 75), de Havilland Propellers, Ltd., Hatfield, Herts; alternatively, for the benefit of those who would prefer to discuss this matter immediately, the company is holding a series of informal interviews at Norman House, 12, Stratford Place, Oxford St., London, W.1 (opposite Bond Street Underground Station). —Applicants are invited to telephone Hyde Park 9811 and make an appointment to see the company's Chief Electronic Engineer at this address on any Tuesday evening between 6 p.m. and 8.30 p.m. [6756

SITUATIONS VACANT

BOULTON PAUL AIRCRAFT, Ltd., have a vacancy in their electronics division for a design development engineer; the work offers scope for originality and experience in a wide range of subjects; B.Sc. or H.N.C. standard required.—Write, with full particulars, to the Manager, Electronics Division, Boulton Paul Aircraft, Ltd., Wolverhampton. [6901

A. T. & E. (BRIDGNORTH), Ltd., Bridgnorth, Shropshire, require skilled personnel for testing V.H.F. and electronic equipment, varied and interesting work in field of radio telecommunications, excellent working conditions, canteen, sports facilities.—Write, stating age, experience and approximate salary required, to Personnel Officer. [6878

McMICHAEL RADIO, Ltd., require experienced television development engineers for responsible and interesting work in their radio and television laboratories, excellent conditions and opportunities for advancement, pension scheme.—Apply in writing to Personnel Officer, McMichael Radio, Ltd., Wexham Rd., Slough, Bucks. [6877

TELEVISION development engineer (senior) with administrative experience required, capable of carrying out development projects with minimum supervision up to production stage.—Write giving full personal details, Chief Engineer, Rediffusion (Wired Radio Service, Ltd.), Fullers Way, Chessington, Surrey. Tel. Elmbridge 5824. [6879

THE Research Laboratories of the General Electric Co., Ltd., North Wembley, Middlesex, have several vacancies for technical assistants; applications are invited from young men who are free from National Service commitments.—Please write to the Staff Manager (Ref. RLB/116), giving details of experience, qualifications and age. [6744

SMITHS Aircraft Instrument, Bishops Cleeve-Cheltenham, required senior and junior technical authors and a technical illustrator for the preparation of descriptive and servicing manuals for aircraft instruments and systems to A.R.B. and M.O.S. requirements.—Write giving full particulars to Divisional Personnel Manager. (Quote reference 91/EN/18.) [6844

ELECTRONIC inspectors required by Decca Radar, Ltd., applicants must have wide practical experience of test methods and equipment, backed by sound theoretical knowledge, staff position, pension scheme, 5-day (39-hour) week.—Write giving full personal details to Personnel Officer, Factory Division, Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [6845

THERE are a limited number of vacancies for Technical Assistants in the experimental test section employed on radar equipments and guided missile work; applicants should possess General Certificate of Education (Advanced level), in mathematics and physics and have had two years' experience with the R.A.F. as Radar Fitters, alternatively the positions are open to ex-Naval Radio Artificers.
APPLICATIONS should be made stating age and experience to the Personnel Manager, Applied Electronics Laboratories, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. Ref. R.G. [6838

DRAUGHTSMEN and Designer Draughtsmen are required by the electronic division to meet an expanding and varied programme of work; these permanent posts will interest all draughtsmen who wish to obtain a position with a good salary which will broaden their experience.—Write, giving details of age, experience, etc., to Personnel Department (E.30), Murphy Radio Ltd., Welwyn Garden City, Herts. [6782

ELECTRONIC Engineers with knowledge pulse circuits required for installation and servicing industrial electronic equipment both at home and overseas; liberal expense allowance while abroad, good salaries and permanent pensionable staff positions; applicant's travelling expenses refunded; write in first instance, giving qualifications and details of career to date to—J. F. Crosfield, Ltd., 2, Elthorne Rd., London, N.19. [6836

RADIO Service Technician required by motor distributors; thorough technical knowledge of radio and servicing experience essential; personality and appearance important, as successful applicant will be responsible for developing the department and its contact with traders and private customers by means of radio service van; unlimited prospects; good salary.—Zenith Motor & Engineering Works, Ltd., 591, Commercial Rd., London, E.1. [6861

DRAUGHTSMAN (Senior) for electronic applications, including magnetic amplifier controls; good conditions, permanency; superannuation scheme; canteen facilities; reliability and initiative essential; existing holiday arrangements honoured; commencing salary above A.E.S.D. rates and according to ability; reply, stating experience, age, etc., to—W. Mackie & Co., Ltd., 129/133, Lambeth Rd., London, S.E.1 (nr. Lambeth Bridge). [6839

RADIO technicians required by International Aeradio, Ltd., for overseas service; permanent and pensionable positions; inclusive salary from £894 per annum to £1,373 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates, to whom replies only will be sent, please write, quoting RT to Personnel Officer, 40, Park St., W.1. [0262

SITUATIONS VACANT

TECHNICAL Authors required for the preparation of technical handbooks and sales literature for T/V transmitters, studio and control equipment, O.B. vehicle installations, telecine, etc.; should have sound electronic background, preferably with T/V experience, and be able to write in clear concise English accurate descriptions of complex apparatus. PLEASE apply in writing to Chief Engineer, Pye, Ltd., Cambridge, quoting "T.P." [6857

ELECTRONIC Instruments, Ltd., have a vacancy in their meter department for a technical assistant, knowledge of movement assembly and standards room practice necessary, must be experienced in handling meter movements or similar fine part assembly; theoretical knowledge to O.N.C. electrical standard.—Please write to Electronic Instruments, Ltd., Lower Mortlake Rd., Richmond, Surrey, or 'phone Richmond 5656. [6847

AN independent subsidiary of an old-established company requires senior and junior engineers for development of all types of electronic instruments, degree or H.N.C. with at least 5 years experience in development works; positions permanent; excellent opportunities for advancement as company expands; salaries, in accord. with qualifications and experience, based on generous scale; five-day week, life insurance and pension schemes, canteen, etc. APPLY in confidence to Technical Director, Cossor Instruments, Ltd., Highbury Grove, London, N.5. [6581

DESIGNER Draughtsmen (senior and junior) and tracers required to learn latest printed circuit techniques; since drawings are subsequently photographed as part of the process a high standard of neatness is required; the job is interesting and working conditions are good; pension scheme, etc.; salary commensurate with qualifications and experience.—Address enquiries to Mr. L. N. Crawford, Cossor Radio & Television Co., N.5, or telephone Can. 1234, ext. 131. [6848

SENIOR Laboratory Technician (temporary in the first instance) required at Norwood Technical College, Knight's Hill, S.E.27, in telecommunications engineering and radio department, for maintenance of equipment and instruments, upkeep and supervision of laboratories and storekeeping; salary scale—£444 to £556 and to £669 with specified qualifications. —Further particulars and application forms (returnable within 14 days) from the Secretary (269). [6855

DESIGN development.—Oliver Pell Control, Ltd., urgently require young qualified electro mechanical engineers to develop electro magnetic devices to the production stage from original thoughts, we want young men with confidence capable of working on their own, the positions have excellent prospects and we are not interested in salary so much as the right type of individual.—If you are such a man please write to the Chief Engineer, Oliver Pell Control, Ltd., Cambridge Row, Burrage Rd., Woolwich, S.E.18. Tel. Woo 1422. [6864

ENGINEER with experience of the mechanical design of electronic equipment, particularly in relation to chassis and case components; preference will be given to an engineer holding H.N.C. in electrical engineering, or has experience in development of units up to production stage; age between 30 and 35.—Apply in writing, stating qualifications, experience and salary required, to Chief Development Engineer, Waymouth Gauges & Instruments, Ltd., Station Rd., Godalming, Surrey. [6860

ELECTRONIC Engineer required to assist on development and maintenance of equipment for use in the production and testing of submarine telephone and telegraph cable; the work, which is varied, will offer scope to an engineer with initiative and an interest in servo-mechanisms and refined measurements; H.N.C. or equivalent essential. The factory is modern and working conditions pleasant; pensions scheme and canteen facilities available.—Apply to: Personel Manager, Standard Telephones and Cables, Ltd., West Bay Rd., New Docks, Southampton. [6859

WAR DEPARTMENT requires lecturers at R.E.M.E. Training Centre, Arborfield. Qualifications: Engineering or Science Degree; lecturing experience preferable and specialist knowledge of electrical engineering, electronics, servo-mechanisms or guided missiles. Salary: Burnham Technical Scale Assistant B. Starting salary according to qualifications and experience; £115 non-pensionable allowance; teacher's superannuation.—Particulars and forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting Ref. D387/6A. Closing date 12th April, 1957. [6858

WAR OFFICE requires experimental officer (male) at Royal Military College of Science, Shrivenham, Berkshire, in Electrical Engineering Branch of Department of Instrument Technology, candidates must be electrical engineers holding H.N.C. in Electrical Engineering or equivalent, good knowledge and practical experience of D.C. and A.C. machines of all types; electrical power applications, electrical measurement, measuring instruments and standards, knowledge of high voltage testing an advantage; salary £875-£1,075, starting pay according to age and experience, age at least 26 years, good prospects of permanency for candidates under 31 years of age.—Particulars and forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting reference D51/7A. Closing date April 12, 1957. [6875

SITUATIONS VACANT

ELECTRONIC engineers or physicists required for rapidly expanding research department, experience of pulse techniques or ultrasonics desirable but not essential, the work is varied and interesting and offers scope and opportunities for people with initiative, B.Sc. or H.N.C. standard, pension scheme.—Write giving details of age, experience, salary required, etc., to Ultrasonoscope Co. (London), Ltd., Sudbourne Rd., London, S.W.2. [6862

SELENIUM Rectifiers.—Senior Executive required by expanding company in North Midlands area to direct research and production of selenium Rectifiers; a knowledge of Germanium and Silicon Rectification would be useful: this is an important appointment with a progressive organisation and offers exceptional opportunities to the successful applicant with suitable experience, initiative and energy.—Applications marked "Personal" to Managing Director, Box 5146, quoting details of education and training, qualifications, career, age and salary required. All applications will be treated in strictest confidence. [6559

PAMETRADA RESEARCH STATION, Wallsend, have a vacancy for a test engineer to work in the electronics section; the duties consist mainly of maintenance and calibration of special electronic instruments; candidates should have several years' experience of electronic work, together with City & Guilds Examination in Radio Communications, No. 3, or equivalent; knowledge of television circuits would be an advantage; the salary offered compares favourably with what men with similar qualifications can earn in industry.—Apply in writing to Director, Pametrada Research Station, Wallsend, Northumberland. [6871

TECHNICAL Assistant required, capable of developing schemes and preparing specifications and drawings for "Strowger" type exchanges; practical experience of installation and/or maintenance of such exchanges and knowledge of Post Office requirements essential; some knowledge of carrier transmission desirable; commencing salary in the region of £1,015 per annum; 5-day week, membership of superannuation fund, favourable travelling facilities.—Applications, giving details of age, experience and qualifications, should be addressed to Signal Engineer, British Railways, Eastern Region, Kings Cross Station, N.1. [6869

UNIVERSITY of Southampton.—Instrument mechanic or tool maker, preferably under 30, required for the mechanical workshop of the electronics department; applicants should be able to do their own milling and turning and be capable of producing mechanical apparatus on a "one-off" basis; experience of precision work is desirable but no experience of electronic techniques is required; excellent working conditions, hours and holidays; staff superannuation scheme.—Applications, in writing, giving full details of experience and qualifications, together with the names of 2 persons to whom reference may be made, should be sent to the Secretary and Registrar as soon as possible. [6883

A VACANCY occurs for a development engineer in a design group concerned with a wide range of small transformers of types used in radio equipment, fluorescent lighting and similar applications, preference will be given to applicants having experience of this class of work, but young engineers with a sound basic training and limited experience will be considered, and, if successful, will have the opportunity of gaining practical knowledge of design problems met in fulfilling commercial and military specifications, an attractive salary is offered together with good future prospects, the company's main laboratory is situated in the London area but there are also several vacancies in our Portsmouth unit.—Please reply, giving details of qualifications and experience to Box 6384. [6811

ELECTRONIC Engineer required for development of Railway Traffic Control and Signalling Equipment; age 25-30; essential qualifications—a Communications Degree or H.N.C. Electronics or C. & G. Certificates; the post is permanent and there are good prospects of progress for a successful applicant showing the necessary interest and ability; applicants should prefrably have had 2 or 3 years' experience in some electronic field, such as the design of communication equipment, or of amplifiers and/or filters for similar purposes; experience with transistor circuitry an advantage but not essential; pension scheme and five-day week; write giving full particulars of age, qualifications and experience to—The Personnel Superintendent, Westinghouse Brake & Signal Co., Ltd., Chippenham, Wilts. [6837

TECHNICAL sales/service managers required for British West African branches of large British company distributing domestic radio receivers, V.H.F. radiotelephone equipment, inter-communication telephones, domestic and commercial refrigerators, air conditioners, and office equipment, good technical radio background essential, refrigeration experience desirable, familiarisation course arranged with U.K. manufacturers prior to departure for Africa, first class passage, sea/air, free furnished quarters, full pay on leave after approximately 18 months' tours, pension scheme, apply in own handwriting, stating age (preferably between 21 and 30), whether married or single, full details education, qualifications, national service and business experience, original references should not be sent.—Apply T.S.D. Box 6803. [6863

SITUATIONS VACANT

MULLARD EQUIPMENT, Ltd., 51/55, Garratt Lane, Wandsworth, S.W.18, require Technical Author, for work in the preparation of user-handbooks in the industrial electronic and telecommunications fields, a thorough technical knowledge of electronics is essential, and a degree or H.N.C. in electrical engineering is desirable, previous experience in technical writing is not necessary.—Apply Personnel Officer. [6876

SITUATIONS WANTED

ELECTRONIC engineer, 38, seeks representative position, resides Middx, car owner.—Box 6970. [6896

TECHNICIAN, ex-radio officer 1st class P.M.G., 10 years' shore experience installation, repair, maintenance, marine electronics, communications, radar, D/F, echo sounders, etc., seeks senior grade situation.—Box 6312. [6799

TECHNICAL TRAINING

LEARN it as you do it—we provide practical equipment combined with instruction in radio, television, electricity, mechanics, chemistry, photography, etc.—Write for full details to E.M.I. Institutes, Dept. WW47, London, W.4. [0006

CITY and Guilds (Electrical, etc.) on "No Pass—No Fee" terms, over 95% successes.—For full details of modern courses in all branches of Electrical Technology send for our 144-page handbook, free and post free, B.I.E.T. (Dept. 388A), 29, Wright's Lane, London, W.8 [0117

TUITION

NOTHING succeeds like success! What we have done a thousand times we can do again for you—see the B.N.R.S. advt. page 150. [C172

WIRELESS operating; attendance and postal courses.—Stamp for reply to Manager, The Wireless School, Manor Gdns., London, N.7. [0104

FULL-TIME courses for P.M.G. Certs., C.G.L.I. Telecommunications, Radar Maintenance Cert. and B.Sc.(Eng.); prospectus free.—Technical College, Hull. [0111

WIRELESS.—See the world as a radio officer in the Merchant Navy; short training period; low fees, scholarships, etc., available; boarding and day students; stamp for prospectus.—Wireless College, Colwyn Bay. [0018

A.M.I Mech.E., A.M.Brit.I.R.E., City and Guilds, etc., on "No Pass—No Fee" terms, over 95% successes—or details of Exams and courses in all branches of Engineering, Building, etc., write for 144-page Handbook—Free: B.I.E.T. (Dept. 387B), 29, Wright's Lane, London, W.8. [0118

T/V & Radio.—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Cert., etc., on "No Pass—No Fee" terms; over 95% successes—Details of Exams and Home Training Courses in all branches of Radio and T/V, write for 144-page Handbook—Free, B.I.E.T. (Dept. 397A), 29, Wright's Lane, London, W.8. [0116

TRAIN at home for a better position or a new hobby.—We offer comprehensive modern home tuition courses covering over 100 careers and hobbies, practical equipment supplied with many courses.—Write for free brochure, stating subject of interest, to: E.M.I. Institutes, Dept. WW39, London, W.4. (Associated with H.M.V.) [0180

FREE! Brochure giving details of Home Study Training in radio television and all branches of electronics. Courses for the hobby enthusiast, or for those aiming at the A.M.Brit.I.R.E., City and Guilds, R.T.E.B., and other professional examinations. Train with the College operated by Britain's largest electronics organization; moderate fees.—Write to E.M.I. Institutes, Dept. WW28, London, W.4. [0179

COURSES in Electronics, covering practical and theoretical aspects, basic principles, industrial applications, electronic apparatus, etc. Also courses in Radio and TV Engineering and Frequency Modulation. Guaranteed coaching for Brit.I.R.E., City & Guilds, etc. Study at home under highly qualified tutors. Write for free book: International Correspondence Schools, Ltd., Dept. CL.42, Kingsway, London W.C.2. [0033

INCORPORATED Practical Radio Engineers' home study courses of radio and TV engineering are recognized by the trade as outstanding and authoritative. Moderate fees to a limited number of students only. Syllabus of Instructional Text is free. "The Practical Radio Engineer" journal, sample copy, 2/-; 6,000 Alignment Peaks for Superhets, 5/9.—Membership and entry conditions booklet, 1/-, all post free from the Secretary, I.P.R.E., 20, Fairfield Rd., London, N.8. [0088

BUSINESS AND PROPERTY

SLOUGH, Wexham Rd. New shops with flats to let in busy centre; flats not let separately.—Day (Contractors), Ltd., 705, High Rd., London, N.12. [6849

BOOKS, INSTRUCTIONS, ETC.

OFFERS invited, Proceedings I.E.E., Pt. IIIA, Nos. 1-20; Pt. IIA Nos 1-3.—Box 6971. [6897

"WIRELESS WORLD," 1946-1956, half price.—L. E. Rolls, 23, Brandreth Ave., Dunstable, Beds [6873

INDEX TO ADVERTISERS

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford St., London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd., William Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co.

Ersin Multicore SAVBIT TYPE 1 ALLOY

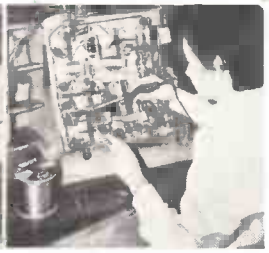
saves wear of soldering iron bits— proof from production lines

Bit on left has made 10,000 joints with SAVBIT Type 1 Alloy. Bit in centre has made 1,000 joints with standard tin/lead alloy and the bit on right 7,500 joints using standard tin/lead alloy.

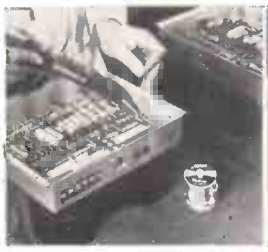
The bits used in this photograph can be seen on the Multicore Stand at the R.E.C.M.F. Exhibition, Grosvenor House, April 9th-11th

An Alba Radio set being assembled and soldered at the factory of A.J. Balcombe Ltd.

An operative from Bush Radio Ltd. using SAVBIT Type 1 Alloy.



SAVBIT Type 1 Alloy being used at Decca.



Soldering on a TL/10 "Point One" High Fidelity Amplifier at H. J. Leak & Co.'s works.

Joints on Pye Television Camera being soldered with SAVBIT.

An operative at R.G.D. Co. Ltd. using SAVBIT Alloy.

Many manufacturers of radio, television and electronic equipment are proving for themselves the value of SAVBIT Type 1 Alloy. Production line tests have shown over and over again the advantages of using this alloy. Soldering iron maintenance and replacement costs have been cut and work speeded up because operatives can work for longer periods without having to resurface soldering iron bits.

If you have not tested Ersin Multicore SAVBIT Type 1 Alloy yet, it will pay you to do so right away. And if you want any further information about it, ask the Multicore Technical Service Department.

British Patent Nos. 704, 763. 721, 881.

7 LB. REELS

Savbit Type 1 Alloy is supplied on 7 lb. Reels for factory use. Ersin Multicore 5-core Solder is also available on these reels in 6 alloys and 9 gauges. Prices on application.

SAVBIT 1 lb. REEL

Approximately 170 ft. of 18 s.w.g. Ersin Multicore Savbit Type 1 Alloy is supplied on this 1 lb. reel. It is invaluable to all who are interested in cutting down on bit replacement and maintenance costs. 15/- each (subject).

SIZE 1 CARTON

This popular pack is now supplied containing Savbit Type 1 Alloy or with any 4 specifications of standard tin/lead alloys. 5/- each (subject).

Catalogue Ref. No.	Alloy Tin Lead	S.W.G.	App. length per carton
C 16014	60/40	14	19 feet
C 16018	60/40	18	51 feet
C 14013	40/60	13	17 feet
C 14016	40/60	16	36 feet

HOME CONSTRUCTOR'S 2/6 PACK

Now available containing alternative specifications: 19 ft. of 18 s.w.g. 60/40 alloy or, for soldering printed circuits, 40 ft. of 22 s.w.g. 60/40 alloy: both wound on reels.

Bib WIRE STRIPPER AND CUTTER

This 3 in 1 tool strips insulation without nicking the wire, cuts wire cleanly and splits plastic extruded twin flex. Adjustable to most wire thicknesses. 3/6 each (subject).

Bib RECORDING TAPE SPLICER

An excellent splicer incorporating many refinements and quickly saving its cost in tape economies. Complete with razor cutter. 18/6 (subject).

MULTICORE SOLDERS LIMITED, MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. (BOXMOOR 3636)