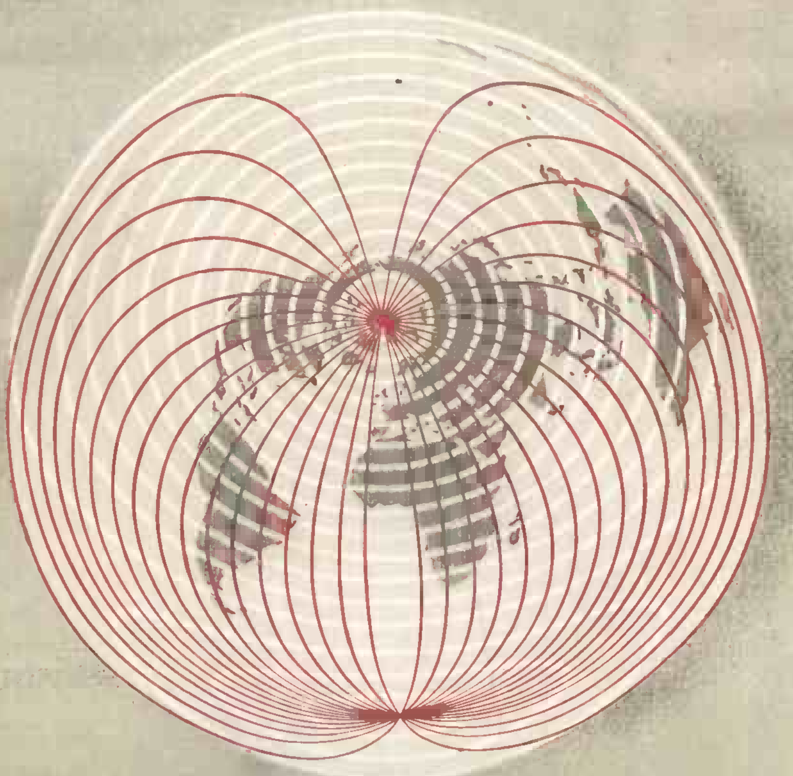
AUGUST 1955

TWO SHILLINGS

Wireless World

Radio · Electronics · Television



FORTY-FIFTH YEAR OF PUBLICATION

Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
HUGH S. POCOCK, M.I.E.E.
Editor:
H. F. SMITH

AUGUST 1955

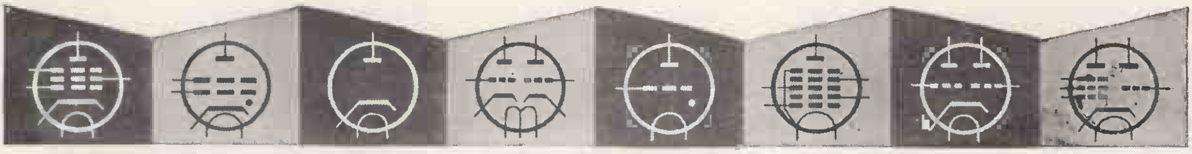
In This Issue

Editorial Comment 353
Colour Television Standards 355
Short-wave Conditions 355
World of Wireless 356
Inexpensive Wave Analyser. *By M. G. Scroggie* 360
Letters to the Editor 367
Band II F.M. Tuner Unit. *By L. Hampson* 368
New Navigational Aids 375
The Automatic Factory 378
Wide Range Electrostatic Loudspeakers—3. *By P. J. Walker* 381
High-Fidelity Home. *By Richard Arbib* 385
Transistor Equivalent Circuits—2. *By W. T. Cocking* 388
Transmitting Colour Information 393
The Cascode. *By " Cathode Ray "* 397
Electronic Teleprinting 401
Random Radiations. *By " Diallist "* 402
Unbiased. *By " Free Grid "* 404

VOLUME 61 NO. 8
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR
OF PUBLICATION

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:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas, £1 7s. 0d. U.S.A. $4.50. Canada $4.00. BRANCH OFFICES: *Birmingham:* King Edward House, New Street, 2. *Coventry:* 8-10 Corporation Street. *Glasgow:* 26B Renfield Street, C.2. *Manchester:* 260 Deansgate, 3.

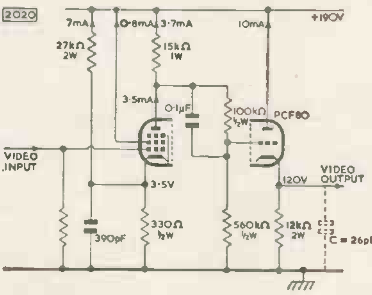


VALVES, TUBES & CIRCUITS

32. A HIGH GAIN VIDEO AMPLIFIER

The gain of a video amplifier with a given bandwidth, using a high slope r.f. pentode, is limited by the output or load capacitance. A typical cathode compensated circuit using an EF80, with a bandwidth of 3Mc/s (6dB), a maximum video output voltage of 50V, and a load capacitance of 26pF, has a gain of 11. The gain can be increased and the bandwidth maintained if the effective load capacitance is reduced by means of a cathode follower. The practical circuit shown in Fig. 1 has a gain of 22. A Mullard PCF80 triode pentode combines the functions of video amplifier and cathode follower in one envelope.

FIG 1



Video Amplifier

The cathode of the pentode (Fig. 1) is held at about + 3.5V by the pentode cathode current and the bleed current through the 27kΩ resistor. With the screen grid at 190V this gives an anode current of 3.5mA. The permissible anode current swing is limited by the maximum screen grid dissipation rating of 0.5W, therefore the output voltage is limited to about 80V. The dynamic characteristic of a typical PCF80 pentode shows that the corresponding maximum limit of the anode current is 8.8mA. The effective slope is 1.5mA/V, therefore the gain $g_m R_l$ = 1.5mA/V x 15kΩ = 22.5.

Cathode Follower

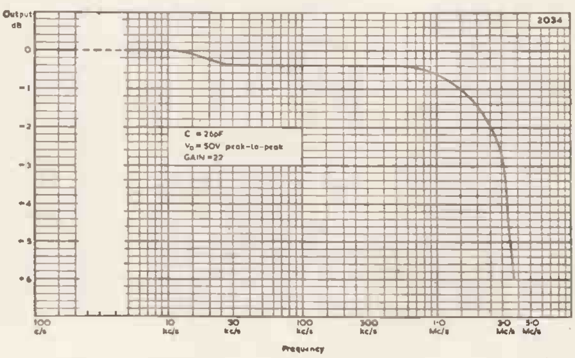
The total capacitive load of a video stage is made up, in a typical good design, approximately as follows: Video output 4pF, C.R.T. 8pF, Synchronising separator 6pF, Noise suppressor 2pF, Strays 6pF = 26pF.

If the total gain of the stage is to be greater than 20 and a cathode follower output (with a gain less than 1) is to be used, the amplifier must have a higher gain—say 25. To achieve this the output capacitance must be less than 11pF. With a cathode follower the capacitive load of the amplifier is reduced to: Video output 4pF, Cathode follower input 3pF, Strays 3pF = 10pF, which is within the 11pF limit. The overall response is limited by the cathode follower, which must be capable of developing an output voltage of at least 50V across a capacitive load of 26pF.

Cathode Current Requirements

The cathode current has two components: a current which maintains the signal across the cathode resistor, and a transient current which charges the output capacitance. The valve must supply both currents. If it failed to do so the cathode voltage would not follow the grid voltage. If the cathode cannot rise at the same rate as the input the valve will run into grid current, and the positive going edge of the signal will be distorted. Alternatively, if the cathode cannot fall at the same rate as the input, the valve will be cut off and the negative going edge will be distorted. In general the second alternative is worse, as cut-off is an absolute limit to change in the cathode current. The onset of grid current does not preclude further change if the source impedance of the driver stage is reasonably low. As each input pulse has two transients associated with it the total current swing is the maintenance current plus twice the transient current. To prevent cut-off the standing cathode current must exceed the sum of the transient and maintenance currents.

FIG. 2



Derivative Correction

It is possible to compensate for a poor fall time in a cathode follower by adding to the output a voltage proportional to the derivative of the video input signal. This voltage, which can be obtained by the inclusion of a resistor in the triode anode circuit, may be a.c. coupled to the c.r.t. grid when the cathode follower is driving the c.r.t. cathode. The derivative correcting voltage is thus added in the correct phase. It is found that this arrangement increases the contrast of the high definition bars of test card 'C' and improves the vertical edges; but it tends to produce ringing and 2.5Mc/s oscillation, therefore the use of derivative correction with this circuit is not recommended.

Performance

In a 21-inch tube receiver the recommended circuit (Fig. 1) gives a composite video output up to 80V before there is any visible sign of cathode follower overload. The frequency response, measured with a sine wave input and a 50V peak-to-peak output, is shown in Fig. 2. The stage gain is 22.

Further notes on the circuit are available with reprints of this advertisement. Reprints of all advertisements in the Valves, Tubes and Circuits series may be obtained free from the address below.

Wireless World

AUGUST 1955 VOL. 61 No. 8

Tape Bookmark

THE rapid growth of tape recording for domestic and business purposes is largely due to the excellence of what is rather pompously called the tape transporting system. Mechanisms for winding the tape from one spool to the other are, generally speaking, remarkably effective; the clumsiest of us find little difficulty in operating even the cheaper and less refined machines.

Judging by letters from readers, however, the domestic tape recorder is widely thought to be deficient in one respect: it is difficult to "find the place" on the tape at which any particular item starts. True, some kind of rough-and-ready gauge is often provided, but it does not give precise location. Most home recordists make use of scraps of paper inserted, like a bookmark, between adjacent turns of tape. This method, though fairly adequate when the "fast wind" mechanism can be smoothly and accurately controlled, is often considered to be crude. What seems to be wanted by a wide circle of users is a device which, by mechanical, magnetic, electrical, or even electronic means, will indicate precisely the part of the tape required. Something much more precise than the classical bookmark is in fact called for.

A device that went a long way towards meeting these needs was described in *Wireless World* for April, 1955. This embodied a selector switch actuated by pads glued to the tape at appropriate positions. Another method, used in certain machines, calls for the use of a revolution counter.

Perhaps the most novel of the various place-finding suggestions put forward by readers is for a system of signals imposed on the tape and audible only during the "fast wind"—forward or back. The idea is that these pulse signals, which could be arranged according to a code, would be recorded at a very low frequency and so would not be heard (or at least would not be obtrusive) at normal playback running speed. This method has obvious attractions—and, probably, what might be considered equally obvious limitations and drawbacks. For one thing, it would not be readily applicable to existing machines in which the playback head is inoperative during "fast wind." However, the method seems worth investigating—always assuming, of course, that no satisfactory alternative that is inherently simpler and cheaper can be devised.

Colour Television Experiments

TOO much significance need not be attached to the standards (set out on another page) chosen for the B.B.C. experimental transmissions in colour television, to begin in the autumn. It was more or less a foregone conclusion that a start would be made with a version based as closely as possible on the standards devised by the National Television Standards Committee of the U.S.A. The so-called "British N.T.S.C." system involves very little change or addition to the B.B.C.'s existing monochrome transmitters. Another factor which might well have influenced the decision is that there is now a large amount of American experience with this system on which to draw. Further, there can be no doubt that the technical elegance of the system is attractive, except perhaps for the complexity of the receivers that go with it. Presumably the main purpose of the experimental transmissions is to allow that section of industry concerned with receiver design and manufacture to carry out field tests and to gain practical experience of colour television.

So far there has been no mention of experimental transmissions using other systems. No doubt, however, these will come; there is no need to make an over-hasty decision as to what system is finally to be adopted in this country. Indeed, a regular colour service is not expected for a long time.

In considering these questions, it must be remembered that all factors affecting British television must finally be decided by the Postmaster-General, who, in his turn, is advised by the Television Advisory Committee. The T.A.C. has uncompromisingly recommended a compatible system, and the British N.T.S.C. standards of the forthcoming transmissions satisfy that requirement. However, there may well be a change of view on this subject before the time comes for making a final decision.

Growth of Aircraft Radio

IN the Golden Jubilee celebrations of the Royal Aircraft Establishment at Farnborough this year, a substantial proportion of the exhibits were concerned with radio aids to navigation, communication and the application of radio and electronic techniques to the guidance of rocket missiles and the simulation and computation of their performance.

An historical exhibit, arranged in chronological order, began with the Sterling Type 52A spark transmitter and the Model TF valve receiver (detector and 2 l.f. stages) of the 1914-18 war, and led up to the multi-channel crystal-controlled equipment in use to-day. One was reminded of the fact that although the possibilities of flying and of wireless communication were both realized at the turn of the century, a decade was to pass before they could come together. With the aerofoils and engine powers then available no designer, harassed as he was by thoughts of how best to save weight, could afford a second glance at the ship-and-shore type of equipment which was the stock-in-trade of the then infant radio industry.

There is still constant pressure from commercial and military aircraft designers to reduce the weight and size of radio equipment to make room for paying passengers or more armament, and this is being met by increasing miniaturization, which was adequately represented in the exhibition.

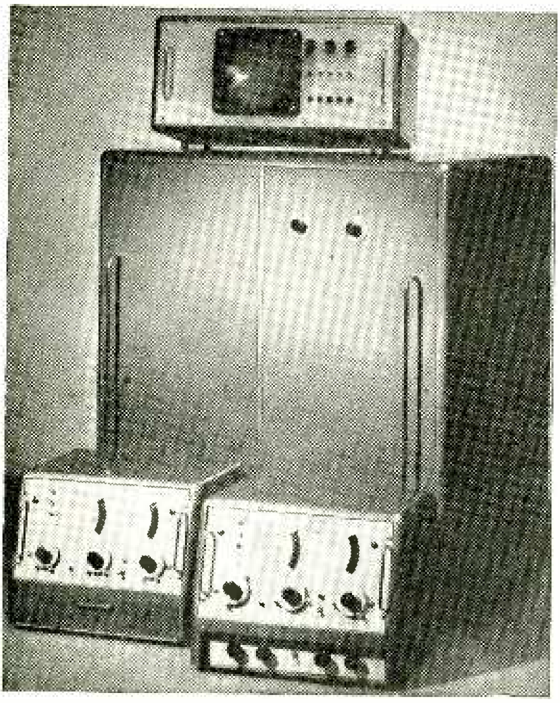
The current work of the Radio Department at R.A.E. covers a wide field including the development of sono-buoys (in which the noises of submarines are picked up by hydrophones and relayed to a searching aircraft by radio) and the detailed investigation of the problems of installing aerials with reasonably omni-directional characteristics on high-speed aircraft.

Electronic methods, once a useful alternative to established methods of physical measurement, can now be said to dominate all branches of aeronautical research. They reach their zenith at Farnborough in the "Tridac" analogue computor for guided missile problems, which occupies the whole of a special building and calls for primary power of the order of hundreds of kilowatts for the functioning of its many circuit elements.

Disc Recording and Reproducing Characteristics

IT has often been said that the ideal disc recording or reproducing characteristic should be one which is also easily realizable with simple circuitry. This provision is met in the proposals contained in the revised British Standard 1928:1955 which gives curves for fine-groove and coarse-groove recordings, and formulæ for their derivation in terms of the time-constants of simple R-C networks. These recommendations are based on C.C.I.R. standards and take into account the recommendations provisionally agreed by the International Electrotechnical Commission at their Philadelphia meeting last year.

The revised standard, which is obtainable, price 6s, from the British Standards Institution, 2, Park Street, London, W.1, includes specifications of commercial and transcription disc dimensions, stylus tip radii and concludes with a discussion of the arguments for standardization of the recording and/or the reproducing characteristic.



Radar Simulator

EQUIPMENT for the training of radar operators and for the synthesis of tactical air exercises without the use of aircraft has been designed and developed by C. E. G. Bailey and J. Somerset Murray in association with the Solatron Electronic Group, Ltd., Thames Ditton, Surrey.

Aircraft are represented by control units which feed signals (analogous to speed, rate of climb or dive, rate of turn and direction of flight) into a computor unit. This unit integrates the factors governing range, bearing and height and translates the result into pulses for transmission to one or more radar display units.

Extraneous effects such as tropospheric refraction can be taken into account, and there are facilities for simulating jamming, either of the reflecting type ("window") or of the active noise-generating type.

The essence of the design is flexibility so that future as well as current characteristics of aircraft performance and radar systems can be simulated.

Typical assembly of Solatron radar simulator units. The main cabinet houses the computors. A display unit is shown on top. In the foreground are two aircraft control units.

COLOUR TELEVISION STANDARDS

For Forthcoming B.B.C. Test Transmissions

EXPERIMENTAL colour television transmissions based on the American N.T.S.C. compatible system will be made by the B.B.C. from Alexandra Palace this autumn as part of the general investigations into the best type of colour system for this country. A specification of the standards to be used shows the method of transmission to be a scaled-down version of the N.T.S.C. system, with the colour information transmitted by means of a sub-carrier within the existing 6.75-Mc/s monochrome channel.

An article on page 393 of this issue elaborates on the principles of the "British N.T.S.C." system, so it is unnecessary to add here more than the bare facts of the B.B.C. specification. First of all, the existing black-and-white transmission from Alexandra Palace will remain as it is and form the "luminance" or brightness component of the complete colour signal. Simultaneously a "chrominance" or colouring signal will be transmitted in the form of two sets of a.m. sidebands of two suppressed carriers in quadrature, these having the common frequency of 525/2 times the line scanning frequency relative to the 45-Mc/s picture carrier—in fact 2.6578125 Mc/s. These two "chrominance" components, known as the E_I and E_Q signals (see article) will carry respectively wide-band colour information up to 1 Mc/s and narrow-band colour information up to 340 kc/s.

The "chrominance" or colouring sync signal will consist of a reference burst of 9 cycles of sub-carrier frequency transmitted during the "back porch" black-level period following each line sync pulse. It will not occur during the eight broad pulses of the frame sync period. Details can be seen from Fig. 1, which shows that the sync burst penetrates into the picture region and that the "chrominance" signal can do the same and also rise above peak white.

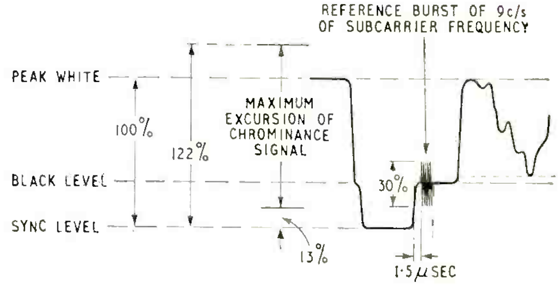


Fig. 1. Video waveform showing the relation of the added chrominance signal and sync burst to the existing monochrome signal.

The complete colour signal, in terms of the total video voltage applied to the transmitter modulator, is composed as follows:—

$$E_M = E_Y + K\{E_Q \sin(\omega t + 33^\circ) + E_I \cos(\omega t + 33^\circ)\}$$

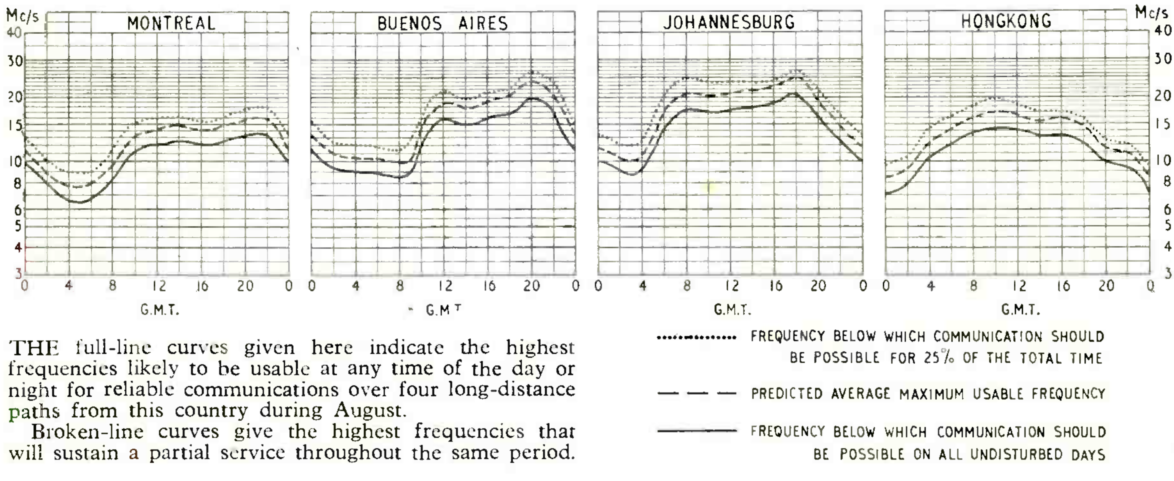
Here E_Y (the "luminance" or black-and-white signal) is made up of $0.3E_R + 0.59E_G + 0.11E_B$ while $E_Q = 0.41(E_B - E_Y) + 0.48(E_R - E_Y)$ and $E_I = -0.27(E_B - E_Y) + 0.74(E_R - E_Y)$. The angular frequency ω is 2π times the frequency of the "chrominance" sub-carrier, while the phase reference is the phase of the sync burst plus 180°. The factor K indicates that various ratios of "chrominance" to "luminance" between 1.0 and 0.3 may be used in certain experiments.

Comparative tests may be carried out with the system locked to and unlocked from the 50-c/s mains. With unlocked operation the sub-carrier frequency will be the 2.6578125 Mc/s mentioned above, but in the locked condition it, and the frequency difference between the vision and sound carriers, will change directly with the mains frequency.

The experimental transmissions will, of course, be made outside normal programme hours, and readers who manage to receive them will perhaps get a foretaste of the effect of compatible colour—detrimental or otherwise—on the picture quality we are used to at present.

SHORT-WAVE CONDITIONS

Predictions for August

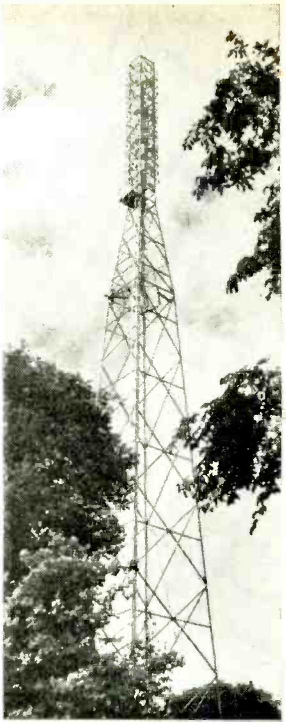


THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during August.

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

WORLD OF WIRELESS

Show News ✦ Anglo-French TV Link ✦ New Television Stations



TEMPORARY 200-ft mast carrying the 8-stack array for the Croydon I.T.A. transmitter. Marconi's are supplying the complete installation for the temporary station due to open on September 22nd. The mast was completed early in July and the sound transmitter is installed.

Earls Court

NEARLY 50 per cent of the 90 or so manufacturers who will be exhibiting at this year's National Radio Show are set makers; the others being makers of components and accessories. The remaining 30 exhibitors are either users of radio—such as the B.B.C., the Services and Government Departments—wholesalers, societies and associations, and organizations providing services for the industry.

The show opens at Earls Court, London, S.W.5, on August 24th for ten days, with a preview for overseas and invited guests on the 23rd.

In addition to the facilities provided on the exhibitors' stands for the demonstration of Bands I and III television sets, there will again be a display of some 100 receivers in Television Avenue. These receivers will be tuned to Band I. Incidentally, as in previous years, the Band I carriers piped round the show will be in Channel 4 to avoid interference from the London transmitter. Channel 8 is being used for the Band III demonstrations.

Each day at 2.30—except on Saturdays—a discussion meeting is being arranged by the British Radio Equipment Manufacturers' Association to bring together retailers' servicemen and representatives of the industry to discuss the servicing of f.m. receivers and the problems of f.m. aerial installation. Tickets must be obtained from B.R.E.M.A., 59, Russell Square, London, W.C.1.

Cross-Channel TV Link

THE first section of the permanent Anglo-French television link, ordered by the B.B.C. from the Post Office last January, will be completed in September. This section consists of a two-tube co-axial cable between London and St. Margaret's Bay, Kent. The next section, consisting of a two-way cross-Channel radio link, will not be completed for three years.

However, so that we can participate in international programme exchanges (the next is planned for this autumn) the cables will be extended temporarily from St. Margaret's Bay to Swingate, near Dover—a distance of about two miles—where a temporary cross-Channel radio station is set up.

It is understood that the cost of laying the cable, which is permanently rented by the B.B.C., and the cost of building the terminal station at St. Margaret's Bay will be nearly £750,000.

NATIONAL RADIO EXHIBITION

WIRELESS WORLD SHOW NUMBERS

September: Show Guide. Plan of the stands at Earls Court, with stand-to-stand guide to the exhibits.

October: Show Review. An analysis of design trends in television and sound broadcast receivers.

B.B.C. Television Progress

DURING the past few days the permanent television station at Divis, near Belfast, has been brought into service by the B.B.C. It replaces the temporary mobile station which has been in use at Glencairn for the past two years. The transmitter, which has an e.r.p. of 20 kW, shares Channel 1 (vision 45 Mc/s, sound 41.5 Mc/s) with Alexandra Palace.

It will continue to receive its programmes directly by radio from Kirk o' Shotts, Scotland. As has been done in the past, if the received picture is unsuitable for retransmission, or below standard, a warning signal—a vertical white bar—will be radiated. This warning signal is also being used by the Norwich transmitter which re-radiates London's transmissions.

The construction of the 640-ft self-supporting tower to carry the aerials for the new B.B.C. London station at Crystal Palace is well under way. At the 440-ft level will be installed parabolic aerials for receiving outside broadcasts. The Band I transmitting aerials—consisting of eight stacks of four dipoles—will be mounted on the section between 440 and 600-ft, above which there will be a 40-ft topmast. The tower is being erected by B. I. Callender's Construction and the aerial by Marconi's.

I.T.A. Links

A RADIO link is to be provided by the Post Office between Birmingham and the I.T.A. Midland station near Lichfield. It will provide two channels to Lichfield and one in the reverse direction. The Lancashire station at Winter Hill, near Bolton, will be linked with Birmingham by cable.

All the equipment for the radio link is being supplied by the G.E.C. who are also supplying the repeaters and terminal equipment for the cable link.

PERSONALITIES

Dr. Robert Cockburn, M.Sc., Ph.D., A.M.I.E.E., principal director of scientific research, guided weapons and electronics (M.o.S.) since March, 1954, has been appointed deputy controller of electronics in the Ministry in succession to Rear Admiral G. Burghard, whose tour of duty has expired. Dr. Cockburn, who is 44, was scientific adviser to the Air Ministry before joining the Ministry of Supply. For some time during the war he was head of the counter-measures group of T.R.E. and was awarded the American medal of merit for his work in this field.

Dr. A. L. Cullen, Ph.D., B.Sc., A.M.I.E.E., is to occupy the newly created chair of electrical engineering in the University of Sheffield. After graduating at the Imperial College of Science and Technology, London, in 1940, he joined the staff of the Royal Aircraft Establishment, Farnborough, where, until 1946, he worked on radar, being mainly concerned with aerials and waveguide techniques. He is at present reader in electrical engineering at University College, London, which he joined in 1946 as a lecturer. Dr. Cullen's special interest is microwave measurement techniques.

J. A. Smale, engineer-in-chief of Cable and Wireless since 1948, has been appointed by the government of Cyprus to be part-time chairman of the new Cyprus Inland Telecommunications Authority set up to administer and operate the island's inland telephone and telegraph services. He will continue in his present post with C. & W., visiting Cyprus as necessary.

H. R. Whitfield, M.I.E.E., who has been with Kelvin and Hughes, Ltd., as chief radar engineer since 1946, has been appointed a director of Kelvin Hughes (Marine), Ltd. In 1936, at the age of 19, he went to the Automatic Telephone and Electric Co., Liverpool, as a transmission laboratory engineer. From 1938 to 1940 he was a member of the War Department civilian technical staff attached to the Bawdsey (Suffolk) radar research station and then went to the research establishments, Malvern, as a member of the scientific staff on gunnery radar.

In addition to those mentioned in our last issue as having received Birthday Honours, **John N. Toothill,** general manager, Ferranti, Ltd., Edinburgh, was appointed C.B.E., **Horace D. McD. Ellis,** engineer in the B.B.C. Designs Department, was appointed M.B.E. and **William Fairhurst,** foreman, Electronic Tubes, Ltd., High Wycombe, received the British Empire Medal.

R. E. Burnett, M.A., A.M.I.E.E., A.Inst.P., has relinquished the principalship of Marconi College, Chelmsford, which he has held since 1950 and the position of manager of education and technical personnel on his appointment as full-time assistant to the general manager. His duties as manager of education and technical personnel will be undertaken by **E. R. L. Lewis,** M.A., A.M.I.E.E., who has been his deputy. The new principal of the college is **R. G. Hulse,** B.Sc., who has been deputy principal during the past year.

L. Hampson, who in this issue describes a Band II tuner unit, has been in the valve measurement and application laboratory of Mullard's since 1951. He joined Mullard's immediately after graduating at the age of 24 at Manchester University where he studied electrical engineering after completing his National Service. While at Mullards he has been mainly concerned with development work on the application of valves in the v.h.f. bands.

After 36 years' service with Marconi's, **H. C. Van de Velde** has relinquished the position of deputy to the managing director of the Marconi Marine Company but will continue to represent the company on the boards of various associated companies overseas. With Mr. Van de Velde's retirement, **R. Ferguson,** the general manager, who joined the seagoing staff of Marconi's in 1910, is extending his managerial responsibilities. He was seconded to the M.W.T. Company in 1934 in order that he might take up the appointment of general manager of Egyptian State Broadcasting which Marconi's conducted for the Egyptian government. On his return from Egypt he was re-appointed to the marine company, of which he became general manager in 1947.

F. G. Robb, chief of Marconi's Test Division since 1948, has retired after 36 years' service with the company. He was for some years in the designs and development section where at one time he worked on the development of beam transmitters for the Marconi-Franklin short-wave beam system. During the war he was seconded to the Admiralty and became chief of radar test. His successor at Chelmsford is **E. H. Evans** who joined Marconi's in 1913. He has been associated with the test division throughout his service and for a number of years has been chief of receiver test.

R. FERGUSON

E. H. EVANS

Obituary.—The death occurred on July 9th of **L. F. Fogarty,** M.I.E.E., who was for many years honorary treasurer of the Wireless Society of London, of which he was a founder-member and then of the Radio Society of Great Britain as it has been known since 1922. He had been managing director of the Zenith Electric Company since its formation in 1918.

IN BRIEF

Receiving Licences Decrease.—Although there was a further increase of 43,192 television licences in the United Kingdom during May, there was an overall decrease of some 17,000 in the number of domestic receiving licences in force. The comparative figures for May and April—the latter in brackets—are: sound 9,102,995 (9,165,242), vision 4,623,917 (4,580,725), car radio 273,883 (271,480), total 14,000,795 (14,017,447).

G. A. Briggs, of Wharfedale Wireless Works, Bradford, whose two lecture-demonstrations in the Royal Festival Hall, London, have created a demand for tickets far in excess of the seating capacity of the hall (3,000), is going to New York to give a similar demonstration in the Carnegie Hall (seating 2,760) on October 9th. Capitol Records Inc. are to make the recordings required for comparing live and recorded performances of piano, violin and organ and, as at the R.F.H., Mr. Briggs will be working in collaboration with P. J. Walker.

At the annual general meeting of the **Television Society,** the following members were elected to fill the vacancies on the Council: T. W. Price (Ediswan), A. E. Sarson (Marconi's), W. R. Smith (G.P.O.), Professor Trewman (E.M.I. Institutes) and C. B. Townsend (G.E.C.). In addition, D. N. Corfield (S.T.C.) and F. Livingston Hogg (Livingston Laboratories), who were co-opted last year, were elected full members.

B.A.T.C.—A convention of the British Amateur Television Club is being arranged for October 1st at the Bedford Corner Hotel, Bedford Square, London, W.C.1, from 10 a.m. to 6 p.m. There will be a display and demonstration of members' equipment and a film show. Tickets (costing 5s) and further information can be obtained from D. S. Reid, 4, Bishop Road, Chelmsford, Essex.

Telesurance Limited, which operates a television insurance and maintenance scheme through registered R.T.R.A. dealers, has issued a statement on its policy regarding sets converted for Band III. No additional premium charges will be made providing the sets are converted by appointed dealers in accordance with the recommendations of the manufacturers.

The mains and output transformers and the smoothing choke specified by W. A. Ferguson for the **20-watt quality amplifier** described in our May and June issues, are being produced by Partridge Transformers, Limited, Roebuck Road, Tolworth, Surrey. A leaflet giving electrical and physical characteristics is available.

In preparation for the advent of commercial television a **television training centre** has recently been opened in London by Marconi's. It provides a complete training course in the operation and maintenance of television studio equipment. The centre is also available to organizations for rehearsals under operational conditions and a mobile unit is available for the production of recorded O.B.s.

Engineering Education.—Lists of colleges in London and the Home Counties providing engineering courses during the 1955/6 session are given in "Engineering Education in the Region" published by the Regional Advisory Council for Higher Technological Education. It includes sections covering engineering crafts (including radio and television servicing), City and Guilds courses in telecommunications engineering, H.N.C. courses in electrical engineering with a bias towards radio and telecommunications, and courses in direct preparation for I.E.E. and Brit.I.R.E. examinations. The 30-page booklet is obtainable (price 1s) from the Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

At the eighth annual presentation of diplomas at the **College of Aeronautics,** Cranfield, Bucks, where a chair in aircraft electrical engineering has now been established, nine of the 68 awards were gained by students specializing in aircraft electrical engineering. The theses covered work on computors, simulators, servomechanisms and on the properties of suppressed aircraft aerials. As already announced, the first professor of the new department is G. A. Whitfield, who was at R.A.E. Farnborough.

"**The Inquiring Mind**" is the title of the documentary film sponsored by the I.E.E. for the purpose of depicting the diverse fields of opportunities open to electrical engineers. Copies of this 30-minute monochrome sound film, which is available in 35 mm and 16 mm, can be borrowed by schools, colleges and similar establishments. Particulars regarding the loan of the film are obtainable from the I.E.E., Savoy Place, London, W.C.2.

Nuclear Electronics.—During the forthcoming international conference at Geneva on the peaceful uses of atomic energy (August 8th to 20th) to which 84 nations have been invited, two exhibitions are being held. At one of these, which will be open to the public, a number of British electronics manufacturers will be participating and there will be a combined exhibit organized by the Scientific Instrument Manufacturers' Association.

R.E.C.M.F. Headquarters.—The Radio and Electronic Component Manufacturers' Federation has moved from Surrey Street, London, W.C.2, to 21, Tothill Street, London, S.W.1. (Tel.: Abbey 4226/8.)

Swindon.—With the object of forming a radio club in the town a meeting will be held on August 31st at 7.30, at the Connaught Café, 34, Cromwell Street, Swindon. Further particulars are obtainable from R. Reynolds, G31DW, 136, Beech Avenue, Swindon, Wilts.

Many demonstrations of high-quality reproduction have been given to gramophone and music societies and at public exhibitions by **Goodmans Industries** during the past few months. Societies interested in receiving a visit from the demonstration team are invited to write to Goodmans Industries Limited, Axiom Works, Wembley, Middx.

The third edition of the **CABMA Register** (1955/6) of British products and Canadian distributors again incorporates an alphabetical buyers' guide to some 4,000 British products, including radio and electronic equipment, available on the Canadian market. Other sections list manufacturers, trade names, Canadian distributors, etc. The register (price 2gns) is published jointly by Kelly's Directories and Iliffe and Sons for the Canadian Association of British Manufacturers and Agencies which operates British Trade Centres in Toronto, Vancouver and Montreal.

EXHIBITION NEWS

Next Physical Society Exhibition.—It is announced by the Physical Society that next year's 40th exhibition of scientific instruments and apparatus will be held in both the Old and New Halls of the Royal Horticultural Society, Westminster, London, S.W.1, from May 14th to 17th.

Marine Exhibition.—A number of radio manufacturers specializing in marine equipment or industrial electronic gear will be among the 500 exhibitors at the Engineering, Marine and Welding Exhibition which opens at Olympia, London, on September 1st for 13 days. Manufacturers appearing in the provisional list of exhibitors include B.T.H., Decca, English Electric (Electronics Division), G.E.C., I.M.R.C., Metropolitan-Vickers, Mullard, Radio Heaters, Redifon and Stratton. The exhibition will open daily from 10 a.m. to 8 p.m.

The dates for the ninth annual **Amateur Radio Exhibition,** organized by the Radio Society of Great Britain, have now been confirmed; November 23rd to 26th. It will again be held at the Royal Hotel, Woburn Place, London, W.C.1, and will be opened at noon on the 23rd by Vice-Admiral J. W. S. Dorling, director of the Radio Industry Council.

Midlands Radio Show.—The success of last year's Nottingham Radio Exhibition has prompted the organizers—the Nottingham Centre of the Radio and Television Retailers' Association—to broaden the scope of this year's show and to re-name it the Midlands Radio Exhibition. It will be held in the Ice Stadium, Nottingham, from September 19th-24th.

At the **British Exhibition in Copenhagen** (September 29th to October 16th) arranged jointly by the British Import Union, Denmark, and the Federation of British Industries, a large stand has been taken by the Radio and Electronic Component Manufacturers' Federation. Some twenty member-firms will be participating.

The **Model Engineer Exhibition,** with which is combined this year the Exhibition of Inventions, is to be held at the new Horticultural Hall, Westminster, from August 17th to 27th.

BUSINESS NOTES

Collins Radio, the well-known American manufacturers of aeronautical radio equipment, have formed a subsidiary in this country—Collins Radio Company of England, Limited. At present it is operating a service depot at Sunflex Works, Colham Mill Road, West Drayton, Middx. (Tel.: West Drayton 2226.)

Ekco-Dynatron Merger.—E. K. Cole, Ltd., have acquired a controlling interest in Dynatron Radio, Limited, of Maidenhead, Berks. It is understood that there is no intention of changing the policy of the business which is concerned with the manufacture of "above-average" domestic sound and television receivers.

The potential output of **G.E.C.** television receivers will be increased by 50 per cent with the rearrangement of production facilities in Coventry. The factory in Spon Street is being devoted exclusively to television and the production of domestic sound receivers is being transferred to another factory in the city.

The exclusive world distribution of acoustical equipment developed by **Kelly Acoustics Limited,** of 295, Regents Park Road, London, N.3, has been taken over by **Thermionic Products Limited,** Hythe, Southampton, to whom all enquiries for the new ribbon loudspeaker (RLS/1) should be sent.

Ampex Corporation, of California, manufacturers of magnetic-tape recording equipment, are to open an office in London. This and similar offices in overseas countries will be run by the recently formed company, Ampex International.

The "**Radiovoyce**" **microphone** equipment illustrated on p. 312 of our July issue, for which Leevers-Rich Equipment Limited are sole marketing agents to the trade, is designed and manufactured by F. W. Hopwood (Developments) Limited, 181, Wollaton Street, Nottingham.

Truvox Limited announce that they have appointed A. B. Thompson (Ireland) Limited, of 15, Newforge Lane, Belfast, as Northern Ireland agents for their tape-recording components and accessories.

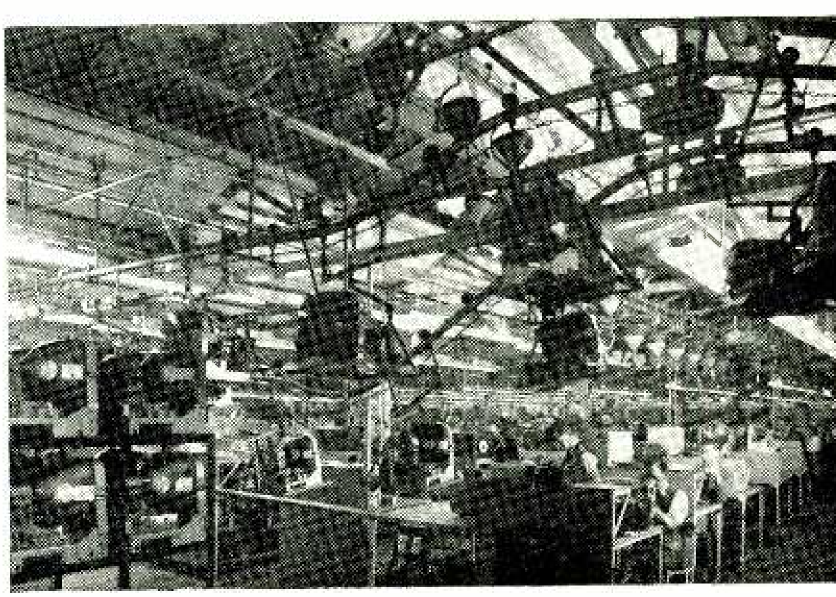
F. W. Electronics, Limited, of New Southgate, London, N.11, which was formed in 1950 and specializes in the design and manufacture of audio and r.f. equipment—including equipment for schools—has moved its works and registered office to 12a, Prince of Wales Road, Hendon, London, N.W.4. (Tel.: Sunnyhill 0683.)

Holiday and Hemmerdinger, Limited, of 74-78, Hardman Street, Deansgate, Manchester, 3 (Tel.: Deansgate 4121) have notified us that they have arranged with the Recording Equipment Division of E.M.I. Sales and Service, Limited, to distribute "Emidisc" lacquer recording blanks and accessories to the trade in the Manchester area.

The telephone number of **Nagard, Limited,** designers and manufacturers of electrical instruments for research and industry, of 18, Avenue Road, Belmont, Surrey, has been changed to Vigilant 9161.

The North-Western Gas Board, which operates two base stations at Manchester and Liverpool and 25 mobile radio-telephone installations, is now using a radio-equipped mobile "paying-in" office. The a.m. equipment being used in the vehicle, which periodically visits outlying districts, was supplied by the Radio & Transmission Division of **Automatic Telephone & Electric Company.** Two additional fixed stations are to be brought into operation by the Board to serve the Wirral and St. Helens areas.

Jack Davis (Relays), Ltd., is moving this month from Percy Street, London, W.1, to Tudor Place, Tottenham Court Road, W.1. Telephone numbers are unchanged.



HALF A MILLION television receivers have come off this assembly line at the Enfield, Middlesex, factory of Ferguson. The conveyors in the foreground are carrying completed chassis, after soak tests, to the section for final testing and adjustment.

EXPORT NEWS

Equipment for a public radio-telephone service in the three neighbouring territories of Sarawak, North Borneo and Brunei is being provided by **A.T.E. (Bridgnorth), Ltd.,** a subsidiary of Automatic Telephone & Electric Company, Ltd. More than 80 single-channel radio links will be required for the service which will link the outlying settlements and the divisional centres where line telephone services already exist. Eventually the main centres will be linked by a multi-channel radio system.

Redifon radio-telephone equipment is being fitted in ten of the vessels of the Niger river fleet of the United Africa Company and fixed stations will be set up at Burutu, Makurdi, Yola and Garua.

A radio network providing for 240 telephone circuits and a two-way 525-line television channel between Osaka and Fukuoka has been ordered from **Standard Telephones and Cables** through its associates the Nippon Electric Company, Limited, of Tokio. Eleven intermediate repeaters, working in the s.h.f. band (3,000-30,000 Mc/s), will be used to cover the 385 miles.

India's Director General of Supplies and Disposals (Shahjahan Road, New Delhi), has asked for tenders for **12,500 broadcast receivers** and associated aerial equipment and loudspeakers. The majority of the receivers are for dry-battery operation and must cover the medium-wave band although some of them must also cover the short waves. About 1,000 receivers are needed for a.c. operation. A copy of the tender documents is available from the Export Services Branch, B.o.T., Lacon House, Theobalds Road, London, W.C.1 (Reference ESB14288/55). Closing date for tenders is July 29th.

International Aeradio, Limited, has received from the Egyptian Air Force an order for three air traffic control desks. I.A.L. is also providing the radio and air traffic control services at Yeadon Airport, near Leeds, which is to be developed to provide scheduled and charter air services.

Airfield control radar equipment (Type 424) is to be supplied by **Decca Radar, Limited,** for installation at Durban National Airport. This surveillance radar equipment, which was reviewed in our November, 1953, issue, was also recently supplied to the South African Air Force.

R. B. Page, of **Birmingham Sound Reproducers, Ltd.,** is on a three-month visit to North America to renew acquaintance with radio-gramophone manufacturers.

F

Inexpensive Wave Analyser

"Zero-beat" System Using Simple Low-Pass Filter

By M. G. SCROGGIE, B.Sc., M.I.E.E.

IN a recent survey of distortion-measuring technique[1] it was noted that published data on distortion usually take the form of a single figure ("total harmonic distortion") whereas for fair comparison one must know about the individual distortion products (whether harmonics or intermodulation) making up this total. One reason for the scarcity of analysed data is no doubt the high cost of wave analysers. In order to measure each distortion product separately it is necessary to have extremely high selectivity, which cannot reasonably be obtained by straightforward a.f. tuning capable of being varied continuously from, say, 20 c/s to 20 kc/s. The difficulty is usually overcome in the same way as in the analogous r.f. problem in radio receivers, with the aid of the superheterodyne principle. By means of a beat oscillator, the frequency of the chosen component of the signal being analysed is transferred to an "i.f.," which might be 50 kc/s; components of all other frequencies are then removed by a filter having a pass band of only a few cycles per second, and after amplification the selected signal deflects an indicating meter.

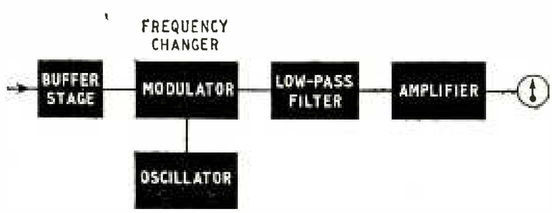


Fig. 1. Block diagram of the type of wave analyser described.

The heart of the instrument is the filter, because on it the capabilities of the wave analyser chiefly depend. For testing high-fidelity equipment it is necessary to measure distortion components of the order of 0.1% (i.e., 60dB down) relative to a fundamental output separated in frequency by perhaps 25 c/s, which relative to 50 kc/s is 0.05% off-tune. At the same time, in order not to render the analyser too tricky to use, or make unreasonable demands on signal-frequency stability, the filter characteristic ought to be flat-topped. Such onerous requirements, calling for carefully applied crystal resonator technique, have no doubt deterred many experimenters from running up an analyser for themselves.

Continuing the radio receiver analogy, we might remember that there is such a thing as a synchrodyne,[2,3] which can be defined as a superhet in which the i.f. is zero. An advantage therein is that instead of the usual highly selective band-pass i.f. system a simple low-pass filter will do. This seems just what is wanted for a wave analyser. Providing a filter to cut out everything above one or two cycles per second presents no difficulty at all. In fact, on top of a great saving in expense, it is easy to obtain substantially higher effective selectivity than in a conventional wave analyser, yet at the same time adjustment is less critical.

One inherent disadvantage of the principle ought perhaps to be declared at the outset. In a frequency changer, harmonics of the oscillator frequency are likely to be present. These, in a wave analyser with an i.f. of the order of 50 kc/s, are too far up in the r.f. region to give i.f. beats with any a.f. (the "bias" frequency in a tape recorder must be watched, however). But in the zero-i.f. type of frequency changer, in which the desired response is obtained by setting the beat-oscillator frequency very nearly equal to that of the signal component to be measured, smaller responses can also occur at multiples (especially odd multiples) of the frequency read. One must therefore take some care to choose signal frequencies that cannot yield misleading responses.

What might be considered to be another disadvantage is that if one desires to cover the full a.f. band the beat oscillator has to be variable over a large tuning ratio, say 1000 : 1, as compared with less than 2 : 1 in the conventional system. On the other hand, however, the fact that the beat oscillator frequency at zero-beat is exactly the same as that of the component being measured makes for much easier adjustment and more accurate and stable frequency calibration, which are decided advantages.

Fig. 1 is a block diagram of a zero-i.f. wave analyser. When measuring very weak distortion products, some amplification ahead of the frequency changer could be helpful, but it is even more important not to add to the distortion before it is measured. Some sort of buffer stage is essential, in order to make the input impedance large enough not to impose appreciable loading on the signal being analysed and at the same time to present to the modulator an output impedance low enough not to introduce appreciable distortion. These requirements are met by a low-resistance cathode follower.

Type of Oscillator

The modulator is a bridge comprising four rectifiers, shunted diagonally across the signal path. The design of the beat oscillator, which is connected across the other diagonal, depends on requirements. For experimental purposes an a.f. generator previously described[4] was more than adequate, and enabled results using square waves to be compared with those using sine waves. For routine tests along the lines suggested, however, a simple fixed-frequency oscillator could be used. A 3-valve oscillator like either of the two shown in Fig. 6 is very suitable for either fixed or variable frequency.

Because the mechanical movement of the indicator

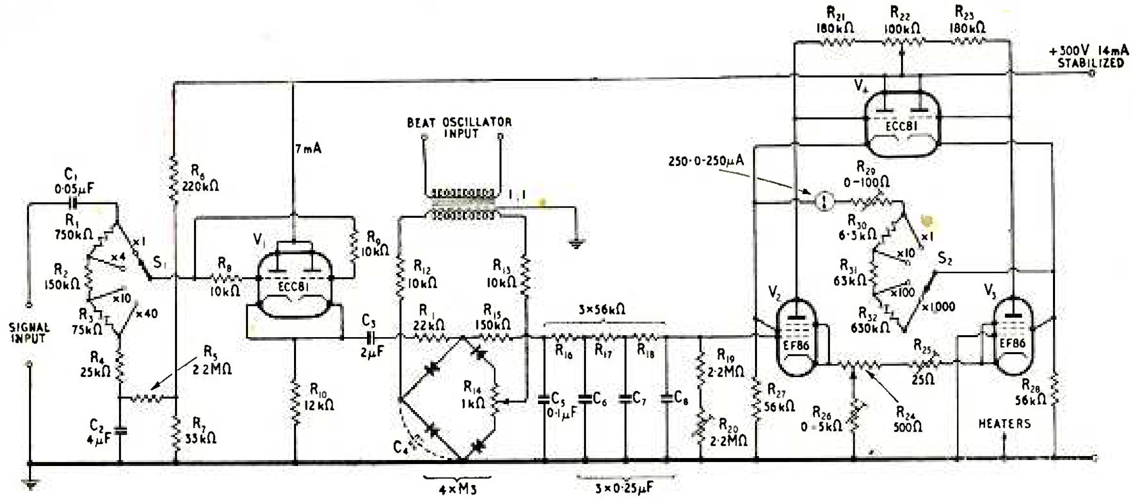


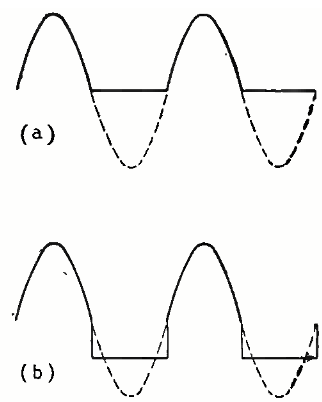
Fig. 2. Circuit diagram of a particular development of Fig. 1.

is itself a low-pass system, a very simple and cheap resistance-capacitance filter is all that is needed between modulator and amplifier. It was this amplifier that presented the greatest difficulty. At first is was supposed that two resistance-coupled stages with the time constants adapted to pass a band of the order of 0.2 to 2 c/s, or a balanced amplifier with heavy negative feedback except over this band, would be a suitable basis for design. By cutting out zero frequency it was hoped to obtain a stable meter zero, but it was found that even in a push-pull system it was impracticable to balance the long time constants sufficiently to avoid perpetual slow drifts, and in spite of the zero-instability problem a d.c. amplifier was actually more workable. Stabilized power supplies are of course necessary in any case.

The design can now be discussed in detail with reference to the circuit diagram, Fig. 2, which is subject to modification to suit individual needs. In order to provide a low output resistance (about 130 Ω) at a moderate anode current (7mA) the cathode follower comprises both halves of a high-slope double triode. The distortion caused by it is too small to estimate precisely; but the total residual inter-modulation, which with two input signals of different frequency, each 2½V peak, is of the order of 0.05% is perceptibly increased if only one half is used. Without R_8 and R_9 there is a tendency to parasitic oscillation. The time constant C_2 R_5 has a valuable stabilizing effect in preventing short-term fluctuations in h.t. voltage from reaching the grid. C_2 has in any case to be fairly large for its impedance at the lowest input frequency (reckoned as 20 c/s) to be negligible in relation to R_4, the lowest step of the input potential divider, which functions as a scale multiplier. Obviously the switch controlling it, S_1, should be of the make-before-break type.

The modulator (known as a Cowan type [2,3]) is made up of four Standard Telephones M3 miniature selenium rectifiers. Under the influence of the beat oscillator their resistance becomes alternately much higher and much lower than R_{11}, so that the signal from the cathode follower is alternately passed to the filter and suppressed. When the signal contains a frequency exactly equal to that of the oscillator, and in phase, the component of the signal at that frequency

Fig. 3. Signal waveforms across the modulator, (a) according to simplified theory, and (b) as modified in practice by C_3 (Fig. 2). The dotted portions of the original waveform are suppressed. In (b) the horizontal portions indicate the displaced zero level.



is in effect rectified. If the phase is reversed, the direction of rectification is reversed. So if the signal frequency is altered by, say, 1 c/s, a 1-c/s signal is created by the slowly shifting phase relationship. This signal is accepted by the filter, the original signal being rejected.

Modulation Wave Shape

If the action were quite as simple as just described, the waveform across the modulator, with the beat oscillator in phase with a sinusoidal incoming signal, would be as in Fig. 3(a), where the dotted line traces the suppressed half-cycles. This condition corresponds to the peak value of the beat-frequency signal, which is clearly equal to the mean value over a whole cycle of one half cycle of the incoming signal, or $1/\pi$ times its peak value. The theoretical efficiency, neglecting all losses, such as those due to the finite resistance of the rectifiers, would therefore be barely 32%. In reality, however, C_3 modifies the action in a manner analogous to that of the reservoir capacitor in an ordinary rectifier circuit, displacing the waveform upwards and increasing its mean value and therefore the efficiency. To obtain the greatest benefit from this, the beat oscillator should have a pulse waveform, so that (just as in the rectifier circuit) the charging of C_3 is concentrated at the peak of the input signal. After investigation it was decided that the increase in efficiency was not worth the trouble of providing the special beat-oscillator waveform and ensuring constancy of its positive/negative time ratio at all frequencies. The undesired responses are also more liable to be troublesome, because if the waveform ratio is $m : 1$ the only harmonics suppressed are integral multiples of $m+1$. Using a 1 : 1 waveform thus suppresses all even harmonics. Both for this reason, and in order to obtain constant efficiency, it is advantageous to preserve an accurate 1 : 1 ratio. This is easier to do with a sinusoidal waveform than with a square; so although the square gives the quickest switch-over for a given peak value, and consequently slightly lower residual intermodulation than an equal sinusoidal voltage, the latter was chosen on balance. The resulting signal waveform is as Fig. 3(b), and the measured efficiency (inclusive of the cathode follower) 52%. For comparison, the efficiency with a 4 : 1 oscillator waveform was 75%.

The time constant C_3R_{11} is important, because it must be long compared with the period of the lowest signal frequency and short compared with that of the highest beat frequency. Since the optimum R_{11} depends on the backward and forward resistances of the rectifiers, a suitable time constant is obtained by choice of C_3.

The higher the oscillator voltage the greater the signal voltage that can be handled linearly, but of course it must be within the maximum rating for the rectifiers, which is 56V peak inverse per rectifier, or 112 for the bridge, less an allowance for inequality of backward resistance. The signal voltage being read is limited by the amplifier to about 10V peak, and for that a sinusoidal oscillation of 20V r.m.s. is sufficient. To allow a margin of amplifier linearity, the maximum reading has been reckoned as that which is given by 6V r.m.s. at the input with S_1 at $\times 1$. Provided that S_1 is not moved to a more sensitive setting than that at which the strongest signal component is within the 6-V limit, the peak value of the whole signal at the modulator is not likely to exceed about 20, and using 28V r.m.s. (40V peak) for modulation it has been checked that this amount of signal voltage does not appreciably affect the accuracy of reading (e.g.) a 4mV component of it. It may, however, make it rather less easy to read, and 10V peak is a more conservative limit. The mean rectified current in the transformer secondary at 28V r.m.s. is about 0.5mA, which is well below the rated maximum of 1mA per rectifier. Linearity of the modulator is excellent.

Meter Zero Stabilization

In theory, this type of modulator automatically balances out the rectified and oscillator-frequency voltages from the signal path, but owing to inevitable inequalities in rectifier characteristics there is in practice a residue of both. A reasonable amount of this has not been found to cause appreciable error, but even a very small residual fraction of the total rectified (z.f.) voltage is enough to displace the pointer considerably. That in itself could be taken up on the amplifier balancing adjustment (R_{24}), but unfortunately the z.f. residue tends to vary with oscillator frequency, so that every change of frequency necessitates readjustment of meter zero. This nuisance can be more or less eliminated by (1) winding the transformer in the manner recommended for impedance bridges—with the secondary in two identical halves, balanced with regard to earth (represented mainly by the inter-winding screen);* (2) using the balance control R_{14}; and (3) connecting a capacitance C_4 across one of the rectifiers. This capacitance, of the order of 100pF, has most effect at high frequencies. The procedure is to adjust R_{14} so that switching on the beat oscillator at some medium or commonly-used frequency (say about 400 c/s) causes no displacement of the meter on the most sensitive range; then to vary the oscillator frequency and try various values and positions of C_4 to minimize shift when the frequency is raised. One of the advantages of tests at a single frequency[1] is that no special transformer or other precautions are needed. Also the advantages of a square modulating waveform can be obtained without most of the disadvantages.

The component values of the filter are not critical, but obviously R_{15} must be large compared with R_{11} if efficiency is not to be lost. As an example of the selectivity obtained by the simple means of this instrument, reading an input of 2.5mV at any frequency is quite unaffected (except for a very slight vibration of the pointer) by the presence of 4,200mV (i.e., 65dB stronger) only 30 c/s away.

Negative Feedback

At first glance the amplifier circuit may look rather like that of the valve voltmeter described in the August 1954 issue, but whereas in that circuit the whole voltage gain was sacrificed in the interests of stability by connecting the output terminals straight back to the control grids of V_2 and V_3, here a large voltage gain is needed in order to be able to measure small distortions, and the only negative feedback is that which results from feeding the screen grids of V_2 and V_3 from the output terminals. This policy not only saves a special potential divider for the purpose, but it provides some degree of zero stabilization, and lowers the output resistance of the amplifier, giving a more stable calibration. The resistance of the 250-0-250μA meter is 500Ω, and the output resistance of the amplifier about 160Ω; R_{29} is used to bring the whole up to a level of 700Ω, so that R_{30}-R_{32} with the values stated give decade ranges by means of S_2.

R_{26} is used to set the valves to suitable working points, indicated by the total amplifier h.t. current being about 7mA. R_{24} is used as a coarse balancing or zero-setting control and R_{25} the fine control. The additional balancing facility afforded by R_{22} is not absolutely essential, but is quite helpful in arranging the best working condition.

Without R_{19} and R_{20} the system was found to give full-scale swing on the $\times 1$ ranges of S_1 and S_2 for 9mV r.m.s. input at the selected frequency. By means of R_{20} this is pre-set to a convenient 10mV, the scale having been provided with a 10-0-10 marking. On the $\times 1{,}000$ setting of S_2 the meter is therefore direct reading in volts, but (as already explained) should not be used above 6 on this range.

The overall voltage gain of the amplifier is thus about $\times 24$. Although not large by higher-frequency standards it can cause quite a lot of trouble unless care is taken with regard to zero stability. The balanced circuit of course goes a long way towards

* A suitable transformer can be obtained from the Majestic Winding Co., 180 Windham Road, Bournemouth.

achieving this and those inexperienced with d.c. amplifiers may perhaps wonder why it does not go all the way, since it might appear that any change in supply voltages would affect both halves of the system equally and therefore would not affect the meter. But a little calculation shows that a perceptible displacement of the pointer—say $10\mu A$—results from a difference between the anode currents of V_2 and V_3 of only about $0.05\mu A$. Now although any initial difference can of course be corrected by R_{21} or R_{22}, it would be too much to expect the anode currents of even a well-matched pair of valves to vary equally within $0.05\mu A$ over a range of anode, screen and heater voltages.

Any reasonably effective stabilizer for the source of the 300V h.t. should be able to eliminate zero-shift due to variations in anode and screen potentials of valves V_1-V_4, but the provision of R_{22} in addition to R_{24} makes assurance doubly sure; by successively shifting the setting of one and recentring the meter pointer with the other, an adjustment can be found at which even several volts change in h.t. has little effect on the meter, and protection is thus obtained against transient fluctuations of voltage of an inferior stabilizer. Protection against such transients (but of course not against long-term drifts) via the grids of V_1 is given by C_2R_5. Trouble due to small fluctuations of h.t. is thus confined almost exclusively to the cathode current of V_1, and it is for this that stabilization of the supply is chiefly needed. Even here an exceptionally high standard is not essential, thanks to the stabilizing effect of the negative feedback.

Incidentally, in case it occurs to anyone to extend the balanced-circuit principle all the way, as in Fig. 4, it should be mentioned that this causes the full signal voltage from V_1 to be applied between the grids of V_2 and V_3 and earth, thereby prematurely overloading

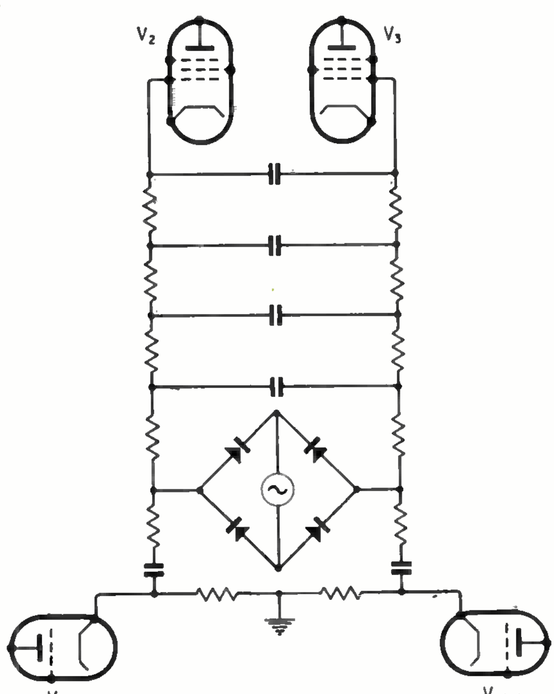


Fig. 4. Alternative, but less satisfactory, arrangement of the circuit up to the d.c. amplifier.

the amplifier on its most sensitive range. Moreover differences in time constants cause h.t. fluctuations to be more, rather than less, troublesome.

Although changes in oscillator amplitude affect the meter by upsetting the adjustment of R_{11}, it has not been found necessary to stabilize the oscillator power supplies, sufficient control being provided by the thermistor.[4]

Except for very low frequency fluctuations that may come in with the signal, the remaining cause of zero instability is the heater voltage. Its effect on V_4 is slight. On V_1 it is more troublesome; a 5% change in V_h was found to cause $100\mu A$ zero shift on the most sensitive range. But the effect is most serious as regards V_2 and V_3. The simple device of differentially adjusting the heater voltages of the two valves, for which very good results have been claimed with triodes,[5] was found to be quite ineffective, at least as regards the few samples of EF86 available. If one is not so fortunate as the writer to pick two valves that are well matched, not only as regards the ultimate

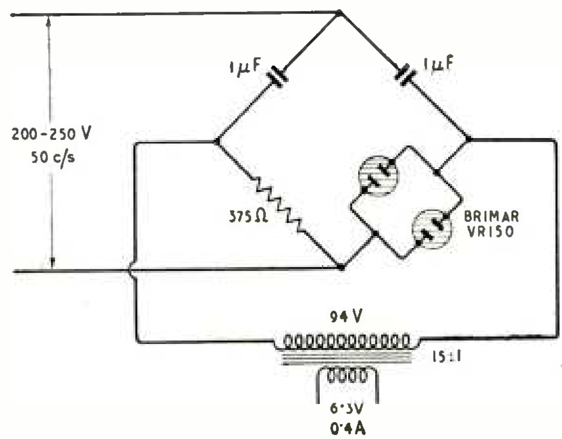


Fig. 5. Cherry and Wild stabilizer for the heater supply to V_2 and V_3, if found necessary. The VR150 tubes in parallel are connected anode to cathode.

inequality in anode-current change caused by a heater-voltage change, but also in the rate at which the anode-current change occurs, it is advisable to stabilize the heater voltage of at least these two valves. If it can be stabilized for all the heaters, so much the better; but stabilization of V_2 and V_3 only is suggested as a second-best, because the comparatively simple Cherry and Wild system[6] provides sufficient output for these two heaters. Fig. 5 shows the circuit, which was found to be amply effective for badly matched valves, giving a stabilization ratio of the order of 30 : 1.

Type of Meter.

Heater-voltage stabilization is rendered ineffective if there is instability of heater-circuit resistance, so good valve-holder contacts are essential; it would be better, if suitable valves with wire leads were obtainable, to solder them in without holders. Of course the whole of the circuit, especially from signal input to the grid of V_2, must be free from uncertain contacts, leakages and stray pick-up; for example, all capacitors should have high and constant insulation resistance, and their cases should be earthed.

Lastly, there is the indicator itself. A 2-in dia.

0–500μA meter, adjusted to a centre zero, was found to have a suitable combination of electrical and mechanical characteristics. Owing to the automatic limitation of current by the circuit, a more sensitive instrument could be used without risk of accidental damage, but there would be no point in doing so, because the minimum effective reading is already limited more by instability of zero and residual distortion than by insensitivity of the meter. Damping of the movement must be enough to suppress resonance without causing excessive sluggishness. The higher the frequency at which the pointer can oscillate without serious error (10% or even 20% is a not unreasonable tolerance in distortion measurements), up to the rate at which reading its amplitude of swing becomes difficult for the eye, the less critical is the adjustment of the signal frequencies and the demands on oscillator frequency stability. In practice a beat period of several seconds per cycle is about right.

Intermodulation Twin Oscillator

Coming now to the signal source, the chief requirement is stability and ease of adjustment of frequency. Dependable frequency calibration is a great help, particularly in identifying and avoiding spurious responses. For measuring harmonics, very pure waveform is obviously needed; this is not so necessary with intermodulation, the errors caused by harmonic content then being only of a second order of magnitude. The three-valve circuit forming the nucleus of the a.f. source already mentioned has proved to be simple and reliable, with quite phenomenal frequency and amplitude stability. A double oscillator for intermodulation measurements, hastily put together without any special care, using ordinary components, has often been set to give a slow beat, at, say, 0.3 c/s, and has continued to maintain this rate, without perceptible change, for hours on end. As regards purity of waveform, the second harmonic is about 0.25%, third 0.3%, and all others negligible. This performance was obtained notwithstanding that six old EF50 valves were substituted for the SP61 used in the original signal generator, whose harmonics are about half as great. The suitability of EF80 valves was checked by plugging them in, via adapters, in place of the EF50; no readjustment was necessary; the total h.t. consumption for the two oscillators was increased from 40 mA to 46 mA, and the harmonic content nearly halved. In every way, therefore, this circuit is eminently suitable as a signal source for intermodulation measurements in conjunction with the wave analyser. Fig. 6 is the circuit diagram.

For economy as regards the ganged inverse semi-log rheostats, the frequency ratio on each range was reduced from the 10 : 1 in the original model to about 3½ : 1; this also slightly facilitated the all-important precision in frequency setting, but the fine controls (R_2) are chiefly relied upon for close adjustment. For the purposes in view, complete coverage of the full a.f. band by both oscillators was unnecessary, and the ranges are as given in Table I.

TABLE I.

Range	Oscillator 1		Oscillator 2	
	Frequency	Capacitance	Frequency	Capacitance
1	40-120 c/s	0.1μF	350-1,100 c/s	0.0115μF
2	350-1,100 c/s	0.0115μF	1,000-3,200 c/s	0.004μF
3	3-10 kc/s	1,330pF	3-10 kc/s	1,330pF
4	9-25 kc/s	450pF	9-25 kc/s	450pF

If lower frequencies were included it would be necessary to increase the values of the coupling capacitors accordingly.

Apart from these modifications of the original design, concerned with frequency coverage, the only new consideration was the necessity for combining the two signals in the output, without giving rise to intermodulation. With the direct mixing system shown in Fig. 6, there is just perceptible intermodulation, and if one wants to avoid this one can substitute a bridge or hybrid-coil system, but the improvement was found to be hardly worth while. It can be shown that, given equal outputs from the two oscillators, the ratio of their voltages at the common output terminals is equal to the ratio in which R_{19}-R_{21} is divided by S_2 (where these resistances include the internal resistances of the oscillators, which, being cathode followers in this case, are negligible). If therefore tests are usually made with either a 1 : 1 or 4 : 1 ratio, it is convenient to provide tappings as shown. This does not prevent any other desired ratio from being set up by the separate controls (R_{14}); the level of the combined signal can then be varied without change of ratio by R_{22}.

Avoiding Spurious Effects

The frequency-selecting section of each oscillator should be enclosed in a screen; it is particularly necessary to remove stray capacitance between the two sections, as failure to do so may cause a small signal from one oscillator to appear at the output even when its own R_{14} is at zero. No difficulty was found, however, in running the twin oscillator unit from the same stabilized power supply as the wave analyser.

Residual intermodulation of modulator, input cathode follower, and signal-oscillator output circuit was checked in turn by first feeding the modulator with a single 420c/s signal from oscillator 2 via analyser cathode follower in series with the secondary of a step-down mains transformer giving a 50c/s signal, each signal being adjusted to give a reading of say 2V on the analyser meter. Intermodulation signals were looked for at 420$\pm$50 and 420$\pm$100c/s, and were barely perceptible on the most sensitive range. The 50c/s source was then transferred to the lead between signal oscillator and analyser cathode follower. Lastly, the test was repeated with the 50c/s mains source replaced by oscillator 1. Overall intermodulation using a sinusoidal beat-oscillator waveform, was 0.1% second order and 0.08% third order. With a 1 : 1 square waveform the figures were 0.04% and 0.02% respectively.

Of spurious responses, the most important are those resulting from signals at multiples of the frequency being read, which is the frequency of the beat oscillator, denoted by f_b. Using a 1 : 1 waveform ratio, the responses due to signals at even multiples of f_b are theoretically absent, and those at odd multiples (frequency $= nf_b$) are one nth of the amplitude resulting from an equal amplitude signal at f_b. In practice this is approximately true of the odd multiples, but although the even-multiple responses are relatively

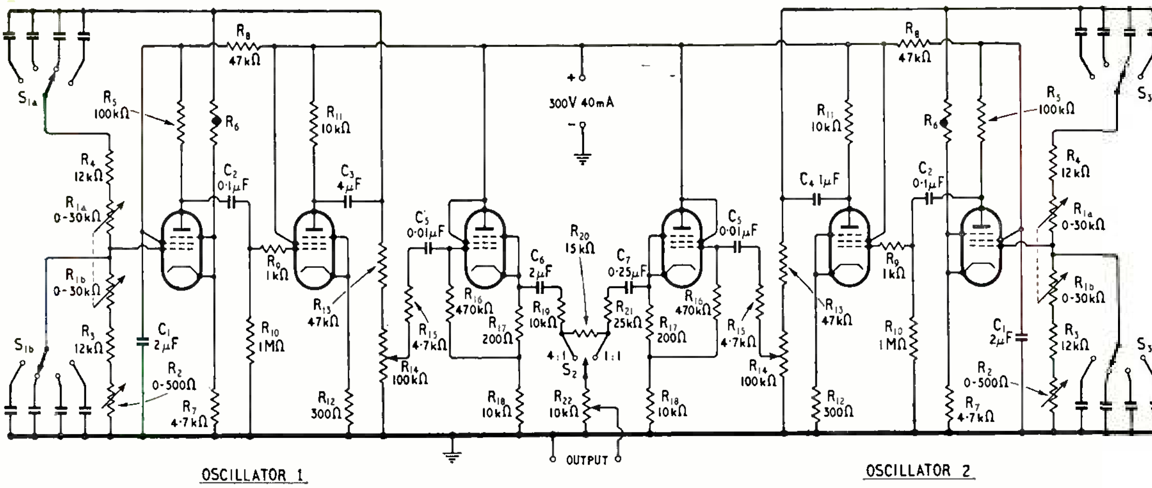


Fig. 6. Circuit diagram of a twin signal source for making intermodulation measurements in conjunction with the wave analyser. The thermistors (R_6) are Standard Telephones type A5513/100, and the valves all SP61, EF50, EF80 or equivalent. S_1 and S_3 are 2-pole 4-way frequency-range switches; the capacitances selected by pole b are the same as by pole a, and typical values are given in Table 1. Components in Oscillator 2 having the same values as the corresponding components in Oscillator 1 bear the same numbers.

small ($<5\%$ of the true response) their existence ought not to be overlooked.

When analysing signals it is inevitable sometimes that the component being read will be accompanied by another component at a multiple of its frequency, in which case an error must result. Fortunately it is seldom large enough to be appreciable. One reason for this is that, taking the odd and even harmonic series separately, their amplitudes almost invariably decrease more or less rapidly with frequency; another is the decreasing response of the analyser, which almost wipes out the even series and greatly discriminates against the odd.

In the very unlikely event of a sixth harmonic not being small compared with a second harmonic, it might (being three times the frequency) appreciably affect the reading of the second. But the only troublesome situation that is at all likely in practice is the measuring of a fundamental accompanied by a very large percentage of third harmonic. This situation is revealed by the non-sinusoidal swinging of the pointer, for the third harmonic in the signal is represented (though at only one third the amplitude) by a third harmonic of the slow beat frequency, and the effect of this harmonic can be still further reduced by bringing the fundamental beat frequency to the point beyond which response falls off rapidly.

In choosing f_1 and f_2, the lower and higher signal oscillator frequencies for intermodulation tests, one would of course avoid making any of the components to be read—$f_2 \pm f_1, f_2 \pm 2f_1$, etc.—equal to a multiple of f_1 or f_2. Fractional relationships between f_1 and f_2 would also be avoided; e.g., if f_1/f_2 were 2/5, $f_2 + 2f$ would clash with $f_2 - f_1$, being its three-fold multiple. Doubt about whether or not a response is due to intermodulation can be dispelled by checking that the beat frequency responds to an adjustment of both f_1 and f_2.

Pick-up from the mains is another possible cause of undesired responses, and 50c/s and its multiples (especially odd) are to be avoided as signal frequencies.

It has been interesting, in using this wave analyser, to confirm the experimental measurements by Warren and Hewlett[7] of the ratio of intermodulation to harmonics with amplifiers having various kinds of distortion and level frequency characteristics. Since the wave analyser reads only the sum *or* difference frequency and not both at once, the ratios are half those obtained by Warren and Hewlett with the same relative signal amplitudes (which were in the ratio 5 for harmonic to 4 and 1 for intermodulation measurement). With a single triode, giving almost pure second-order distortion, the amplitude of the component at $f_2 + f_1$ or $f_2 - f_1$ is 1.6 times that at $2f_1$; and with a push-pull amplifier, giving mainly third-order distortion, the amplitude ratio of $f_2 + 2f_1$ or $f_2 - 2f_1$ to $3f_1$ is 1.92. When negative feedback is used, distortion is of course greatly reduced; but if the signal amplitude is then raised to reintroduce distortion, its onset is more rapid, and instead of being concentrated mainly in second or third or both, it continues far up the series with comparatively slow convergence, and the aural unpleasantness is worse.

While admittedly a keen ear is the only instrument that is valid in the final assessment of sound reproduction, instrument readings are of very great value if properly taken and interpreted; and if analysed measurements rather than lumped were more generally made the much-needed establishment of accepted correlation between instrument readings and listening tests would assuredly be speeded up.

REFERENCES

1 Scroggie, M. G., "Measurement of non-linearity distortion," *Wireless World*, July, 1955, p. 317.

2 Tucker, D. G., "The Synchrodyne," *Electronic Engineering*, March 1947, p.75.

3 "Cathode Ray," "The Synchrodyne," *Wireless World*, Aug. 1948, p. 277.

4 Scroggie, M. G., "Audio signal generator," *Wireless World*, Aug. 1949, p. 294, and Sept. 1949, p. 331.

5 Aitchison, R. E., "A new circuit for balancing the characteristic of pairs of valves," *Electronic Engineering*, May 1955. p. 224.

6 Cherry L. B., and R. F. Wild, "Electronic a.c. power regulator," *Proc. I.R.E.*, April 1945, p. 262.

7 Warren, W. J., and W. R. Hewlett, "An analysis of the intermodulation method of distortion measurement," *Proc. I.R.E.*, April 1948, p. 457.

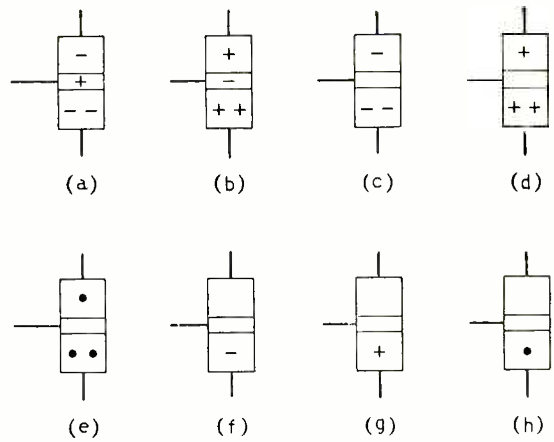
Transistor Symbols

SUGGESTIONS for the symbol to be used for the transistor have appeared from time to time in *Wireless World*, and especially in the April and May issues (pp. 151 and 201). Another symbol of an interesting kind is used in *L'Onde Electrique* (March-April, 1955, pp. 243-263). The symbols for *n-p-n* and *p-n-p* junction transistors are shown in the figure, at (a) and (b) respectively. Plus signs are used to designate p-type material and minus signs for n-type.

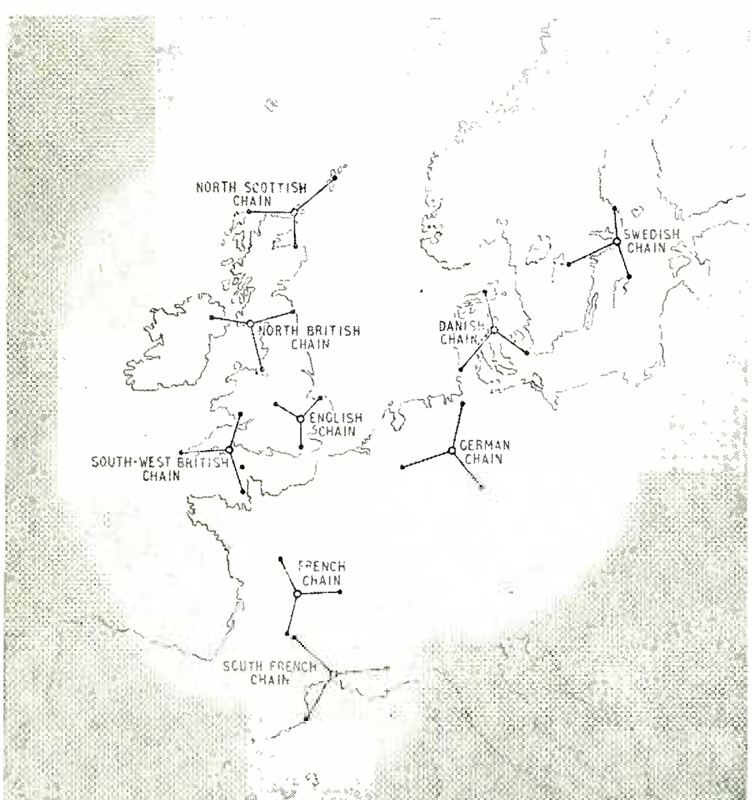
Since the emitter, as their source, contains more charge carriers than the collector (by those leaving through the base), the emitter and collector are distinguished by two signs and one sign respectively.

The full sign complement of (a) and (b) is actually unnecessary, for the base material is always of opposite kind to the emitter and collector. One can, therefore, omit the signs on the base and reduce the symbols to the form (c) and (d). This is quite commonly done in the article in *L'Onde Electrique*. A further modification consists in replacing the signs by dots as in (e). This is done when one wants to designate a transistor without being specific about whether it is a *p-n-p* or an *n-p-n* type.

There is still some redundancy, however, and the symbols could be reduced to (f), (g) and (h) without losing anything. The convention here is to mark only the emitter by a sign indicating the nature of the charge carriers, so (f) is for an *n-p-n* transistor, (g) is for a *p-n-p* and (h) is a general symbol for either.



DECCA NAVIGATOR EXTENSIONS



PLANS have been made to build three new chains of Decca Navigator stations in Europe—in Sweden, southern France and northern Scotland—making a total of nine. When the new stations are completed some 2,000,000 square miles of Europe will be covered. As will be seen on this map, coverage will extend from Cape Finisterre to the Gulf of Bothnia and from Corsica to beyond the Faroes.

It is also announced that plans are being made for the first two chains of permanent stations to be erected outside Europe. They will cover the Bombay and Calcutta areas of India. Temporary low-power chains have been set up overseas for survey purposes; one of the latest being for the Japanese Hydrographic Department.

Since the first Decca chain in south-east England was opened in July, 1946, over 2,600 naval and merchant ships have been fitted with the Decca Navigator. An increasing number of civil aircraft are also using it, and a new receiver, the Mark 10, designed especially for aircraft, is being produced. It will cover seventeen different chain frequencies and provide automatic lane and zone identification.

LETTERS TO THE EDITOR

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

Spurious Radiations from Wrotham

IN his article in your July issue J. R. Brinkley drew general conclusions on the co-siting of f.m. transmitters from observations made on the performance of the transmitters at Wrotham as they are at present installed. The arguments against co-siting of television transmitters are of course irrelevant when applied to f.m. transmitters, and "co-siting" is perhaps a misleading term to apply to the practice of feeding one aerial system with the output from three transmitters.

Mr. Brinkley is correct in pointing out that adequate steps must be taken to reduce coupling between transmitters, and he is also right in his statement that at the present time the attenuation of the filters now installed at Wrotham is insufficient. But, because of the severe interference on the medium-wave band the B.B.C. decided, in agreement with the Post Office and the radio industry, to bring Wrotham into regular service before the second half of the Home Service transmitter and the aerial combining units for the three transmitters were in their final form. In this way a v.h.f. service was made available at the earliest possible moment to listeners in London and South-East England. The temporary filters at present in use will be replaced by the final filters within the next few weeks. When this has been done the intermodulation products to which Mr. Brinkley refers, and of which we are naturally aware, will become negligible.

E. L. E. PAWLEY
Head of Engineering Services Group, B.B.C.

F.M. Receiver Design

WE cannot agree with J. K. Carter (correspondence in July issue) who rebukes us for using the ratio detector in our f.m. tuner described in the April and May, 1955, issues. The decision to use this in preference to the Foster-Seeley discriminator was made after considerable thought and the saving of one valve is only one of the factors which influenced us. A more important consideration is that the low distortion of the Foster-Seeley circuit can be obtained only by critical adjustment of the coupling between primary and secondary windings of the discriminator transformer. To make this adjustment requires equipment unlikely to be possessed by the amateur constructor. The linearity of the ratio detector is less dependent on circuit adjustment; moreover there is less inter-station noise than with the Foster-Seeley type.

Mr. Carter accuses us of being illogical but he conveniently overlooks the other sources of distortion in the complete f.m. chain and in particular the chief offender; namely, the moving-coil loudspeaker. "Or," to use his own words. "is there some mystic reason why *n*% distortion in the loudspeaker doesn't matter but *n*% cent in the output stage does?"

S. W. AMOS, G. G. JOHNSTONE.

Design for a Pre-amplifier

D. H. W. BUSBY, on p. 328 of his article in your July issue, says that a capacitance of 400pF could be placed across the output with the gain control fully advanced, with negligible loss of output at 15 kc/s.

This may well be so, but if the gain control is turned down to half-way, the reactance of the capacitor would appear across 50 kΩ and would be fed from a source impedance of at least 50 kΩ. In this case the response would be down by at least an extra 3.5 dB at 15 kc/s. In addition, the amount of high-frequency cut introduced would vary with gain control setting, being greatest with the slider electrically at centre, and would become progressively less on either side of this position.

London, S.E.26. W. C. R. WITHERS.

The designer of the pre-amplifier writes.—Mr. Withers is quite correct. The amount of high frequency cut will indeed vary with the gain control setting. If the loss due to the interconnecting cable is not to exceed 1 dB at 15 kc/s for any setting, the corresponding permissible value of capacity is approximately 150 pF. This will normally correspond to at least 7-8ft of cable, which, for most purposes, will be found adequate.

D. H. W. BUSBY.

Damping Factor : A New Approach

AS the one originally responsible for introducing the term "damping factor"* the writer feels some responsibility for finding an alternative form now that we are so deeply in the morass. The term had many shortcomings but it could, at least, be used safely so long as it was always finite and positive. The commercial release of amplifiers with negative damping factors has been very confusing to engineers, to say nothing of the general public. For an increase of 22% in total circuit damping, the "damping factor" increases from 10 to infinity, then returns back from $-$infinity to -10. All these extraordinary changes in the damping factor would lead one to believe that something important was happening. In reality nothing has happened except a slight and steady increase in the total damping. The tricks played by the so-called damping factor are due merely to an unfortunate choice of definition. With this definition, instability occurs when the damping factor ≤ -1.

The total circuit damping is a function of the total circuit resistance, that is, the algebraic sum of the voice coil resistance (always positive) and the amplifier output resistance (positive or negative). I therefore put forward the following as a much more satisfactory and logical substitute for damping factor:

$$\text{Damping ratio} = \frac{R_L}{R_L + R_O}$$

Where

R_L = load resistance

R_O = output resistance of amplifier

and where both R_L and R_O are referred to the same side of the transformer.

The following table is for $R_L = 15$ ohms and is purely as an example:

R_O ohms	R_L+R_O ohms	Damping factor $=R_L/R_O$	Damping ratio $=R_L/(R_L+R_O)$
+75	+90	+0.2	0.167
+3	+18	+5	0.83
+1.5	+16.5	+10	0.91
+0.15	+15.15	+100	0.97
0	+15.0	∞	1.0
−0.15	+14.85	−100	1.01
−1.5	+13.5	−10	1.11
−5.0	+10.0	−3	1.5
−12.0	+3.0	−1.25	5.0
−13.6	+1.4	−1.1	10.7
−14.3	+0.7	−1.05	21.4
−15.0 on verge of instability	0	−1.0	∞

It will be seen that the proposed damping ratio is positive and finite so long as instability does not occur. It is also proportional to the actual damping in the circuit. It appears to be the only available function with all the desired qualities.

F. LANGFORD-SMITH
Amalgamated Wireless Valve Company,
Sydney, N.S.W., Australia.

* Langford-Smith, F., "Radiotron Designer's Handbook", 3rd ed. 1940.

Band II F.M. Tuner Unit

Design Suitable for Use With a Wide Range of A.F. Amplifiers

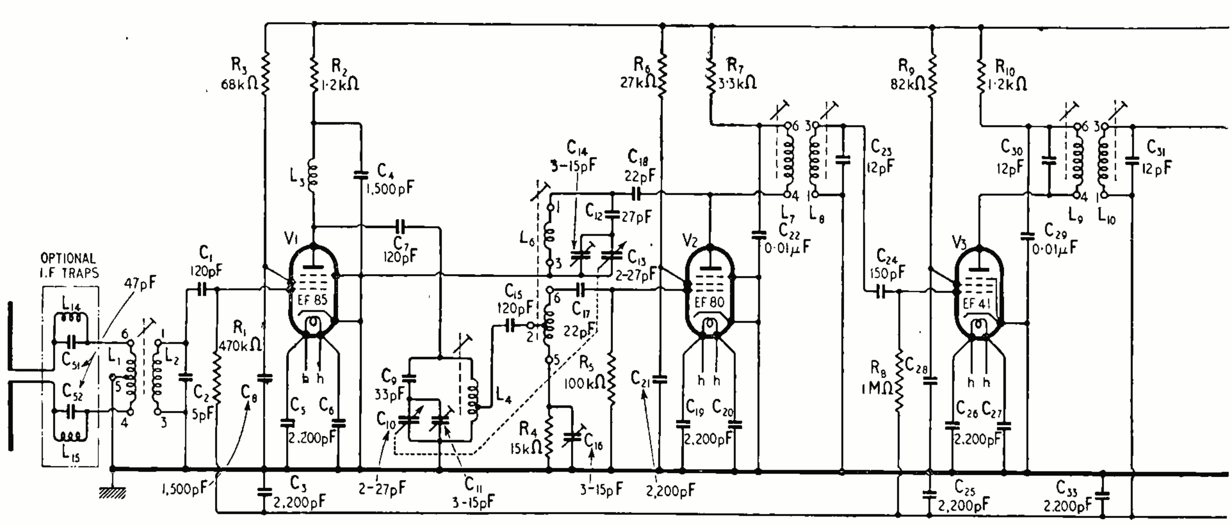
ALTHOUGH the tuner circuit described in the following pages was designed primarily for use with the Mullard 5-valve 10-watt amplifier circuit[1], or with the 20-watt circuit using EL34s[2], it is suitable for use with a wide range of amplifiers. The frequency range covers the whole of Band II (87.5-100 Mc/s), and while the circuit design chosen incorporates some of the more modern developments applicable to this type of reception, the construction is kept free from complication. The power supply would normally be taken from the main audio amplifier.

Circuit Description.—A complete circuit of the tuner unit is given in Fig. 1. The r.f. stage is a conventional pentode amplifier circuit, using a Mullard EF85. The associated aerial circuit is pre-tuned to the centre of the Band II range. In the anode circuit is an r.f. choke (L_3), with the parallel-fed r.f. tuned circuit (L_4, C_9, C_{10}, C_{11}), of which C_{10} forms one section of the two-gang tuning capacitor. The r.f. voltage, taken from a tap on L_4, is fed into the grid circuit of a Mullard EF80 operating as a self-oscillating additive mixer. The oscillator section of the mixer is basically of the tuned-anode type, with a tuned circuit consisting of L_6, C_{12}, C_{13} and C_{14} (C_{13} forming the second section of the tuning gang.) The intermediate frequency developed by the mixer valve is fed to two conventional i.f. stages using Mullard EF41s, at an intermediate frequency of 10.7 Mc/s. In the second i.f. stage the EF41 operates as a partial limiter valve at high signal levels, and the bias developed across its associated grid circuit capacitor C_{32} is fed back to the first i.f. valve and to the r.f. valve. The final i.f. stage drives a ratio detector circuit containing a Mullard double diode, type EB91. Audio-frequency voltages developed in the detector circuit are taken through a 50-microsecond de-emphasis network consisting of R_{16} and C_{45}, and thence to the a.f. output socket for feeding to the audio amplifier.

Aerial Circuit and R.F. Stage.—The aerial circuit has been designed to be matched to a 75-Ω balanced feeder line, thus permitting a simple connection from a conventional type of dipole aerial. In cases where the feeder line of this type is unscreened, L_1 may be centre-tapped to earth so that any noise voltages picked up in the feeder itself are reduced. Dust core tuning is employed, and the resonant frequency of the grid tuned circuit is arranged to be 94 Mc/s. The total tuning capacitance in the grid circuit is of the order of 18pF, of which C_2 forms 5pF and the remainder is formed by the valve input capacitance, plus stray capacitance. The input damping of the valve amounts to 3,800 Ω, giving an effective secondary circuit impedance of the order of 1,600 Ω (without the aerial circuit connected). When attached to an appropriate feeder cable, the aerial circuit bandwidth is 10.8 Mc/s for 3 dB down on 94 Mc/s and the measured aerial gain is 14 dB.

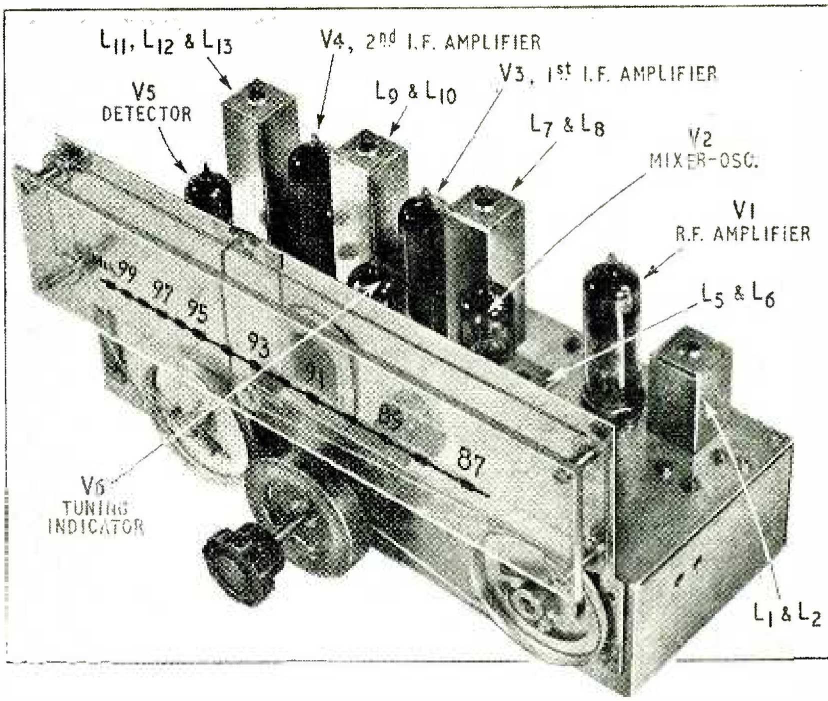
C_{10} which has a maximum capacitance of 27pF tunes the r.f. circuit, and the series capacitor C_9 and trimmer C_{11} are added to track the r.f. circuit correctly to the oscillator circuit. Thus the equivalent capacitance swing is limited to approximately 8pF, and, in addition to the lumped capacitor constants, a further 12pF and 4pF are added to the circuits in the form of the r.f. valve output capacitance plus strays and the equivalent input capacitance of the mixer reflected into the tuned circuit, respectively. To assist further in obtaining correct tracking over

Fig. 1. Complete circuit diagram. Further details of component specification are given at the end of the article.



By

L. HAMPSON, B.Sc.*



Layout of components on the top of the chassis.

the whole of the band, L_4 is tapped by means of C_{15}, so that the loaded Q factor of the r.f. circuit is comparatively high. The average value is 75, and a mean bandwidth of 1.3 Mc/s for 3 dB attenuation is maintained over the whole tuning coverage, for any point in the band. Therefore, with an equivalent load impedance of the order of 4.5kΩ at 94 Mc/s for the r.f. tuned circuit, a theoretical gain of 43 dB is obtained for the r.f. stage (including the aerial circuit). Under the circuit conditions shown the EF85 operates at a mutual conductance in the region of 9.5mA/V. Measurement of the stage gain showed it to be only slightly less than calculated.

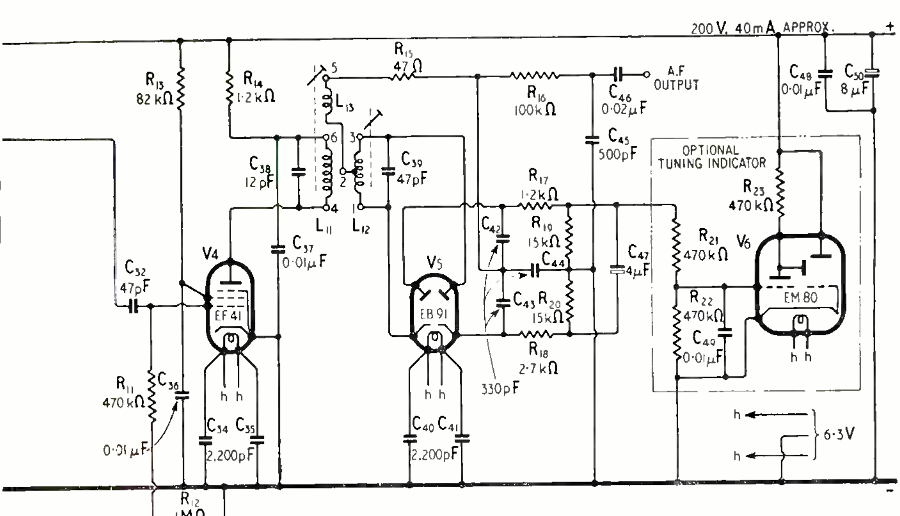
Mixer Circuit.—The self-oscillating type of mixer adopted in this circuit, has proved highly popular in countries where f.m. reception is well established. For successful operation the frequency difference between the developed intermediate frequency and the incoming signal frequency should be large. Fortunately this is generally so in f.m. receiver applications, where the intermediate frequency is usually about 10 Mc/s. As its name implies it is essentially an oscillator with provision for feeding in an r.f. signal, so that additive mixing occurs on a common electrode (in this case the control grid of the EF80). The anode circuit contains an i.f. transformer which is tuned to the intermediate frequency developed.

The voltage gain of this single valve circuit is equivalent to that of a two-valve stage consisting of an oscillator and a separate mixer. At the same time the inherently low equivalent noise resistance obtainable with additive mixing is retained. In addition the use of a single valve makes the circuit economically more attractive.

In a mixer of this type, it is generally essential to have some form of "isolation" between the r.f. tuned circuit and the oscillator circuit of the mixer to prevent interaction and pulling of the oscillator section. This is achieved by operating the oscillator in a bridge circuit, the equivalent circuit of which is shown in Fig. 2. It will be seen then, that for the bridge circuit to be in balance, the relation,

$$C_{16} = \frac{C_{in} \times L_{5A}}{L_{5B}}$$

must hold. When this condition has been achieved there will be minimum interaction between the two relevant circuits. An obvious added advantage of this bridge connection is that when in balance, there will be minimum oscillator voltage at the r.f. input point. This is important in order



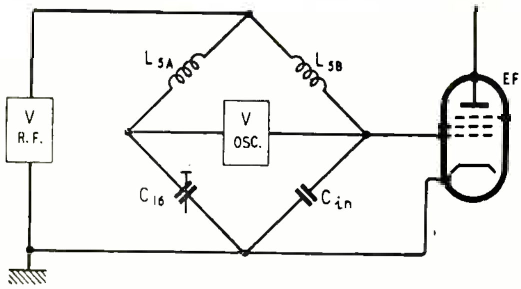


Fig. 2. Equivalent bridge circuit of oscillator section of mixer valve. C_{in} represents the valve input capacitance.

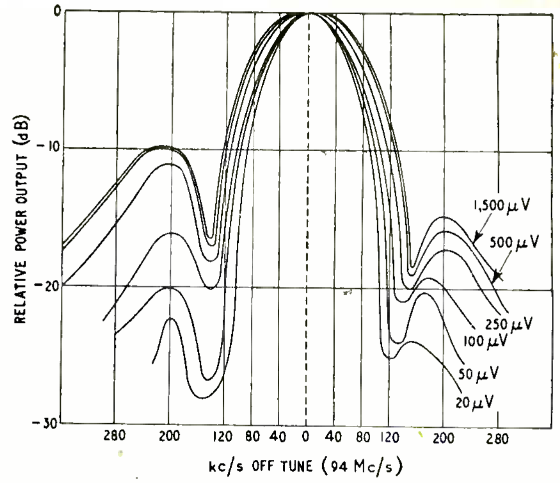


Fig. 3. Tuning characteristics for various input signal levels at the aerial terminals, with a frequency deviation of 22.5 kc/s.

to keep the oscillator voltage at the aerial terminals as low as possible. In this circuit, it is possible to reduce the oscillator voltage to an average value of 100mV at the r.f. input point.

The oscillator circuit is operated at a frequency higher than the signal frequency, i.e. at approximately 97 to 111 Mc/s. As with the r.f. circuit, a series capacitor C_{12} and a parallel trimmer C_{14} are included for tracking purposes, giving an effective swing of the tuning capacitor C_{13} of approximately 7 pF. To keep the oscillator circuit as stable as possible the total capacitance associated with the tuned circuit has been made as large as possible, consistent with obtaining sufficient oscillator drive for the mixer valve. Also the cathode of the mixer valve is directly earthed in order to avoid capacitive hum modulation.

The blocking capacitor C_{18} also forms the tuning capacitance for L_7, since L_6 is effectively a short-circuit at the intermediate frequency. Similarly L_7 forms an r.f. choke at the oscillator frequency. It will be seen then that the effective lumped tuning capacitance across L_7 is equivalent to:

$$\frac{C_{22} \times C_{18}}{C_{22} + C_{18}}$$

and the voltage tap down in the i.f. transformer is equal to

$$\frac{C_{22}}{C_{out} + C_{18} + C_{22}}$$ where C_{out} is the valve output capacitance.

However, as the value of C_{22} is so much higher than C_{18}, the loss in gain of the mixer is negligible.

In order to ensure that the mixer valve operates on the optimum point of the conversion conductance curve, it is recommended that the oscillator grid current should not fall below a level of 35μA in any part of the band. It will be found in operation that the oscillator grid current will not vary by more than approximately $\pm 10\%$ of the mean value over the tuning range.

A conversion conductance of 2.5 mA/V is obtainable with the EF80. Therefore, with the i.f. transformer used, the mixer gain from the tap point of L_5 to the signal grid of the first i.f. valve will be 32 dB. Due to the tapping of L_4, the effective gain of the r.f. stage is proportionately reduced to 34 dB. At 94 Mc/s the overall "front end" gain is of the order of 66 dB, measured from the aerial terminal to the control grid of the first i.f. valve.

I.F. Stages.—The design of i.f. stages for f.m. receivers presents a considerable number of conflicting problems. Very briefly summarized they are:—

(i) There should be adequate transmission of the significant side currents.

(ii) A good measure of adjacent channel selectivity is required.

(iii) There should be a reasonably linear phase/frequency characteristic in the transformers.

(iv) A certain allowance in the bandwidth should be made for small random drift in the oscillator.

(v) The uses of comparatively large values of overcoupling to give a wider bandwidth can produce a high degree of amplitude modulation on the carrier wave, and may give rise to ringing with impulsive interference.

It was decided that for the two i.f. transformers used in this tuner, a coupling factor K of design centre 1.2, would be most suitable to meet a compromise for the above requirements, provided the average loaded Q factor of the tuned circuits in the i.f. transformers is in the region of 60 to 70. ($K = k\sqrt{Q_pQ_s}$, where k is the coupling coefficient and Q_p and Q_s refer to primary and secondary windings.)

TABLE I

	1st I.F. Transformer		2nd I.F. Transformer		Ratio Detector	
	Prim. L_7	Sec. L_8	Prim. L_9	Sec. L_{10}	Prim. L_{11}	Sec. L_{12}
Fixed tuning capacitance (pF)	22	12	12	12	12	47
Valve capacitance + strays (pF)	8	10	10	10	10	—
Loaded Q in circuit	55	55	68	60	35	26
Coupling factor .... $K = k\sqrt{Q_pQ_s}$	1.25		1.25		0.65	
Transfer impedance (kΩ)....	15.8		21.2		—	
Input impedance (kΩ)	—		—		16.8	

In addition to the above requirements it is essential that feedback through the anode-to-grid capacitance of the valve, should be kept small. This usually calls for a strict limit on the maximum usable transfer impedance obtained in an i.f. transformer when applied with any particular valve type. With the EF41, the recommended maximum design centre transfer impedance for the i.f. transformer is 21 kΩ at 10.7 Mc/s, taking into account the added effective anode-to-grid capacitance in the valveholder, and assuming identical impedances in grid and anode circuits.

Table 1 gives a summarized performance of the transformers used in this tuner. All the values quoted were measured in circuit.

The two EF41 valves operate with a mutual conductance of 2.3 mA/V, and from the relevant impedances given in Table 1, it can be calulated that the total i.f. gain, from the control grid of V3 to the anode of V4 will be 64 dB. Actual measurement showed a slightly lower value.

Measurement of the overall bandwidth of the first and second i.f. transformers gave approximately 210 kc/s for 3 dB, and 600 kc/s for 20 dB, attenuation. The response curve is flat for approximately 70 kc/s, with a slight dip at the centre frequency.

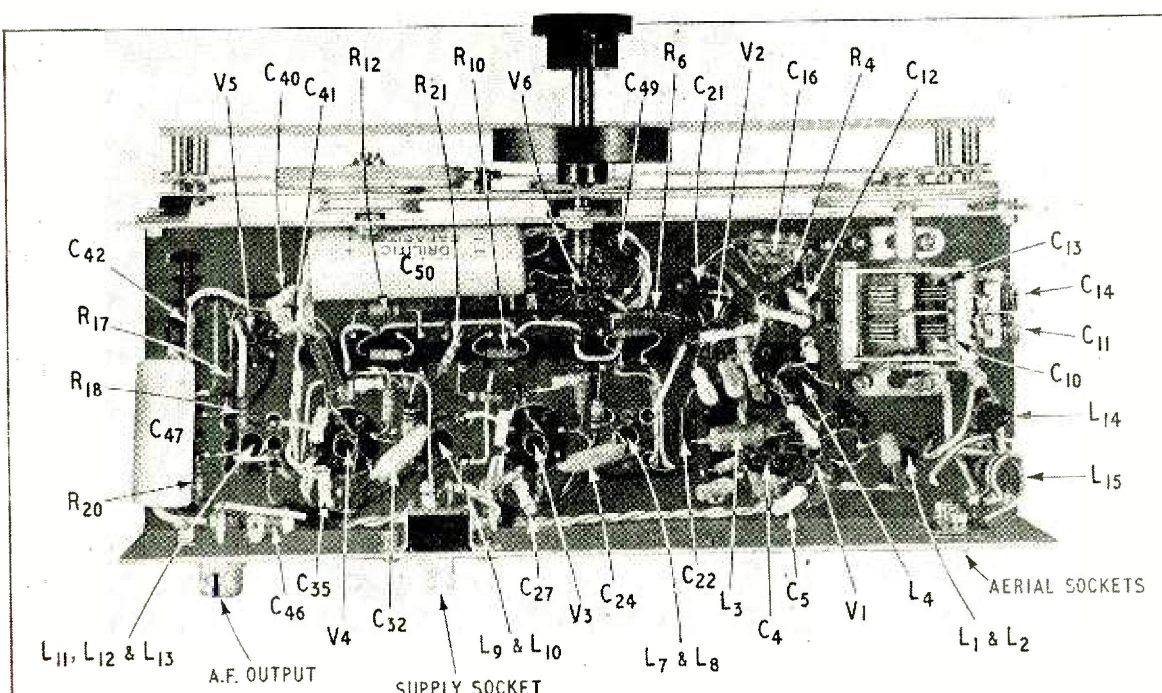
The coils for the i.f. transformers are wound on common formers, details of which are given later in the Appendix. An inherent drawback in this method of construction is that movement of the dust cores can materially alter the coupling factor if the primary and secondary windings are, by necessity, brought too close together. This is to some extent eliminated in the design presented here, by separating about 25% of the total windings on the coils, so as to form small coupling coils at the earthy end of each winding. Thus the dust cores are kept at least 15 mm distant in the main body of the windings and little measurable difference in the coupling factor is obtained when the transformers are tuned to ± 1 Mc/s of the correct working centre frequency. The unloaded Q factors of the coils are about 90, with the exception of L_{12} which is approximately 85.

As previously mentioned, on high signal levels V4 is driven into appreciable grid current, and the derived bias voltage developed across R_{11} and R_{12} is used as semi-automatic gain control. Positive peaks of amplitude modulation appearing on the carrier wave are therefore clipped in the grid circuit. With V4 primarily designed as an amplifier, a very high input voltage to the grid is required before saturation occurs. Therefore with only partial limiting occurring, the valve does not deal completely with positive—or negative-going amplitude variations of the carrier. For similar reasons partial limiting may give only restricted elimination of impulsive interference. The time constant of the grid circuit of V4 has been set at 25 microseconds to deal with the upper frequency limits of amplitude variations in the carrier. The small changes in the input capacitance of V4 due to limiter action in the grid circuit and of V3 due to the restricted range of applied bias voltage were not found to introduce any serious deterioration in the required performance of the band-pass filters. Further, harmonics produced by limiter action do not usually cause trouble, as they will be tuned out in the anode circuit of V4.

Ratio Detector—A balanced ratio detector circuit incorporating a double diode (V5) is used in this tuner. To give optimum a.m. rejection under working conditions, R_{17} should be adjusted for each individual circuit and is specified here as a nominal value.

The value of a.m. rejection measured in the circuit was 46 dB at the centre frequency (10.7 Mc/s) for 30V r.m.s. of i.f. voltage at the anode of V4, falling to

View of underside of chassis with some of the more prominent components identified.



28 dB for ±75 kc/s detuning of the signal. Similarly for 20 and 10V r.m.s. of i.f. signal, the values were 34 and 26 dB respectively, with corresponding values of 22 and 17 dB for ± 75 kc/s detuning. These figures include limiter action produced by V4. The peak separation of the "S" shaped detector curve is 320 kc/s.

Measurement of the tuning characteristic is advantageous in a prototype f.m. receiver, in order to examine the side responses which are inherent in most f.m. detector systems. These are shown in Fig. 3, where the tuning characteristic of the unit is plotted for various values of input signal.

These characteristics can be regarded as typical for a receiver equipped with a ratio detector circuit. The side responses are shown at about ± 200kc/s from the centre frequency. To a certain extent these side responses are controlled by the selectivity characteristic of the preceding i.f. stages, and also by the action of a.g.c. In general, receivers designed with a rounded-top overall i.f. response curve, and a comparatively wide peak separation in the detector system help to reduce side responses and produce a peak in the audio output, when the signal is in tune. It may be noted in passing that, with the Foster-Seeley detector circuit and limiter valves, the side responses may be of a higher value than the main signal response. Although the side responses show a comparatively high value in the graph at the larger signal levels, they are in fact hardly noticeable when tuning through the signal.

The audio output from the detector is taken through the 50-microsecond de-emphasis network R_{16} and C_{45}, and coupling capacitor C_{46} to the a.f. output socket. When the output from the tuner is fed to an audio amplifier it is recommended that the amplifier input impedance be not less than 500 kΩ. For use with the pre-amplifier[3] designed for use with the 20-watt EL34 circuit[2] and with other pre-amplifiers of similar input impedance and sensitivity it is recommended that a correction circuit (Fig. 4) be used to obtain the required input impedance and attenuation.

Tuning Indicator.—An optional tuning indicator using a Mullard EM80 is fitted. The bias voltage for this valve is derived from the ratio detector circuit.

Overall performance.—The total gain of the prototype tuner from the aerial terminals to the anode of V4 was approximately 130 dB for a small signal at 94 Mc/s. When coupled to a Mullard 5-valve 10-watt amplifier, the average sensitivity over the band for 50 mW output was 1.2μV with a signal of 22.5 kc/s deviation. The average input signal over the band for 500 mV audio output is approximately 12 to 15μV.

Oscillator radiation.—The average oscillator voltage measured at the aerial terminals was 350 μV for the fundamental oscillator frequency and 75 μV for the 2nd harmonic. The average radiated field strengths over the band are 40 μV per metre and $<$15 μV per metre respectively at a distance of 10 metres from the measuring aerial.

Constructional details.—The accompanying photographs show the main layout of the tuner. A chassis of 16 s.w.g. aluminium, dimensions 10 in × 3½ in, with 2 in depth, is used. With the exception of the valves, i.f. transformers, aerial and oscillator coils and scale assembly, all components are mounted underneath the chassis.

A balanced heater circuit is used. This enables the tuner to be connected to the centre-tapped heater supply of either of the amplifier circuits previously

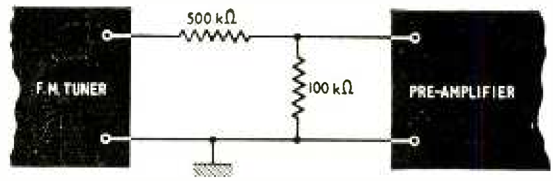


Fig. 4. Simple attenuator recommended for use with amplifiers of high sensitivity and input impedance less than 500kΩ.

referred to[1,2]. Adequate r.f. decoupling of the heater supply lead is essential, in particular to prevent harmonics from the detector from reaching the earlier stages. The ninth harmonic of the i.f. can be particularly troublesome, as this falls in the centre of the tuning range. Strict attention should be paid to the general decoupling of the valve electrodes, and to the tuned circuits. The relevant decoupling capacitors, should be returned to, or very near to, the cathode-to-chassis connection of the valve concerned, with the shortest possible leads. It is also essential that C_{16} should have a short connection to chassis.

The tuner requires an h.t. supply of 200 V at approximately 37 to 40 mA and a heater supply of 6.3 V at 1.6 A. Where the h.t. supply is obtained from an amplifier and exceeds 200 V the necessary dropping resistance should be included in the amplifier itself.

To minimize oscillator drift during the warming up period, C_{12} should be of the negative temperature coefficient type, a component of temperature coefficient 750 parts per million being suitable. This will help to keep the long term oscillator drift to a minimum. In the prototype, C_{14} and C_{16} were formed of a 6.8pF capacitor in parallel with a 1.25-10pF trimmer to make up the nominal total. The tap on the r.f. coil is arranged to be at 0.4 of the total number of turns, counting from the earthy end. Optional i.f. traps L_{14}, C_{51} and L_{15}, C_{52}, have been incorporated in the aerial circuit for use where a high degree of i.f. rejection is considered essential. In most cases they may be found unnecessary.

Neatness in wiring is essential. In particular, in the i.f. stages, components should not be piled over the top of the valveholder as this may lead to an increase of effective anode-to-grid capacitance.

Alignment.—The correct alignment of an f.m. receiver calls for the use of some expensive equipment, but good results can be obtained by using only an a.m. signal generator, covering Band II (87.5-100 Mc/s) and the intermediate frequency of the tuner (10.7 Mc/s). As the first two i.f. transformers are overcoupled, it is essential to damp the transformers whilst they are being tuned, otherwise unsymmetrical response curves may result. A resistor of about 5 kΩ is suitable for this purpose and it should be placed across the grid circuit tuned winding, when the anode circuit is being tuned, and vice versa. The resistor can be temporarily held on with a touch of solder.

Connect the signal generator output (10.7 Mc/s) to the control grid of V4 and tune L_{11} for maximum deflection either in the tuning indicator or on a high resistance voltmeter (20 kΩ/V, 10 V scale) across C_{47}. Transfer the generator in turn to the grid of V3, and the centre-tap point of L_5. Tune L_9, L_{10} and L_7 and L_8 respectively for maximum deflection, using the damping resistor for the coils as before.

To eliminate considerable trial and error in the alignment of the r.f. and oscillator circuit, some approximate values of the correct trimmer settings are given. C_{16} can be set initially at about 10 pF, and C_{14} to 12 pF, with the dust core of L_6 tuning in the *base end* of the coil away from L_5. C_{11} is set at approximately 5 pF. The bridge circuit may be balanced by connecting an r.f. valve voltmeter from the tap point of L_4 to earth, and adjusting C_{16} for minimum oscillator voltage. While this operation is being done, the main tuning gang should be set with the vanes about half-way between minimum and maximum capacitance. If an r.f. valve voltmeter is not available, a rough and ready, but quite effective method of obtaining balance is to short-circuit the tap on L_4 to earth and observe the change in grid current through R_5 (on 50μA scale). C_{16} is then adjusted until the change in grid current on short-circuiting L_4 to earth is a minimum.

With the signal generator connected at the aerial terminals and the tuning gang at maximum capacitance apply a signal of 87 Mc/s, and tune L_6 dust core so that a maximum deflection is indicated in the tuning indicator or voltmeter. Re-tune the signal generator to 100 Mc/s and adjust C_{14} for optimum output with the tuning gang at minimum capacitance. These settings may need to be checked a number of times to give the correct frequency range for the oscillator.

Re-set the signal generator to 91 Mc/s and adjust L_1 dust core for maximum output. Adjust C_{11} for maximum output at 98 Mc/s and finally set L_2 dust core for maximum output at 93-94 Mc/s. The dust core of the aerial coil should also be at the base end of the former. To align the i.f. traps apply a comparatively large input signal of 10.7 Mc/s to the aerial terminals, and tune L_{14} and L_{15} for minimum indicated output. With the signal generator connected again to V4 grid and with the signal of 10.7 Mc/s adjust L_{12} core, for zero d.c. voltage across C_{44}. This ensures that the ratio detector circuit is reasonably well balanced.

REFERENCES

1 "Mullard 5-valve 10-watt High Quality Amplifier Circuit," published by Mullard Ltd.
Also briefly described in:
"Inexpensive 10-watt Amplifier," *Wireless World*, August 1954.
"A High-quality Ten-Watt Audio Amplifier," by D. H. W. Busby and W. A. Ferguson. *Mullard Technical Communications*. Vol. 1, No. 9. Nov., 1954.

2 "Design for a 20-watt High-Quality Amplifier, 2—Constructional Details and Performance," by W. A. Ferguson. *Wireless World*, June 1955.

3 "Design for a Pre-amplifier, for use with a 20-watt High-quality Amplifier." by D. H. W. Busby. *Wireless World*, July 1955.

(*Appendix—Coil Winding Data—on next page*)

COMPONENTS LIST FOR F.M. TUNER

Capacitors

- C_1 120 pF±20%(C)
- C_2 5 pF±10% (C or SM)
- C_3 2,200 pF±20%(C)
- C_4 1,500 pF±20%(C)
- C_5, C_6 2,200 pF±20%(C)
- C_7 120 pF±20%
- C_8 1,500 pF±20%
- C_9 33 pF±5%
- C_{10}, C_{13} 2/27 pF Two-gang variable (Jackson U101 S-S)
- C_{11} 3–15 pF (nominal) (composed of 1.25 —10pF trimmer, Wingrove & Rogers, Type C32.01 + 6.8 pF, SM)
- C_{12} 27 pF±5% (optional n.t.c. 750 parts per million)
- C_{14} 3–15 pF (nominal)
- C_{15} 120 pF±20%(C)
- C_{16} 3–15 pF (nominal)
- C_{17} 22 pF±10%(C)
- C_{18} 22 pF±5%(C)
- C_{19}, C_{20} 2,200 pF±20%(C)
- C_{21} 2,200 pF±20%(C)
- C_{22} 0.01 μF Met. paper
- C_{23} 12 pF±5%
- C_{24} 150 pF±20%
- C_{25}, C_{26}, C_{27} 2,200 pF ± 20%(C)
- C_{28}, C_{29} 0.01 μF Met. paper
- C_{30}, C_{31} 12 pF ± 5% (C or SM)
- C_{32} 47 pF±20%
- C_{33}, C_{34}, C_{35} 2,200 pF±20%
- C_{36}, C_{37} 0.01μF Met. paper
- C_{38} 12 pF ± 5% (C or SM)
- C_{39} 47 pF±5% (C or SM)
- C_{40}, C_{14} 2,200 pF ±20% (C)
- C_{42}, C_{43}, C_{44} 330 pF±5%
- C_{45} 500 pF (SM) ±10%
- C_{46} 0.02 μF (T.C.C. "Metalmite.")
- C_{47} 4 μF 150 V.W. electrolytic
- C_{48}, C_{49} 0.01 μF Met. paper (for optional tuning indicator)
- C_{50} 8 μF 350 V.W. electrolytic
- C_{51}, C_{52} 47 pF ± 5%(C) (for optional i.f. traps)

C — Ceramic. SM — Silvered mica

Resistors (all resistors ½ watt Dubilier "BTS" type)

- R_1 470kΩ ± 20%
- R_2 1,200Ω ± 20%
- R_3 68kΩ ± 10%
- R_4 15kΩ ± 10%
- R_5 100kΩ ± 10%
- R_6 27kΩ ± 10%
- R_7 3,300Ω ± 20%
- R_8 1.0MΩ ± 20%
- R_9 82kΩ ± 10%
- R_{10} 1,200Ω ± 20%
- R_{11} 470kΩ ± 20%
- R_{12} 1.0MΩ ± 20%
- R_{13} 82kΩ ± 10%
- R_{14} 1,200Ω ± 20%
- R_{15} 47Ω ± 10%
- R_{16} 100kΩ ± 10%
- R_{17} 1,200Ω ± nominal ± 5%
- R_{18} 2,700Ω ± 5%
- R_{19}, R_{20} 15kΩ ± 5%
- R_{21}, R_{22} 470kΩ ± 20%; R_{23} 470kΩ ± 20% (For optional tuning indicator)

Valves

V1	Mullard EF85
V2	Mullard EF80
V3, V4	Mullard EF41
V5	Mullard EB91
V6	Mullard EM80 (Optional tuning indicator)

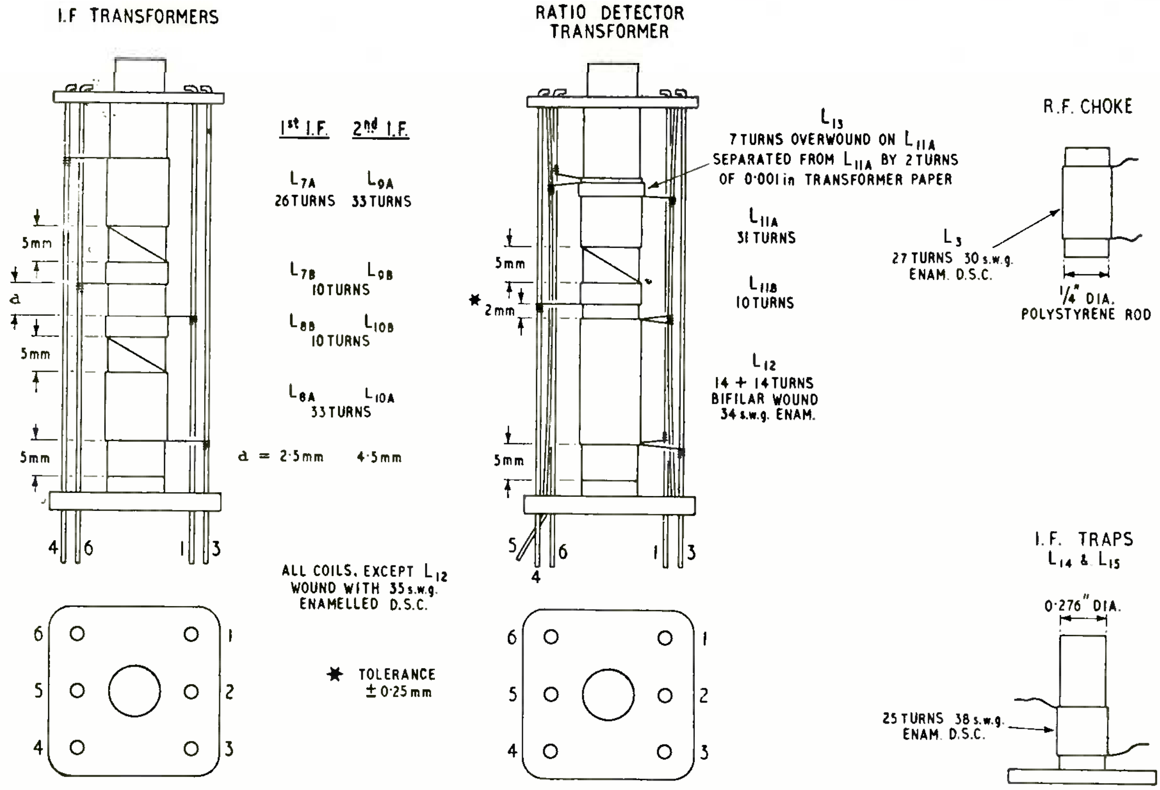
Coils

Aerial transformer L_1, L_2	Denco 510/AE
R.F. choke L_3	Denco 510/RFC
R.F. coil L_4	Denco 510/RF
Oscillator coil L_5, L_6	Denco 510/OSC
1st i.f. coil L_7, L_8	Denco 510/IFT.1
2nd i.f. coil L_9, L_{10}	Denco 510/IFT.2
Ratio detector Transformer, L_{11}, L_{12}, L_{13}	Denco 510/RDT
I.F. traps L_{14}, L_{15}	Denco 510/IFF

Other Components

Miniature tag strips—British Moulded Plastics Type A 5556
Stand-off insulators—Wingrove and Rogers. Type TS1-01/1.
Scale and drive assembly—Jackson, Type SL15.

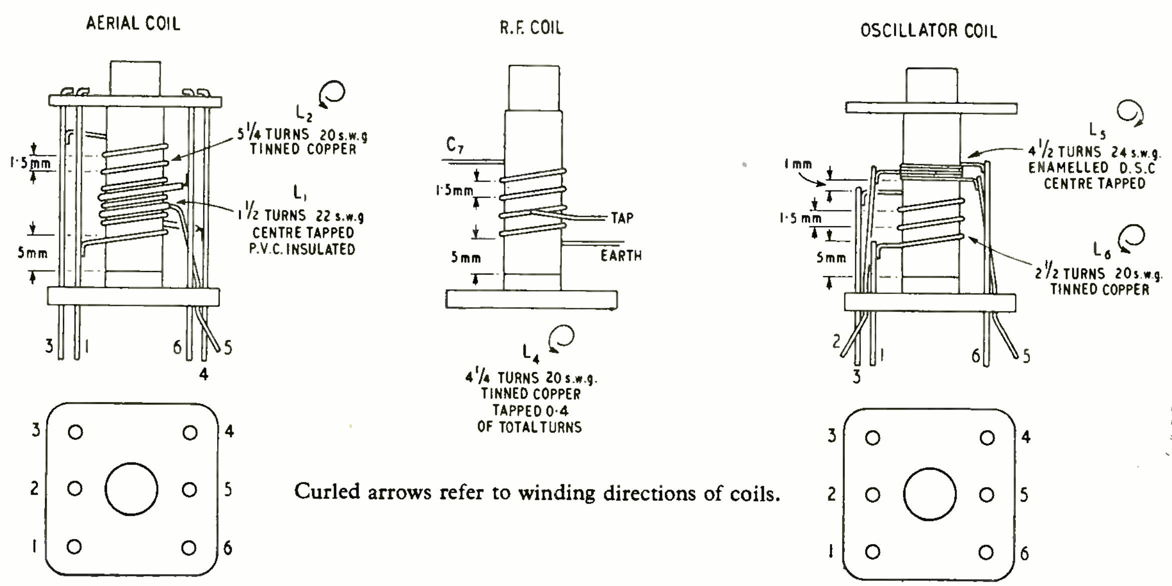
APPENDIX—BAND II F.M. TUNER UNIT COIL WINDING DATA



Formers: Aladdin PP No. 5937 (with screening can) or Neosid 5000B.
Dust Cores: Neosid Grade F 900. Length 16mm. Dia. 6mm. Pitch 1mm.

Former: Neosid type 358/8BA.

It is emphasized, that only the absolute minimum amount of sticky tape should be used to hold the i.f. transformer coils in position, otherwise the Q factor will be affected considerably or the self-capacitance of the coils will be increased.



Curled arrows refer to winding directions of coils.

Formers: Aladdin PP No. 5938 (with screening cans) or Neosid 5000A.
Dust Cores: Neosid Grade I 901. Length 12.7mm. Dia. 6mm. Pitch 1mm.

New Navigational Aids

Radio and Radar Equipment at the Paris Air Show

THE twenty-first international aeronautical exhibition, held recently at Le Bourget aerodrome near Paris, demonstrated once again how very closely aviation progress and electronics are allied. Of the 180 exhibitors, representing ten different countries, some twenty were radio and radar manufacturers, and there was equipment from France, Great Britain, the U.S.A., Sweden, Italy and Germany on view.

In the field of radar, the French Compagnie Générale de Télégraphie sans Fil were giving interesting demonstrations of the remote presentation of radar pictures by a television system. The radar equipment was installed at Pontoise, north-west of Paris, and its images were transmitted by television link to the top of the Eiffel Tower, from which they were retransmitted to Le Bourget aerodrome. The system used depends largely on an analyser storage tube which the C.S.F. have developed and which is described as being a tube capable of storing signals in the form of a pattern of electrical charges deposited on a thin insulating target by a "writing" electron beam. The signals are "read" by a second beam, enabling them to be used to modulate a transmitter. The device is capable of storing the signals for periods ranging from microseconds to hours.

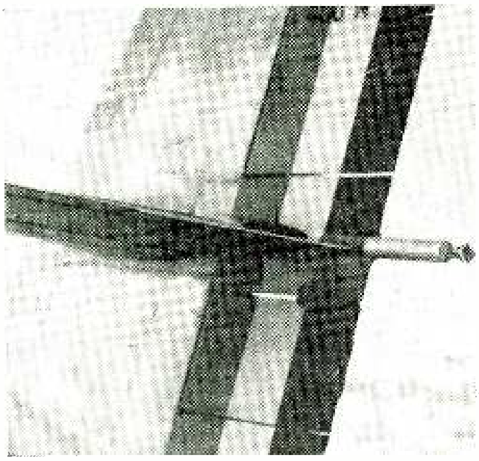


Fig. 1. Rear warning radar aerial in the form of a horn in the tail of a French "Ouragan" fighter aircraft.

One half of the storage tube can be considered as the radar display system and has deflection coils synchronized with the aerial rotation. Instead of actually showing the image, however, it produces a charge pattern on the target plate in the middle of the tube. The electron beam in the other half of the tube, which has its own scanning system (usually a normal television scan), then discharges the target, the output of which is taken off at a collector electrode and used to modulate the television transmitter. The reading half of the tube is intensity modulated at 20 kc/s in order to avoid interference between the writing and reading scans. Thus on the writing side of the tube the scan can be radial, while on the reading side it can be orthogonal without inconvenience.

The television display equipment appeared to consist of domestic television receivers and they were relaying a radar picture of the Paris air traffic control zone. Until actual pictures are seen it is difficult to realize the full value of the storage tube for air operations, since the inherent tracking feature is so unusual to those who are used to seeing normal persistence radar screens. With the long "memory" the aircraft track is left on the screen from the moment it is first picked up until its goes out of range of the radar.

The chief advantages of the system are the inherent automatic tracking already mentioned and the great improvement in contrast obtained in the television reproduction of the radar image, which can be made far better than the original picture on the radar screen and clearly readable in daylight.

Another unusual radar system, known as the "3D" (for "three-dimensional"), was exhibited by the French firm Radio Industrie. The equipment, which operates in the 10-cm band, provides range, bearing and height information from one aerial which moves only in the horizontal plane, the usual tilting movement of the reflector for height-finding being eliminated. This feature is obtained by the use of a system of scanning (known as a Robinson scan) in which the waveguide feed is moved mechanically so as to produce a change in the vertical direction of the beam from the aerial reflector. In practice the vertical beam can be varied over some 15 degrees and the scan rate is about 800 per minute. This form of height-finding is not new, of course, but in the Radio Industrie radar the disadvantages of previous equipments of this kind are claimed to have been overcome. The side-lobe suppression is stated to be greatly improved by the use of a specially shaped reflector and the beam width throughout the scan remains constant.

Coming now to airborne radar, an interesting feature of the cloud and collision warning radar shown by the Société Francaise Radioelectrique was the arrangement for preventing reduction in range by cloud "clutter" when the equipment is being used for collision warning. This takes the form of a series of probes which are introduced at an angle of 45° into the waveguide feeding the reflector. These are stated to make the polarization circular, under which conditions echos from clouds and rain are greatly reduced in amplitude. The equipment, which was shown installed in a full-sized model of an aircraft, uses a 5-in cathode-ray tube and a scanner reflector about 2ft across.

Also noted was a rear warning radar aerial in the tail unit of a French fighter aircraft (Fig 1).

Outstanding among the radio navigational aids on show was a new instrument landing system by the French company C.S.F. It has the advantage over previous systems of operating on a single frequency and of giving the facilities of azimuth, elevation and distance measurement to the pilot on dial-type instruments. As in other landing aids, overlapping radio beams with different modulation frequencies are used for azimuth and elevation measurement and an interrogator-responder is used for the measurement of distance, the interrogation frequency being between 984 and 996 Mc/s.

The use of a single frequency only is made possible by a form of time-sharing pulse transmission. The cycle of transmission is for an azimuth left-hand beam first, followed by an elevation lower beam and then an azimuth right-hand beam and finally an elevation upper beam. The pulse for each of these tranmissions lasts 1/65 second and each is separated by an interval of 1/360 second. There is then an interval of 1/40 second, during which time the transmitter can send out the response signals to the airborne interrogator, using the distance-measuring facility. The cycle of operations is controlled by a rotary switch revolving 600 times per minute (Fig. 2) which feeds into waveguides and thence to the four aerials. Two of the aerials are for laying down the azimuth beams (known as the "localizer") and are placed upon either side of the runway. The other two are "cheese" aerials providing the elevation beams (known as the "glide-path"), one radiating the upper and the other the lower beam to form a $2\frac{1}{4}°$ descent guidance path. The pulses sent out are modulated with a square wave of 20 kc/s for the left-hand "localizer" lobe and 24 kc/s for the right-hand lobe. For the "glide-path" the upper lobe modulation is 34 kc/s and that of the lower lobe 30 kc/s. The aerial for the distance measurement is a "cheese" with separate feeds for transmission and reception.

The airborne equipment consists of two small units and a power supply, together with a crossed-pointer "localizer" and "glide-path" indicator. Distance is indicated on an edge-scale instrument.

Signals can be received from the "localizer" transmitter at a distance of about 25 miles and the distance-measurement transmitter has a slightly shorter range. The "localizer" accuracy is to within $\pm\frac{1}{2}°$ at $1\frac{1}{2}$ miles from the transmitter and the distance measuring facility has an accuracy to within 150yd up to 5 miles from the transmitter.

A new "talking beacon" made by the Swedish firm AB Gasaccumulator and intended mainly for fighter aircraft does not require the installation of any special receiver in the aircraft as it operates off the normal v.h.f. equipment on 100-150 Mc/s.

The beacon depends upon sharply defined beams for its correct operation and these are obtained from two aerial arrays mounted back to back with a screen between them (Fig. 3). This permits forward and backward beams to be radiated without mutual interference. When, for instance, the forward beam is pointing in a northerly direction a transmission by voice of the course to steer to reach it is made, while at the same moment, when the backward beam is pointing south, a voice transmission of the reciprocal bearing is also made from a second transmitter. There is a limitation to the number of voice announcements which can be made, determined by the frequency with which information is needed in practice, and this has been settled at a repetition rate of every 30 seconds when flying on a constant compass heading. At this speed the announcements are made every 20 degrees of beam rotation. Since the aerials are relatively simple there are side lobes present which could give rise to false courses unless precautions were taken to prevent them. The side lobes are therefore masked by a third transmitter which is ten times more powerful than the voice transmitters and which feeds into an "H" type aerial having a figure-of-eight polar diagram. This aerial is so placed that the wanted beams for the two bearings appear in the crevasses of the masking figure-of-eight polar diagram. Thus all of the side lobes are rendered inaudible by the modulation of the masking transmitter, which is synchronized in time with the voice announcements.

The "Narco Omnigator," made by the American National Aeronautical Corporation and exhibited by the French firm Air Tourist, was of considerable interest, being typical of American radio equipment technique for small aircraft. The instrument, which is compactly designed and only weighs 18lb, combines the functions of v.h.f. transmission on 8 channels, continuously tuned v.h.f. reception over the 108-127 Mc/s band, instrument landing system (ILS), v.h.f. aural range (VAR), v.h.f. omni-directional range

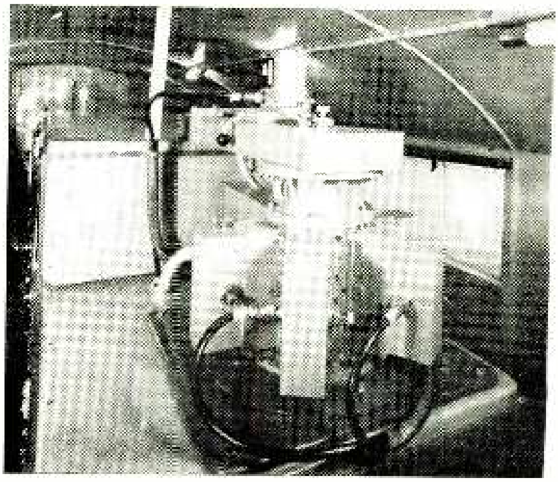
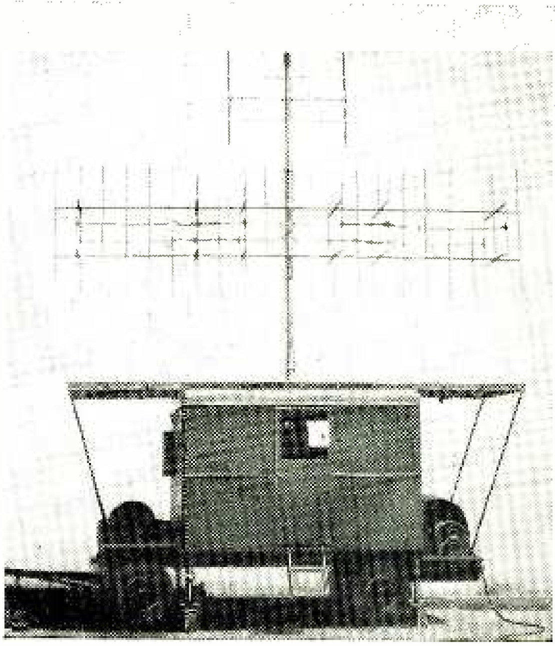


Fig. 2. Rotary switch used at the transmitter of the C.S.F. instrument landing system.

Fig. 3. Swedish "talking beacon" showing the masking aerial mounted above the main array.



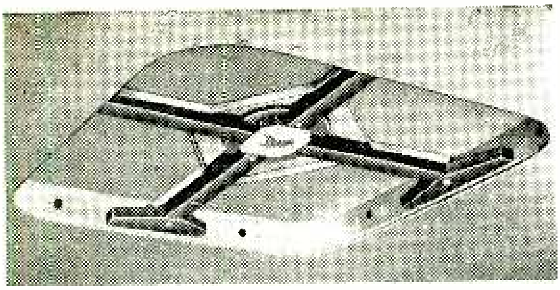


Fig. 4. Bendix radio compass with ferrite-rod aerial elements flush-mounted underneath an aircraft fuselage.

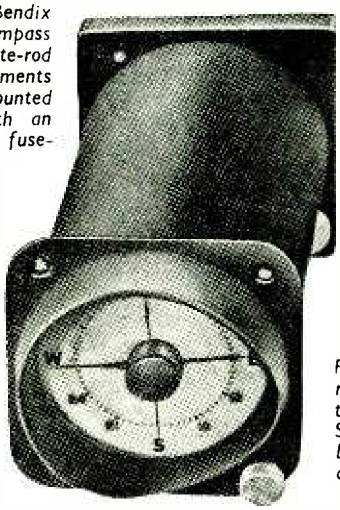


Fig. 5. Cathode-ray tube indicator used in the S.I.N.T.R.A. airborne radio compass.

(VOR) and "marker" reception. It is panel mounted and occupies a frontal area of only about 6½in × 6½in.

Flight demonstrations of the latest Decca Navigator flight log computers* were given throughout the period of the show. These devices, which operate from signals provided by Decca Navigator airborne receivers, are very much lighter in weight than previous computers and effect a saving of some 40lb when used in a complete installation. They are entirely electro-mechanical, using no valves, and are designed for operating speeds up to 700 knots. To permit operation at this very high speed, a special memory circuit is included which prevents interference from "lane identification" signal breaks causing loss of "lanes" and is similarly effective during short signal interruptions.

In air navigation nowadays most of the official procedures for approach and departure to and from civil aerodromes are based on radio beacons and ranges. In some flying zones a rapid change-over from one beacon to another is required, and to enable this to be done as quickly as possible three of the French made radio compasses provide means for instantaneous change-over of frequency. In the S.F.R. and Radio Air models a mechanical "memory" arrangement is included whilst in the S.I.N.T.R.A. equipment 18 pre-set, crystal-controlled frequencies are provided. In the mechanically tuned receivers the procedure for enabling the change-over to be made is for the pilot to tune the receiver to the second frequency required —such as the last beacon frequency wanted for a given procedure—and to close a "storing switch," after which he can use the radio compass on any other frequency until the second one is wanted, which he simply obtains by opening the "storing switch." The time taken for the compass pointer to settle to the new bearing is between 5 and 8 seconds.

In two radio compasses exhibited, including the British Marconi (see last issue p. 306), fixed-coil loop aerials were used, while Bendix showed their new "magnetic antenna." This aerial (Fig. 4) does not entirely dispense with moving parts at the aerial proper but greatly reduces the size of the search coil, thereby increasing the rapidity of action of the direction finder when seeking a new bearing.

The theory of the device is based on the ability of high-permeability ferromagnetic materials to conduct magnetic lines of force easily and to draw into their conducting paths more lines of force than would be found in an equivalent area in free space. In the Bendix loop, four ferrite poles, each with a short-circuited turn of wire round it, are placed at 90° to one another around a small coil, and their effect is to increase the number of lines of force across the coil. The orientation of the lines of force across the coil depends on the relative signal strengths in the collector rods. Thus pick-up in the quadrants of the aerial causes the maximum concentration of energy across the collector rods which lie transversally to the direction of the transmitting station. The lines of force therefore travel across the loop coil in paths parallel to the collector rods which are receiving the maximum energy. At angles of reception lying between the quadrants, the relative signal amplitudes in the collector rods result in a shifting of the magnetic lines across the coil so that they are parallel to the field in free space.

In the radio compass developed by the French firm S.I.N.T.R.A. the indicator is in the form of a small cathode-ray tube with a graduated scale round its periphery (Fig. 5). This avoids any moving parts in the direction finder proper when used in conjunction with a crossed loop with fixed coils. Operationally the cathode-ray tube indicator has the advantage of immediate indication of the disappearance of the signal and of very rapid indication of transit over the top of a beacon or "coning."

When the loop is installed in the aircraft, one coil is arranged to point in the line of flight, leaving the other at right angles to it. When a signal is received in the line-of-flight loop, its amplitude is proportional to the cosine of the bearing angle of the transmitter being received relative to the heading of the aircraft, whilst the amplitude of the signal received in the other loop is proportional to the sine of the angle. Each loop is arranged to feed into an r.f. transformer and thence into the grids of a double triode valve which also have applied to them an a.f. modulation of equal amplitude but in phase opposition. The outputs from the anodes of the triodes are then fed into a balanced transformer, thereby suppressing the carrier, but leaving the sidebands. The r.f. signal is also received on a small vertical aerial and, after amplification, fed into the r.f. transformer, resulting in a carrier with two sidebands. The phase of the modulation of the carrier is a function of the bearing of the transmitter relative to the heading of the aircraft. The modulated carrier is then amplified and detected and, after suppression of the d.c. component, applied to a pulse generating circuit where a pulse is formed each time the detected signal passes through a maximum. This pulse is applied to the cathode-ray tube and appears as a notch in the circular sweep corresponding to the bearing of the transmitter in relation to the direction of flight.

*See *Wireless World*, April, 1951, for principles and description of early type.

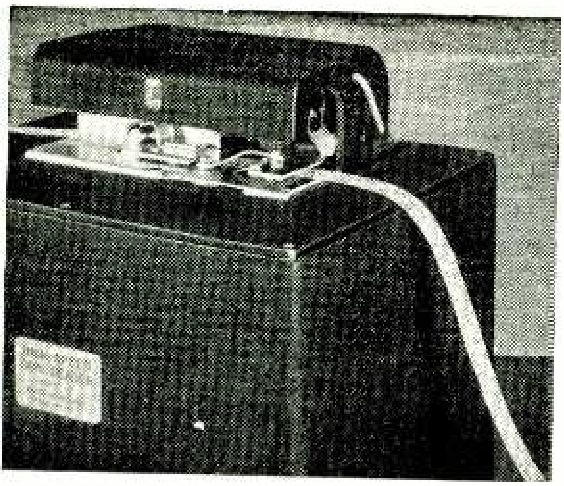


Fig. 1. Coded information in the form of punched holes in paper tape being fed into a high-speed reading device.

The Automatic

WHAT SCOPE DOES IT

AUTOMATION is the magic word that seems to have everyone by the ears (and possibly by the nose as well) in the mass-production industries just now. Radio and electronics engineers, however, appear to be taking the idea very calmly, even with indifference; seeing it perhaps as little more than a new term which has just been invented to describe techniques they have known about for years. And certainly if one looks through the radio and electronics literature for the past decade there is plenty of evidence to support this attitude.

Electronic techniques, of course, are not the whole of automation, but it seems they have a big part to play in the new sphere (in so far as anyone can say what it is). This came out fairly well at the recent conference at Margate on "The Automatic Factory—What Does It Mean?" organized by the Institution of Production Engineers. The titles of some of the papers were in themselves a fair indication—"Automatic Electronic Control of Machine Tools," "Atoms, Electrons and Automation," "The Computer—Electronics Contribution to Production," "Automatic Inspection—The Anatomy of Conscious Machines," "Computer-controlled Machine Tools," "The Automatic Office—Industry's Electronic Pulse." Nevertheless it was clear from the content of these papers that the advent of automation (or at least the talk of it) has not so far elicited anything new from electronics. It has merely taken a number of established techniques in electronic measurement, computing and control and placed them under the heading of Automation, together with other equally well-established techniques from mechanical engineering.

It seems, then, that the present conception of "The Automatic Factory" is little more than an ordinary factory to which a large number of electronic (and other) control devices have become attached like barnacles on a ship. This is not greatly significant to the electronics engineer, because it merely means an intensification of his work along the same lines and not a radically new approach. There is, however, a much more highly developed view of the automatic factory which sees the whole organization, and not just the individual bits of machinery, controlled and co-ordinated by automatic means. (It is sometimes forgotten that there is more to a factory than just the manufacturing processes themselves.) To use a biological illustration, whereas the former conception is equivalent to little more than a mass of disconnected local reflexes all working independently (such as the automatic control of the pupil of the eye with varying light), this highly developed idea is more like a complete animal, with all its sensing and actuating organs not only reacting to local conditions but controlled and co-ordinated by a central nervous system.

Here then is considerable scope for the electronics man—in the design of information-handling systems for overall control and in the linking of these systems to the local electronic control devices. To elaborate on the possibilities we cannot do better than quote from a recent edition of a book* by Norbert Wiener, the American mathematician, who is known principally for his writings on cybernetics. Describing an automobile factory of the future he says: "In the first place, the sequence of operations will be controlled by something like a modern high-speed computing machine. In this book and elsewhere I have often said that the high-speed computing machine is primarily a logical machine, which confronts different propositions with one another and draws some of their consequences. . . ."

"The instructions to such a machine, and here, too, I am speaking of present practice, are given by what we have called a taping (Fig. 1). The orders given the machine may be fed into it by a taping which is completely predetermined. It is also possible that the actual contingencies met in the performance of the machine may be handed over as a basis of further regulation to a new control tape constructed by the machine itself, or to a modification of the old one. . . ."

"The computing machine represents the centre of the automatic factory, but it will never be the whole factory. On the one hand, it receives its detailed instructions from elements of the nature of sense organs, such as photo-electric cells, condensers for the reading of the thickness of a web of paper, thermometers, hydrogen-ion-concentration meters, and the general run of apparatus now built by instrument companies for the manual control of industrial processes. These instruments are already built to report electrically at remote stations. All they need to enable them to introduce their information into an automatic high-speed computer is a reading apparatus which will translate position or scale into a pattern of consecutive digits. Such apparatus already exists, and offers no great difficulty, either of principle or of constructional detail. The sense-organ problem is now new, and it is already effectively solved.

"Besides these sense organs, the control system must contain effectors, or components which act on the outer world. Some of these are of a type already familiar, such as valve-turning motors, electric clutches and the like. Some of them will have to be invented,

* "The Human Use of Human Beings," revised edition 1954, Eyre and Spottiswoode.

Factory

OFFER ELECTRONICS?

to duplicate more nearly the functions of the human hand as supplemented by the human eye. . . ."

"Of course, we assume that the instruments which act as sense organs record not only the original state of the work but also the result of all the previous processes. Thus the machine may carry out feedback operations, either those of the simple type now so thoroughly understood, or those involving more complicated processes of discrimination, regulated by the central control as a logical or mathematical system. In other words, the all-over system will correspond to the complete animal with sense organs, effectors, and proprioceptors, and not, as in the ultra-rapid computing machine, to an isolated brain, dependent for its experiences and for its effectiveness on our intervention. . . ."

Undoubtedly Wiener's description is very much of a pipe-dream at the moment (or should we say a pipe-nightmare?), but it comes from an informed imagination and should not be dismissed too lightly. Already, in fact, we are beginning to see the initial developments. On the purely manufacturing side there are automatic electronic devices using "sense organs" and "effectors" coming into use for the control of continuous processes, while on the organizational side electronic digital computers, originally introduced into factories for straightforward accounting work, are being used to assemble data for production control purposes. What Wiener refers to as "the general run of apparatus now built by instrument companies for the manual control of industrial processes" could be seen in great variety at the recent British Instrument Industries Exhibition. The newer "information-handling" side was also well represented. For example, both Fielden and Elliott were showing automatic devices for continuously monitoring industrial plant by sampling physical variables (e.g., temperature, flow, level, pressure) at various points and printing out the results on paper (Fig. 2). Electronic discriminating circuits detect when the values are above or below pre-set limits, and cause the appropriate alarms to be given. The British Iron and Steel Research Association were showing how the angular position taken up by a shaft in a self-balancing servo system can be automatically registered in digital form as a decimal number and a coded version of it recorded as punched holes in a paper tape. Such "analogue-to-digital converters" are, of course, essential components in apparatus for numerical monitoring.

In another type of work an important development for the metal-working industries is the computer-controlled machine tool, which is now emerging from the laboratory and being sold as a commercial product. The Ferranti equipment, which has already been described in *Wireless World*†, was the subject of a paper by D. T. N. Williamson at the Margate conference, and some of the computer circuitry was shown in a small exhibition which ran concurrently (see Fig. 3). The computer here is used for interpolation between points of change on the contour to be machined, and is a digital machine plotting out the curves point by point. R. H. Booth, of E.M.I. Engineering Development, showed, in another paper, how the same sort of interpolation could be achieved by analogue computing techniques, and there was

† "Electronic Positioning," *Wireless World*, January, 1955.

Fig. 2. Electric typewriters, suitably modified, are convenient devices for automatically recording sampled values. This unit is actually the electronic part of an automatic weighing and filling equipment.

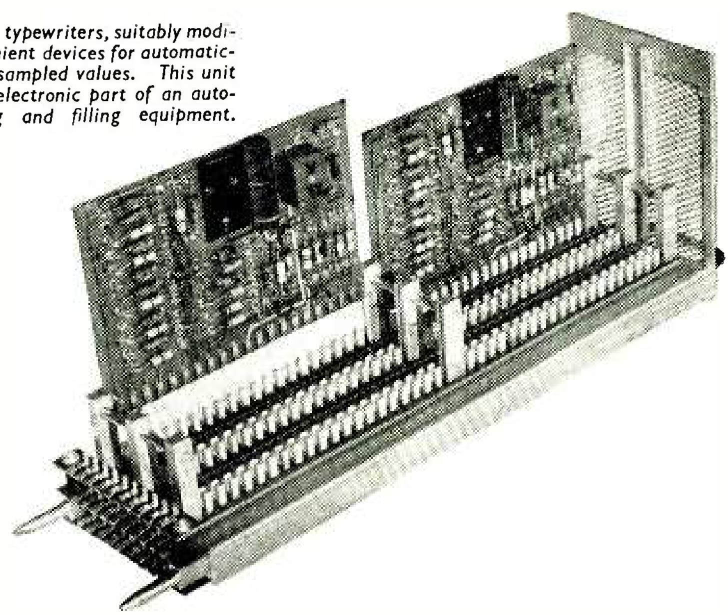


Fig. 3. The digital computer used in the Ferranti computer-controlled machine tools is built up from replaceable plug-in drawers, each of which contains a number of logical units in the form of replaceable plug-in circuit cards. Most of the actual computing is done with semi-conductor diodes, and thermionic valves are used only for amplification between logical operations.

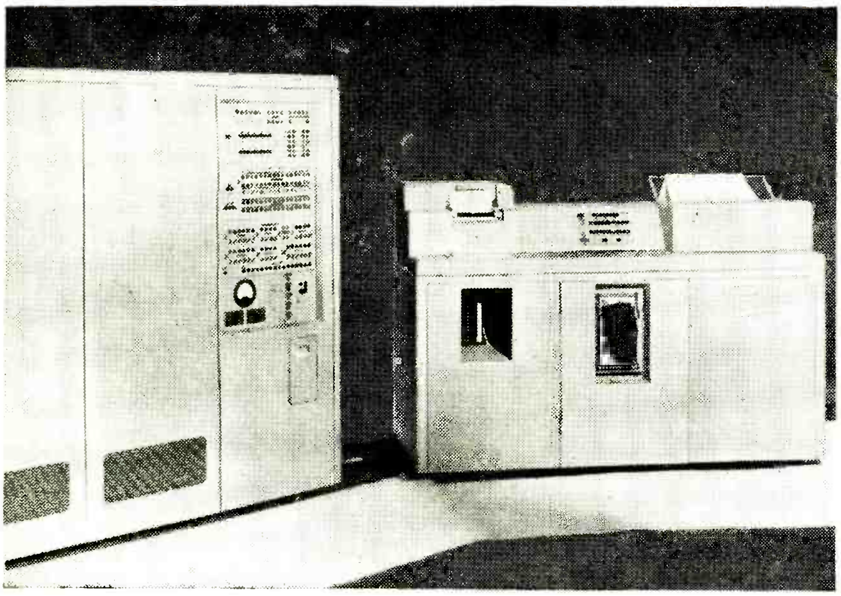


Fig. 4. Commercial electronic digital computer suitable for production planning. The unit on the left contains the programme controller and arithmetic unit, while on the right is a tabulating machine which feeds in information from punched cards (left-hand side) and automatically prints the computed results (right-hand side). This computer and the equipment in Fig. 2 were developed by the British Tabulating Machine Company.

considerable discussion on the relative merits of the two rival methods.

The use of computers for the overall planning of factory work was also discussed by Mr. Booth. He envisaged a machine into which could be fed information on the articles to be manufactured (in terms of the processes needed to make them) and out of which would be obtained information on such things as completion time, costs and requirements for fresh supplies of raw materials. To do this the computer would have to incorporate storage systems containing all the necessary reference data such as stocks of materials, available capacity for machining and assembly and costs of individual processes. A commercially built digital computer of the kind that could be adapted for such work was shown in the exhibition by the British Tabulating Machine Company (see Fig. 4). In the completely automatic factory, however, such a computer would do more than just produce results for human beings to act upon. Also fed into it would be the "operational" information from the plant monitoring systems described above, and this would be assimilated with the "planning" information to produce data from which the computer would control the plant automatically.

A more specialized type of computer for the control of continuous manufacturing processes was described by J. A. Sargrove and Peter Huggins, of Sargrove Electronics. It works on statistical principles and makes corrections to the processing machinery on the basis of error trends which it detects in the finished product. The apparatus (Fig. 5) includes a mechanical measuring device to sense the variations in the product, a transducer to turn these into electrical signals, a selecting device which samples the product at suitable intervals and filters out unwanted information, and a "deviation classifier" which quantizes the error information into three distinct categories—"positive error," "no error" and "negative error." A statistical analyser then computes the sum of the errors, retaining in storage their net sense, and actuates correction timers (positive or negative, as appropriate) which by their time of operation control the amount of correction applied to the processing machinery. A "muting circuit," consisting of a timer, disconnects or paralyses the statistical analyser until the corrected product is itself being sampled, while a "backlash compensator" increases the operating time of the timers if there is a change of sense in the correction. "Electronic brains" such as these are very specialized and limited in their abilities, with none of the flexibility which characterizes the human brain. It is a good thing, however, that they can be designed to replace the human operator, whose very complexity and desire for better things makes him unreliable as a control mechanism. As a character says in Karel Capek's play about robots, *R.U.R.*—"anyone who has looked into human anatomy will have seen at once that man is too complicated, and that a good engineer could make him more simply." The electronics engineer is now in the process of learning to do precisely that, although he may not know it.

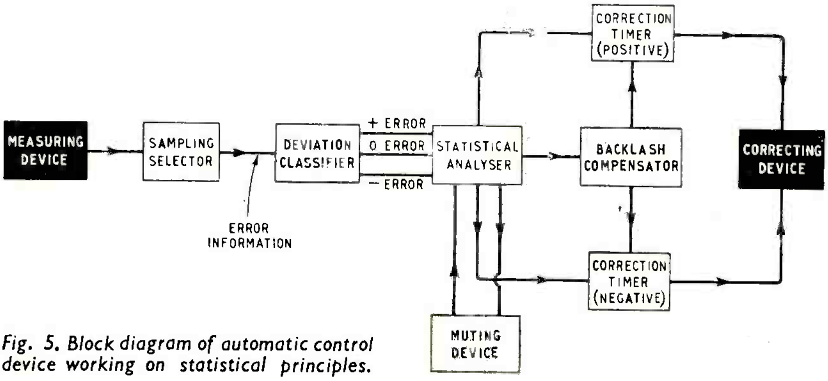


Fig. 5. Block diagram of automatic control device working on statistical principles.

Wide Range Electrostatic Loudspeakers

3—Complete Systems: Loudspeaker/Room Relationships

By P. J. WALKER*

IN the first part of this article we showed that for a given size, the apparent efficiency of an electrostatic unit may be increased by reducing the bandwidth which that unit is required to cover. An obvious method of increasing the overall efficiency of a complete electrostatic system, therefore, is to divide the system into a convenient number of frequency bands and to feed them via crossover networks. Optimum design is obtained by increasing gaps and areas with decreasing frequency.

An alternative method of increasing apparent efficiency is to subdivide the loudspeaker area into a number of smaller units each covering the whole frequency range, the units being coupled by inductors so that the whole loudspeaker becomes a transmission line. (Fig. 1.) The acoustic radiation resistance appears as conductance in parallel with each capacitive element. For a fixed total area, and neglecting losses, the efficiency varies directly with the number of subdivisions.

Consideration of these two systems shows that frequency division has considerable advantages over transmission line divisions for most complete systems of domestic size and power requirements. First, if a single nine-octave unit is subdivided into a two-unit system, the apparent efficiency is increased 16 times. To obtain the same increase by transmission line division would require a minimum of 12 divisions. Unless the total area of the loudspeaker is large, and the plate separation small, the capacitance of each section of the transmission line becomes very small indeed and requires correspondingly large inductance which must be of relatively high Q.

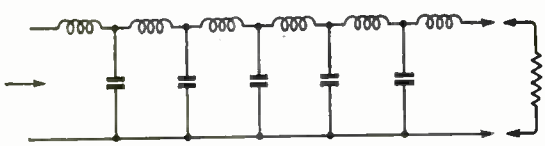


Fig. 1. Capacitive loudspeaker elements coupled with inductances to form a transmission line.

This apparent efficiency advantage of frequency subdividing over transmission line dividing holds until the bandwidth of each unit is reduced to two octaves.

Apart from transmission line subdivision applied to individual units of a frequency-divided system, practical consideration normally limits transmission line techniques to large-area diaphragms. When such is the case, however, additional facilities are available to the designer both in the accurate control of directional characteristics and in providing a constant phase contour, independent of frequency.

In discussing various possible forms of complete electrostatic systems, a novel situation arises. The quality criterion of a loudspeaker usually concentrates on three performance parameters, as measured in an unlimited atmosphere. (a) Ability to produce a required sound intensity over the audio spectrum with negligible non-linearity distortion. (b) The sound pressure over the designated listening area should be independent of frequency throughout the audio range. (c) Operation should be aperiodic.

Complete loudspeakers designed on the principles which we have been discussing are capable of meeting these three requirements to a new and exciting degree. We shall see that different designs and approaches differ not so much in terms of (a), (b) and (c) above, but in other factors of importance to quality reproduction; factors which have previously had to take second place or have been masked in the struggle for (a), (b) and (c).

Corner Mounting

There has been a strong tendency in loudspeaker design to make use of the corner of a room. This is because at low frequencies the air load resistance for a given size of diaphragm is increased 8 times over that of an unlimited atmosphere.

Since the ratio of cabinet "stiffness" to air load resistance is independent of diaphragm size, any increase of resistance due to boundary walls and floors fundamentally reduces the size of cabinet required for a given performance.

As an example, the form of corner electrostatic loudspeaker illustrated in Fig. 2 and designed for full performance down to 40 c/s utilized an internal resonance with a Q of 3 and a built-in enclosure of 10 cu ft. Fundamentally the enclosure size could be reduced either by (1) increasing Q, (2) reducing power and apparent efficiency requirements, or (3)

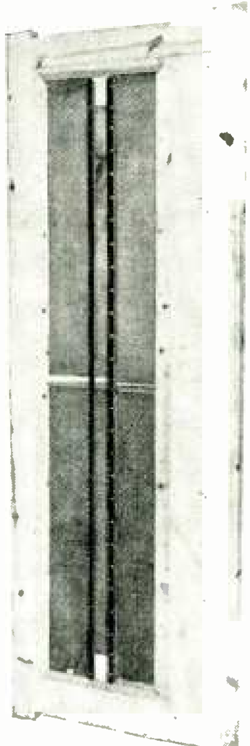


Fig. 2. Wide-range electrostatic loudspeaker in a resonant corner enclosure.

* Acoustical Manufacturing Co. Ltd.

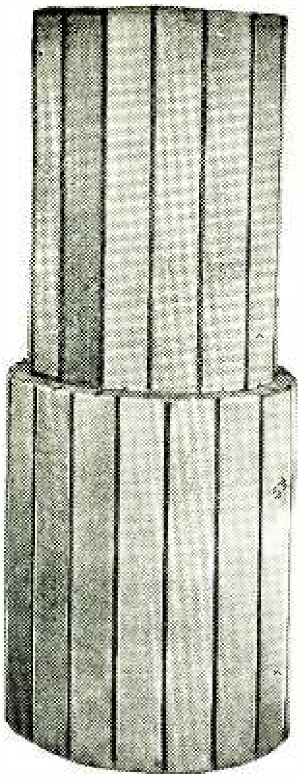


Fig. 3. Cylindrical electrostatic loudspeaker. Each strip carries the full frequency range and the sections are coupled to form an electrical transmission line. The inductor assembly is shown below.

restricting frequency range. Any one factor may be traded for any or all of the others.

It should be noted that with the diaphragm area of Fig. 2 the resistance could be substantially increased by reshaping the whole of the low-frequency area near the floor so that, with the boundary reflections, its dimensions laterally and vertically are similar. Such a form, with a suitably shaped treble unit above it, can be designed to give a level response in direct radiation to the listening area, so that the (a), (b), (c) requirements are not affected. Homogeneity on the other hand, due to the physical spacing of units, is destroyed. This may be more important than is generally realized, particularly in rooms of normal domestic size.

The high-frequency section (centre strip in Fig. 2) is sealed at the rear by an enclosure of width equal to that of the strip and incorporating a fibreglass wedge to offer almost pure resistance throughout the range of the unit. This sealing is necessary in order to maintain front air load resistance by preventing coupling between front and back.

Fig. 3 shows an entirely different form of corner design. The diaphragm area covers the whole surface and extends around the back to form an enclosed cylinder. Every part of the diaphragm carries the whole frequency range. The surface area is divided into units to form a transmission line. The total volume is 15 cu ft. The step in diameter is introduced because the transmission line rotates around the top portion and thence around the bottom portion. The time delay in the sound expanding from the top portion to the diameter of the bottom portion is equal to the time delay of the electrical voltages in the transmission line.

The complete assembly is placed a small distance from the corner of a room so that the boundary reflectors are aiding at the lowest frequency of interest. The large diaphragm area together with the boundary reflections provide a loading approximately equal to ρc at 30-40 c/s. Internally there is acoustic resistance treatment, so that there will be resistive loading at high frequencies, changing to a capacitive load due to the lumped enclosure at low frequencies. Simplified equivalent circuits for high and low frequencies are shown in Fig. 4. The turnover occurs at about 400 c/s and it is obvious that with constant voltage the response will be level above 400 c/s and drop at 6dB/octave below this frequency. This is corrected by progressively rematching to the amplifier below 400 c/s. The section shape may be elliptical to give a degree of direction at high frequencies.

It is obvious that the corner boundaries will introduce peaks and troughs throughout the frequency range. These are, however, exactly the same as occur naturally with live speech or music originating near boundaries in a room. To what degree these effects are important must at the present time be a matter of conjecture. It can safely be said that the subjective effect is by no means as alarming as the appearance of the response curve.

The advantage of a corner position has already been noted. This advantage is not gained without considerable detriment in other directions. If we wished to excite every room resonance to its fullest extent with a sound source of high internal impedance, we put this source in a corner because this is the position of highest impedance for every mode. In placing our loudspeaker in a corner therefore we are placing it in the *worst possible* position if our aim is smooth aperiodic sound.

Although the present trend appears to be to tolerate this state of affairs in the interest of the organ's 32ft rank (or reduction of cabinet size), the inherent smoothness of electrostatic loudspeakers once experienced is not lightly thrown away, and there is added impetus in attempts to improve the loudspeaker/room relationship.

Double Wall Enclosure

The strip "twin" unit design of Fig. 2 may be built into a wall in such a way that most room modes are not excited or are excited only feebly. If it is an outside wall, the rear enclosure may be added externally. If an inside wall it may spread over the wall so that from the appearance point of view it has virtually disappeared. Fig. 5 shows the general form of installation. The strip unit extends from floor to ceiling and the low-frequency sections are backed by 5in wide enclosures 4½ft in length, with fibreglass wedges incorporated. The impedances and response are shown in Fig. 5 (June issue). With the dimensions of this example, $d=10$in since both 5in units are coupled, and the response will be within 3dB of 1 kc/s response down to 35 c/s. These figures include floor, one wall and ceiling, but do not, of course, include the effects of other room boundaries. Assuming a 2in thick wall for rigidity, the volume of a room of 300 sq ft floor area would be reduced by 2%.

There can be no initial excitation of floor to ceiling modes because vertical excitation is evenly distributed. Modes excited in a direction parallel to the wall on which the speaker is mounted will be reduced in number. Assuming a rectangular room, the number of modes excited will be some four times less than the number excited by a corner floor position.

As can be seen by the following summary, this form of loudspeaker leaves little to be desired.

1. The enclosure being "built-in" can be completely rigid.

2. The only fold in the enclosure is narrow compared to wavelength and being close to the diaphragm can cause no reflections in the range of that unit.

3. The loudspeaker and its enclosure are completely predictable.

4. The (a), (b) and (c) requirements previously mentioned can be met virtually to perfection.

5. Radiation throughout the whole frequency range is homogeneous; there is no source displacement and no phase problems at crossover.

6. Total radiated energy (as well as axial pressure) is independent of frequency.

7. The loudspeaker/room relationship is good.

Item 6 deserves further mention. The normal frequency response specification of a loudspeaker is in terms of sound pressure produced on the axis or over a limited listening arc. The mean spherical radiation (total power output) is not usually specified, although it will have a profound effect in a room because the intensity of indirect sound is dependent upon it. If high-frequency radiation is limited to a segment of, say, $90^\circ \times 30^\circ$ (a typical figure) and bass radiation is hemispherical, and if the axis response is level, then there will be a step of 12dB in the mean radiated response. This produces an artificial step in the acoustic ratio (ratio of direct to indirect sound) producing unnatural hardening of the reproduced sound.

Doublet Sources

We now come to consideration of the doublet as a sound source and we shall see that it possesses properties of considerable significance in improving loudspeaker/room relationships. By a doublet we mean a diaphragm, radiating on both sides.

If we assume a 12in-15in unit (moving coil or electrostatic) mounted in a 4ft-5ft baffle, we find that the

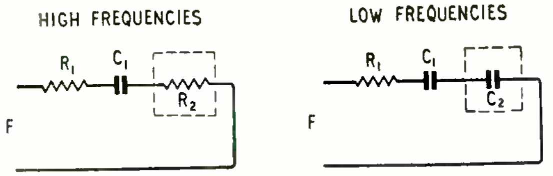


Fig. 4. Equivalent circuits at high and low frequencies of the acoustic loading on the loudspeaker of Fig. 3.

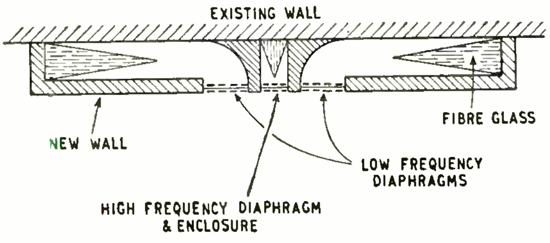


Fig. 5. Sectional plan showing one method of rear enclosure for a strip electrostatic unit.

acoustic system has three main faults. (1) The acoustic air load falls to very low values at wavelengths larger than the baffle size. (2) The acoustic load is very irregular at low frequencies and (3) reflections from the baffle edge occur at higher frequencies. The second, and third faults can be mitigated by adopting peculiar shapes.

If, instead of a baffle, we construct a composite electrostatic unit of the same area, the position is completely altered. The resistance per unit area and the total working area are both increased so that the air load is many times that of the baffle case. The load, and consequently the performance, is regular and predictable.

The construction is that of strip units progressively increasing in plate spacing and area from the centre line. Due to the air load resistances involved for each strip, the permissible bandwidth is reduced over that which could be obtained if the back radiation were sealed off and it is necessary to split the frequency range into three to obtain efficiency comparable to a two-way "sealed" system.

Any unloaded strip considered alone will have a resonant frequency when the diaphragm stiffness reactance equals the air load mass reactance. This is, however, placed below the frequency range of the strip, so that the mutual radiation of the adjacent strip carrying a lower frequency range increases the radiating area and *prevents the application of any effective mass*. The complete system is therefore entirely free of resonance except at one low frequency (usually placed at 30-35 c/s). The Q of this resonance is adjusted to maintain response to this frequency.

The complete loudspeaker has a cosine characteristic and this is substantially maintained through the range. It cannot radiate sound in the direction of its surface, horizontally or vertically, so that it cannot excite room modes in two out of the three room dimensions. It will only excite modes in the remaining dimension when placed at a region of maximum velocity for that mode. (The impedance looking into the loudspeaker is low.)

Having a "cosine" polar characteristic the mean spherical radiation is reduced by a factor of 3 at all frequencies, so that quite apart from freedom of mode excitations any colour due to the room is reduced by a factor of three. This is exactly analogous to a "velocity" microphone. In the same way that a "velocity" microphone is used in place of a "pressure" microphone to reduce studio colour, this "velocity" speaker will reduce colour due to the listening room.

Listening tests comparing "pressure" and "velocity" speakers of otherwise similar characteristics indicate that a velocity characteristic may well have important features for high-quality reproduction. An electrostatic loudspeaker of this type correctly positioned in the room meets all requirements as did the "wall" form previously described, with the addition of an even better loudspeaker/room relationship. The fact that it requires to be free standing well within the room may or may not be advantageous.

The more the acoustic ratio is reduced (provided always that it is reduced equally at all frequencies), the more one approaches the state of affairs that the pressure at the ears is a replica of the pressure at the position of the microphone in the concert hall or studio (ideal headphone conditions). It must be emphasized that many arguments for and against this condition have been proposed. It is outside the scope

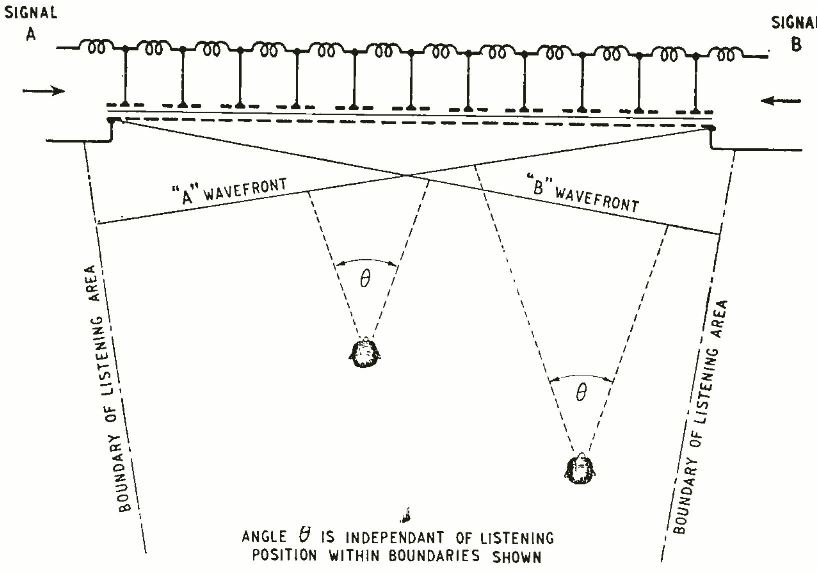


Fig. 6. Stereophony from a single transmission line loudspeaker, with separate channels feeding each end of the line.

of these articles to enter these arguments other than to say that with a monaural channel the choice must be an æsthetic one.

A complete listening room can be designed to produce pressures throughout the room which are more or less equal to the pressures at the studio microphone.

A tube of small diameter compared to wavelength fitted with a piston at one end, and terminated at the other by a resistance of ρc will give pressures anywhere in the tube which are directly proportional to piston velocity and independent of frequency. Provided that the area of the piston equals the tube cross-sectional area, then the requirement of small diameter disappears.

A rectangular room with a diaphragm covering one wall and correct termination on the opposite wall meets the requirements. The space behind the diaphragm must be at least 10in deep and treated like the speaker in Fig. 3. The equivalent circuit is the same as Fig. 4. The sound absorption treatment of the opposite wall must ideally be several feet in depth.

Sound intensity throughout the room is independent of position (including the distance from the diaghragm). The apparent sound source is always in a direction perpendicular to the diaphragm and, of course, moves as the listener moves.

The same loudspeaker may be used for stereophony. With transmission line matching and feeding the signal at one end the wavefront will be tilted, due to time delay. Separate signals may be fed from either end to produce two tilted wavefronts, one for each signal. Since each apparent origin is perpendicular to its wavefront, the aspect angle from the listener is a constant and entirely independent of the listener's position over a large triangular area (Fig. 6). The relative intensity of the two signals is also constant.

A fixed angle, two-channel system of this type may be obtained with a less elaborate listening room. The strip arrangement of Fig. 5 may be installed horizontally instead of vertically. If each unit is a transmission line along its length, then two cylindrical wavefronts will be produced with exactly the same feature of constant aspect angle already described.

To summarize, the electrostatic principle is capable of surmounting the present limitations of other methods of drive. It is capable of overcoming the present tweeter/woofer concept to produce a closely coupled, integrated assembly. The problem of loudspeaker/room relationships (common to all loudspeakers) still remains, although the design versatility of the electrostatic makes it possible to design for optimum relationship if these can ever be defined for a monaural channel.

A closer understanding of the relative importance of the many factors involved are needed. (a) Source movement with frequency, (b) Homogeneity, (c) Acoustic ratio, (d) Mode excitation, (e) Phase contour, etc. All are factors which can only be tentatively assessed after long usage.

The author wishes to thank Ferranti Ltd. for permission to publish the result of work jointly carried out, and to acknowledge the invaluable work of D. T. N. Williamson, W. D. Oliphant, and their colleagues at Edinburgh. Thanks are due to J. Watson, J. Collinson and others at the Acoustical Manufacturing Company, and to the several specialists who have been able to assist with problems in their own field.

COMMERCIAL LITERATURE

Thermocouples, vacuum and air types, suitable for measurement of r.f. voltages and currents in conjunction with m.c. meters, described in leaflet giving ranges available from Ormandy & Stollery, 56, High Street, Brightlingsea, Essex.

Multi-range Test Meter covering a.c. and d.c. voltage, each in six ranges, a.c. current in one range, d.c. current in six ranges and resistance in two ranges. Specification on a leaflet from Measuring Instruments (Pullin), Electrin Works, Winchester Street, Acton, London, W.3.

Printed Circuits by the "Plasmet" process. Hints to designers on the preparation of suitable circuit layouts given in a folder from Printed Circuits, Whadcoat Street, London, N.4.

Test and Measuring Instruments by Hewlett-Packard (U.S.A.) obtainable in this country at 8s per dollar plus duty where payable. Short catalogue, giving brief details of major instruments, from Livingston Laboratories, Retcar Street, London, N.19.

Ceramic Trimmer Capacitors suitable for pre-set adjustment of r.f. and oscillator circuits in television tuners. Maximum capacitances from 3 to 20 pF. Also electrolytics with very low leakage currents and subminiature electrolytics for transistor circuits. Technical bulletins from The Telegraph Condenser Co., North Acton, London, W.3.

Band-III Television Convertor with PCC84 s.f. amplifier and ECC81 oscillator and frequency changer. Models available for double-sideband and single-sideband receivers (for London area). Brief technical specification on a leaflet from Invicta Radio, 100, Great Portland Street, London, W.1.

Tape-to-Disc Transfer Service and other recording services Leaflet giving brief details and prices of records from Sound News Productions, 59, Bryanston Street, Marble Arch, London, W.1.

General view of the complete fitment. At the left-hand side of the centre section is the 15in speaker, with the treble speaker assembly on the top of the fitment. The only part of the top that opens is on the extreme right-hand side where the transcription motor is situated. The upper part of the centre of the fitment is a steel drawer in which are contained the tape recorder, f.m. tuner, pre-amplifier, amplifier and cross-over unit. Three drawers underneath each accommodate 40 boxes of tape. Five cupboards provide storage space for records or tape and in nine small drawers tools and stationery are kept. The drawer underneath the gramophone turntable was made to correct dimensions to house a ribbon microphone.

High-Fidelity Home

By Richard Arbib

A SOLUTION TO THE PROBLEM OF LIVING WITH AUDIO EQUIPMENT

IT is hard to determine whether it was the difficulty of finding room for the 91st tape, the wish to have sand in the sitting room, or the fact that the new Garrard 301 transcription motor was so massive that it would not fit along the side of the Leak "Varislope 2" pre-amplifier in the only available space in the existing cabinet. They had both been mounted temporarily in tiers and it was very awkward to adjust the controls on the pre-amplifier by threading the hand under the transcription motor. Incidentally, if it is thought that the possession of 91 tapes is plutocratic, it should be remembered that quite a number of people collect thousands of stamps.

Built-in Furniture Fitment. At last the decision was made. The window alcove in the sitting room should house an elaborate furniture unit to incorporate all the equipment which had been spread around the room or kept in the radio-gramophone cabinet. This had been made specially, more than a quarter of a century ago, with the idea that it would accommodate any developments of the future. However, this thought had now been proved to be erroneous, for it was designed at a time when life was simple and gramophone records were made to play at only one speed, tape machines had not been invented and only one loudspeaker was used at a time in a room.

In the window alcove there had been a writing desk, and at once an argument arose as to how one was to write letters without a desk. However, it was remarked that in this electronic age, one should not write letters at all, and writing was needed only for cheques. Any correspondence could be undertaken on tape and either transcribed by a secretary or heard by the recipient.

As is usually the case in planning any new development, the first thing was to undertake some research and thus many *Audio* and *High Fidelity* American magazines were perused. In their pages are illustrated the elaborate high-fidelity installations which, with ranch houses, Cadillacs and typewriters that type as though they are printing, have become the essential acquisitions of the successful American executive. However, an examination of these designs showed clearly that whilst they housed all the pieces of equipment which were considered necessary for the addict of high fidelity, much of the apparatus was situated in a way which was most difficult to operate. It is very nice to have a tape recorder built into a room, but many will agree that it is inconvenient to have to lie on the floor to change the reels.

Basic Principles. In designing this equipment, therefore, it was decided that three basic principles had to be observed. First, everything had to be right technically. For example, the pickup must be some distance away from the loudspeaker. All equipment must be accessible for operation and must be capable of being withdrawn from a fitment in a time not exceeding five minutes. To the service engineer who has to struggle with the servicing of many television sets in a day, this time may appear to be excessive, but in view of the reliability of the units concerned, it was considered that five minutes would not be an undue time. Furthermore, it was also thought that every standard unit should be unaltered. For example, the tape recorder should not be taken out of its original case, for if any section did want servicing, it could be withdrawn as a complete unit and thus returned easily to the manufacturer.

After having attempted for some years to read the titles on tape boxes sideways in bookcases, it was decided that the majority of the tape boxes should be kept in drawers in such a way that they could be located easily. It was thought that the basic storage space available should be capable of housing 100 12in records and 200 reels of tape.

Although the window alcove was 7ft wide and 5ft deep, one snag was that a height of only 31in was available under the windows. However, it was agreed that the whole of this space should be occupied by the units, loudspeakers and nine small drawers for stationery and odd tools which had been kept previously in the desk. As, apparently, most wives insist on putting vases of flowers, photographs, ash trays and other bric-à-brac on top of furniture, it was arranged that only one small portion of the installation should have a lid which opened. Although record changers may be placed in drawers, it was realized that a transcription motor with a pickup weighing only a few grams should not be mounted in anything movable, and thus of the whole surface area of 22 sq ft only 3 sq ft lifts up.

Accommodating the Units. The basic units which had to be accommodated comprised a 15-in Wharfedale loudspeaker, which, from the counsels of Mr. Briggs, it was appreciated must be housed in a cabinet exceeding 9 cu ft, 8-in and 5-in speakers which should be mounted in an open form of baffle, a Ferrograph Model 2A tape recorder, a Leak TL12 amplifier and "Varislope 2" pre-amplifier, an American Browning f.m./a.m. tuner, which had been brought over to this country long before British f.m. tuners were available, and the Wharfedale 3-way cross-over network unit. Furthermore, a panel was required for switches. The gramophone equipment, for which space had to be found, was a Garrard 301 transcription motor with a Leak moving-coil pickup and arm. Arrangements had to be made for feeding the output to the loudspeaker network, which has been in existence for some time and extends to practically every room in the house.

Owing to the comparatively low height of the top level of the fitment, it was decided that the only way in which to operate the Ferrograph and the amplifier controls conveniently, was to mount everything, except the loudspeakers and the transcription motor, in a drawer. From the accompanying illustrations it will be clear how the units are arranged. The steel drawer was made in two sections and welded together, the Ferrograph drops in on the left-hand side, the TL12 amplifier is in the base of the right-hand side. Mounted above it on a shelf is the Wharfedale cross-over network unit to the controls of which extension rods have been fitted so that the potentiometers on the medium and treble cross-over network sections are controlled by knobs mounted on the top panel. The f.m. tuner unit is mounted behind and the little available space in front of that is occupied by a felt-lined recess in which a small crystal microphone is kept and which is connected permanently to the appropriate socket on the Leak pre-amplifier. This unit is mounted at the front of the drawer at the same angle as the control panel of the Ferrograph. A ribbon microphone is used also and this is kept in a special drawer below the gramophone motor.

A potentiometer has been added at the tape input socket of the Leak "Varislope 2" so that the levels from the Ferrograph, the tuner unit and the pickup are all the same. On the left of the "Varislope 2" is a special control panel which has four switches and four jack sockets. Reading from left to right (1) switches the TL12 amplifier to the three loudspeakers through the cross-over unit, (2) switches the amplifier to the extension loudspeaker network, (3) switches the output of the Leak amplifier, either to the three loudspeakers through the cross-over unit or direct to the 8-in loudspeaker, when it is required to reproduce speech only, and (4) switches off everything at the mains, irrespective of the positions of the switches on the individual units. The jacks below are: (1) connected to the three loudspeakers, (2) connected to the external loudspeaker network, (3) connected to the output of the tuner, and (4), connected to the sound output of the television set which is situated in another part of the same room. The jack sockets are provided for the three loudspeakers and the extension network in case it is wished to feed the output of the Ferrograph direct to these speakers without going through the Leak amplifier. In the same way the tuner socket is used for feeding from the tuner into the Ferrograph. The tuner is also connected permanently to the appropriate socket on the pre-amplifier.

Operation.—One length of shielded cable with screened jack plugs at each end and the various sockets are used as follows. If it is wished to record a radio programme the output is taken from the tuner socket on the small panel and fed into Input 2 of the Ferrograph, the monitoring to the tape machine being undertaken by the gain control on it. A programme can be recorded without it being heard in the room, or if it is wished to be heard in the same room or another room the appropriate loudspeaker switches are thrown and the gain control on the "Varislope 2" adjusted to a suitable volume. If it is desired to record a television programme, the jack is plugged into the TV socket on the sub-panel. If the TV programme is desired to be heard through the Leak amplifier either in the same room or around the house, the output is fed from the TV socket to the input jack socket on the pre-amplifier. To record speech from the room the main control switch on the pre-amplifier is turned to "microphone" and the output from the pre-amplifier connected to Input 2 of the Ferrograph. If it is desired to reproduce a gramophone record on tape, the same procedure is observed with the Leak main control knob in the position to suit the frequency response of the record concerned.

Loudspeaker Mounting.—The arrangement for the loudspeakers is that the section of the fitment for the 15-in speaker has the sides made of 1-in wood, 1-in of sand and ½-in of plywood. The front has a port 12-in × 6-in. On the main top of the fitment is situated the assembly for the 8-in and 5-in speakers. As the height of the alcove is only 7ft the two speakers do not point upwards but are at an angle of 45° into the room. In order to obtain a simple and attractive design, they are mounted on a flat baffle which is held by skeleton woodwork at an angle of 45°, the front and the sides being covered by expanded metal, and the back is open.

The Garrard 301 transcription motor is mounted on a motor board which floats on springs. Also mounted on the motor board is a light which illuminates the turntable and an extra switch which stops the motor without any danger of the pickup being moved.

Cabinet Work.—The finish of the whole cabinet work is bird's-eye maple for the exterior of the front and interior of the cupboard doors, motorboard and panel above the tuner unit. The top is of walnut and the drawers are made of mahogany veneered on the outside with bird's-eye maple.

The front of the steel drawer which accommodates the recorder, amplifier, f.m. tuner, etc., is a dummy to the extent that it has five handles or knobs but opens as one drawer. The units in this drawer have, with the drawer, a combined weight of about 2cwt. The drawer is mounted on Admiralty pattern ball-bearing slides and moves forwards and backwards easily. The wood front is hinged at the top so that the recorder and pre-amplifier controls may be operated without pulling out the drawer.

Having all these units in a comparatively confined space does, of course, raise the problem of ventilation. This has been solved by having the underside of the left-hand section of the drawer completely open except for two channels on which the Ferrograph rubber feet rest. The sides of this section of the drawer are cut away to coincide with the loudspeaker fret and ventilation holes of the recorder case. The other side of the steel drawer has slots 17in × 2in cut at the lower ends of the back and sides. Holes are provided at the top of one side, in the felt-lined recess, and an expanded metal grille is mounted between the pre-amplifier control panel and the switch-jack panel, which have purposely been fixed half-an-inch apart.

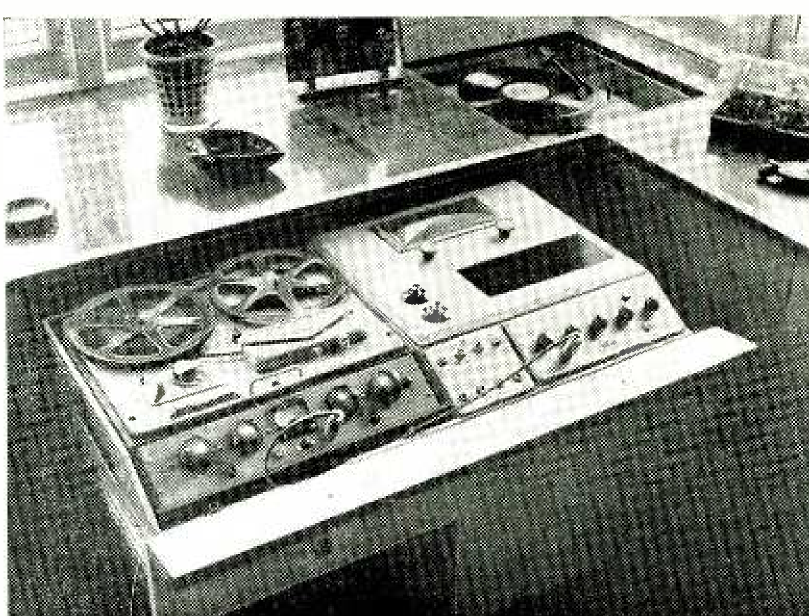
The large drawer at the side and the two underneath the steel drawer are of the exact dimensions to take boxes of 7in and 8¼in reels of tape respectively. Each drawer takes two rows of 20 tapes which are filed with the titles uppermost and in line with the front of the drawer. Three shelves in the large right-hand cupboard each accommodate 25 tapes. Four smaller cupboards, whilst being of the correct dimensions to accommodate 12in records could, of course, be used for the storage of tape.

Having spent many hours in making the necessary drawings for the furniture fitment and undertaking all the wiring and connections, of course the question asked most frequently by other high-fidelity enthusiasts is, what alterations would be made if it was being designed all over again. The answer, quite honestly, is none. There is only one snag to the whole system which was apparent when it was planned originally, and that is the desirability of having the main loudspeaker assembly on the side of the room opposite the control equipment, so that the volume could be adjusted from a distance. With the space available this was not possible, and the only refinement which could be introduced to the system other than stereophonic sound, for which space is available, would be remote operation for the main gain control of the amplifier.

What Next?—Other friends have said, "Well, now you have everything, what can you do in the future, other than record and listen?" Apart from stereophonic sound which will, of course, be coming along later this year, work has already started upon re-wiring the rest of the house with a system whereby the loudspeakers in each room will have individual volume controls and be operated through fourway switches. By this system the occupants of each room and the garden will have choice of the tape or record programmes from the equipment in the sitting room or the Home, Light or Third B.B.C. f.m. programmes. This system is a development of an idea suggested by Douglas Lyons, of the Trix Electrical Co., Ltd. In one cabinet in another room three f.m. tuners, each tuned to a different programme, will be connected to three 10-watt amplifiers. The outputs of these amplifiers will be connected to three pairs of the four-pair cable. The remaining pair replacing the existing extension speaker pair on the main sitting room equipment.

The three f.m. tuners and amplifiers will be switched on and off by a time clock set to switch on at 7 a.m. and off at midnight.

Acknowledgements. — In conclusion, grateful acknowledgement must be made for the assistance of the following friends who have given much technical advice which has been the means of avoiding many of the pitfalls which fall to the experimenter who tries to put together the parts of different manufacturers. Reference is made particularly to Hector Slade of Garrard Engineering & Manufacturing Co., Ltd., Harold Leak of H. J. Leak & Co., Gilbert Briggs of Wharfedale Wireless Works, Ltd., and E. H. Niblett of Wright & Weaire, Ltd. Yes, this article was dictated on tape!



The steel drawer pulled out with the flap covering the controls turned down. The tape recorder is on the left with a tape splicer mounted below the main control knob. Set at the same angle as the recorder control panel is the switch panel and pre-amplifier. On the panel above are the knobs controlling the potentiometers of the cross-over unit and the dial and controls of the f.m. tuner. In the felt-lined recess a crystal microphone is kept and is permanently connected to the pre-amplifier. The flap at the top right-hand corner is up to disclose the transcription motor and moving coil pickup. A lamp to illuminate the turntable is fitted on the motor board.

Transistor Equivalent Circuits

2.—*Earthed-Emitter Junction Transistors*

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

SUMMARY: As a sequel to the derivation of the equivalent circuit of the thermionic valve in Part 1, equivalent circuits for the n-p-n transistor in the earthed-emitter circuit are developed here. They are based upon the same form of straight-line approximation to the transistor characteristics as was used for the valve. The characteristics of the transistor are represented by four quantities which are easily derived from the characteristic curves; they are base and collector a.c. resistances and forward and backward current-amplification factors.

It is shown that, within the limits of accuracy imposed by the straight-line representation of valve and transistor characteristics, the transistor is exactly equivalent to a thermionic valve having a cathode feedback resistance and a second resistance between grid and cathode.

In Part 1, we developed an equivalent circuit for the thermionic valve. In doing this we started with the experimental evidence of the characteristics of the valve in the form of a family of curves relating anode voltage to anode current for a series of values of grid voltage. We then approximated these accurate curves by a series of equally-spaced parallel straight lines, which we may conveniently call a linear approximation. The next step was to find an equation which would represent this approximation algebraically and, finally, we found an arrangement of components which could be represented by the same equation. This formed an equivalent circuit.

The accuracy with which an equivalent circuit represents a valve depends entirely upon the goodness of the linear approximation. Over any range of voltages and currents where the straight lines fit the valve curves closely, the accuracy is good.

With the transistor, the procedure is exactly the same as with the valve. There is a complication, however. It is an experimental fact that all the electrodes of a transistor pass current, not two of them only as in the negative-grid valve. The transistor is more like a positive-grid valve in this respect. Because of this, two families of characteristic curves are needed to describe it and the equivalent circuit is more complex than that of the valve.

The newcomer to the transistor is apt to be misled by certain conventions which are commonly adopted. Most published characteristics are for the transistor in the earthed-base condition and many circuit diagrams show it used in this way. Also, in the usual transistor symbol, the base is represented by a heavy line which is not unlike the cathode symbol of a valve. It is hardly surprising, therefore, that the newcomer gets the impression that the base of a transistor corresponds to the cathode of a valve.

The base is, of course, the equivalent of the grid and the earthed-base transistor is analogous to the earthed-grid valve circuit. To anyone accustomed to valve circuits, it seems very wrong-headed to make the earthed-base circuit the basic one of transistor circuit theory. Actually, there are reasons why it is more suitable than the earthed-emitter circuit, but this is not the stage at which they can well be appreciated.

To the newcomer, however, the earthed-emitter circuit is the natural approach and this is the one that we shall adopt here. At first, only this circuit will be considered and only the junction transistor. This exists in two forms, the *n-p-n* and the *p-n-p*. It consists essentially of two pieces of *n* or *p* type impurity germanium with a thin slice of the opposite kind sandwiched between them.

One of the end pieces functions as a source of charge carriers and the other as a collector of them; the one is called the emitter and the other the collector. The meat in the sandwich functions as a control electrode and is called the base. Emitter, base and collector are analogous to the cathode, grid and anode of a thermionic valve. With the *n-p-n* transistor the analogy is rather close, because the internal conduction is mainly by electrons, with the result that base and collector are normally maintained positive to the emitter and the conventional currents enter at base and collector and leave at the emitter.

The *p-n-p* transistor, however, is rather different. Internal conduction is by positive "holes." Base and collector must normally be negative to the emitter and the current enters at the emitter and leaves by the base and collector. There is no valve which behaves like this but if it were possible to make one with a "cathode" which emitted positrons instead of electrons it would do so.

The circuits of typical *n-p-n* and *p-n-p* transistors in the earthed-emitter connection are shown at (a) and (b) respectively of Fig. 1.

The n-p-n Transistor

In Fig. 2 are shown the general forms of the characteristics of an *n-p-n* transistor. The family of curves at (a) relates collector voltage and current for a series of values of base current, while the family at (b) relates base current and voltage for a series of values of collector current. If the curves at (a) were for values of base voltage V_b instead of base current I_b, they would be of exactly the same form as an ordinary set of valve curves and the ordinary equivalent circuit could be used.

Transistor characteristics can be plotted in terms of V_b, but it is customary to use I_b instead, mainly because a transistor has such a low input resistance that we are often more interested in current than in voltage.

In Fig. 2 (a), the dotted lines represent a linear approximation to the real characteristics upon which we base our equivalent circuit. We proceed in the

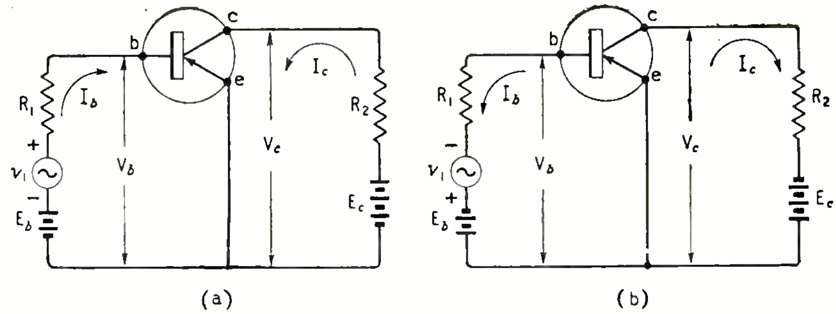


Fig. 1. The circuit diagrams of a simple transistor amplifier are shown at (a) for an n-p-n and at (b) for a p-n-p transistor.

same way as in the case of the valve, which was described in detail in Part 1. Some line, not shown, passing through the origin, represents a resistance of value $\rho_{22} = V_c/I_c$. The slope resistance $\delta V_c/\delta I_c$ has the same value for this line. For any other line the value V_c/I_c does not apply but, since the lines are all parallel, they all have the same slope resistance which is, therefore, defined as

$$\rho_{22} = \delta V_c/\delta I_c \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

We are, for the present, using the Greek letter rho to represent resistance instead of the more usual r, because the latter is commonly used in equivalent circuits derived for the earthed-base connection and we want to avoid any confusion between the two. We are using the subscripts "22" to denote what, by analogy with the valve, we may call the collector a.c. resistance, because that is customary with transistors. This resistance, which we call ρ_{22}, is the transistor equivalent of the anode a.c. resistance of a valve.

The particular line in Fig. 2(a) for zero base current

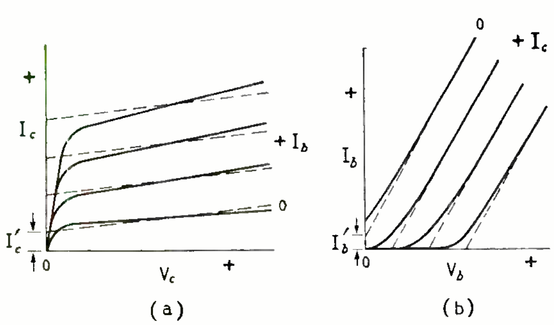


Fig. 2. Collector (a) and base (b) characteristic curves for an n-p-n transistor. The dotted lines represent ideal straight-line approximation to the characteristics.

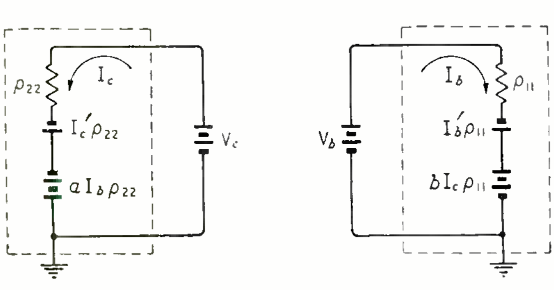


Fig. 3. D.C. equivalent circuit of an n-p-n transistor. The output side is shown at (a) and the input at (b).

($I_b = 0$) cuts the current axis at some current I'_c. The equation for the line through the origin is

$$I_c = V_c/\rho_{22}$$

The equation for the line $I_b = 0$ becomes simply

$$I_c = I'_c + V_c/\rho_{22}$$

and this derivation is exactly analogous to that for a pentode valve, Fig. 9 of Part 1.

We now define a current amplification factor

$$a = \delta I_c/\delta I_b \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

for constant V_c. This is merely the ratio of a change of collector current to the change of base current which causes it. The complete equation for Fig. 2(a) now becomes

$$I_c = I'_c + aI_b + V_c/\rho_{22}$$

which is more conveniently written as

$$V_c = I_c\rho_{22} - I'_c\rho_{22} - aI_b\rho_{22}$$

Now what does this represent? On the left-hand side, V_c is the externally applied collector–emitter voltage and is not part of the equivalent circuit of the transistor itself. $I_c\rho_{22}$ is an internal voltage drop due to the current I_c flowing through a resistance ρ_{22}. $I'_c\rho_{22}$ and $aI_b\rho_{22}$ can be taken to represent e.m.fs acting round the circuit to assist V_c but internal to the transistor. The first term of the pair accounts for the offsetting of the $I_b = 0$ line of Fig. 2(a) from the origin; the second accounts for the effect of base current upon collector current.

The complete circuit which the equation represents is thus one like Fig. 3(a) in which the transistor part is shown boxed. It is the same as a valve equivalent save for the labelling of the elements.

Now consider the base characteristics of Fig. 2(b). A line through the origin represents a resistance $\rho_{11} = V_b/I_b$. This has a slope resistance $\delta V_b/\delta I_b$ which is the same for all lines. We, therefore, define the base a.c. resistance as

$$\rho_{11} = \delta V_b/\delta I_b \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

for constant I_c.

The equation for the $I_c = 0$ line is

$$I_b = I'_b + V_b/\rho_{11}$$

We now define a reverse current amplification factor as

$$b = -\delta I_b/\delta I_c \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

for constant V_b. This is the ratio of a change of base current to the change of collector current responsible for it. The negative sign comes in because it is convenient to have b as a positive number and $\delta I_b/\delta I_c$ is itself negative since an increase of I_c reduces I_b. The complete equation is now

$$I_b = I'_b - bI_c + V_b/\rho_{11}$$

This is conveniently written as

$$V_b = I_b\rho_{11} - I'_b\rho_{11} + bI_c\rho_{11}$$

This has the same interpretation as the one for the collector circuit and so a circuit to which this applies

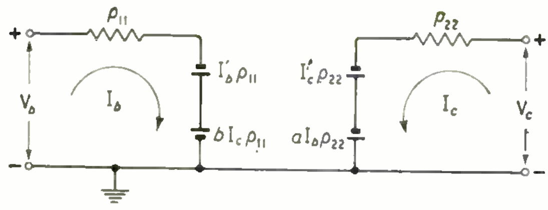


Fig. 4. Complete d.c. equivalent circuit of an n-p-n transistor. For a p-n-p transistor all voltages and currents are reversed.

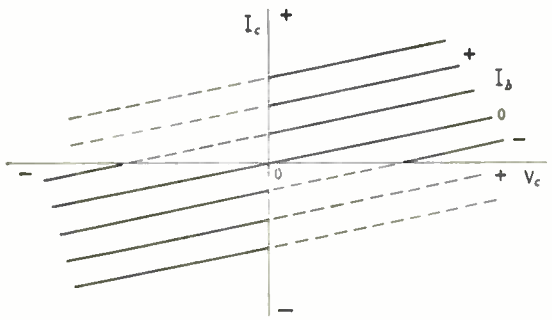


Fig. 5. This diagram as a whole is a graph of a resistance in series with a battery. The part in the first quadrant approximates an n-p-n transistor, while the part in the third quadrant approximates a p-n-p transistor.

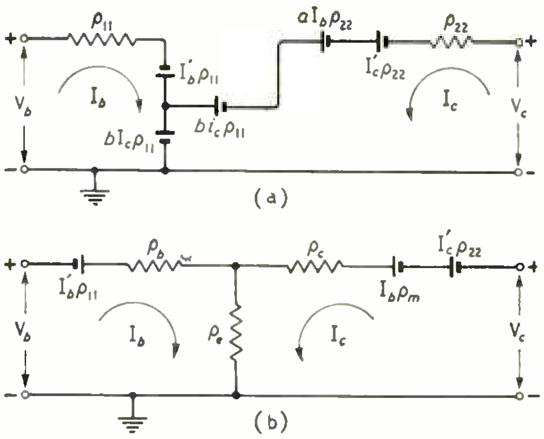


Fig. 6. This diagram illustrates the transformation of Fig. 4 into a different equivalent form. At (a) $bI_c\rho_{11}$ is made common to both base and collector circuits, but its effect in the latter is nullified by the extra battery of the same value opposing it. In (b) this common battery is replaced by a resistance ρ_e, the voltage being developed across it by the current through it.

has the form shown in Fig. 3(b). However, since $bI_c\rho_{11}$ has the opposite sign to $aI_b\rho_{22}$ it is connected the other way round, to oppose the external driving voltage.

The two circuits of Fig. 3 represent the input and output parts of the transistor and together, as in Fig. 4, they form one equivalent circuit of the *n-p-n* transistor. It is valid for d.c. conditions and accurate in so far as the linear approximations to the transistor characteristics are accurate.

The p-n-p Transistor

We have now to consider the *p-n-p* transistor. It is an experimental fact that its characteristics are of the same form as those of the *n-p-n* but with all the positive signs changed to negative. Because of this, the characteristics are usually drawn upside down compared with Fig. 2. Because *all* the signs for voltage and currents are reversed, it follows that the same equations apply with the signs of all voltages and currents reversed, and so the equivalent circuit of Fig. 4 also applies to a *p-n-p* transistor if all voltages and directions of current flow are reversed.

It should be noted that the reversal of signs applies only to the currents and voltages. The quantities ρ_{11}, ρ_{22} a and b still remain positive. Each of these terms is the quotient of a voltage by a current or the ratio of two currents and the quotient or ratio of two negative quantities is positive.

All this may be a little clearer from Fig. 5. Viewed as a whole, the diagram represents a resistance in series with a battery. The line $I_b = 0$ is for a resistance alone and is merely the graphical representation of a simple resistance. Inserting a battery in series with it to aid the external voltage V_c shifts the line upwards; inserting it to oppose the external voltage shifts it downwards.

The characteristics shown by full lines in the top right-hand quadrant are by themselves those of an ideal *n-p-n* transistor. Those in the bottom left-hand corner are those of an ideal *p-n-p* transistor. The dotted parts are non-existent for transistors. The whole diagram can be expressed by one equation which, using the transistor symbols, is

$$I_c = aI_b + V_c/\rho_{22}$$

For the *n-p-n* transistor V_c is positive and I_c is positive and only the top right-hand part of the diagram exists. Theoretically, I_b can then be negative as long as $aI_b < V_c/\rho_{22}$, but usually I_b is positive. For a *p-n-p* transistor, V_c and I_c are negative and only the bottom left-hand part of the diagram exists. Again, I_b can be of opposite sign and so positive, but it is usually negative.

One can see, however, quite clearly that ρ_{22} and a must be positive with both types of transistor for, with parallel straight lines, the values of these quantities are independent of the part of the diagram at which they are taken.

Reverting now to the equivalent circuit of Fig. 4, it is possible to transform this to a different arrangement of its parts which is sometimes convenient. The first step in doing this is shown in Fig. 6(a). The only changes that we have made here are to move the positive terminal of $aI_b\rho_{22}$ from earth to the junction of $I'_b\rho_{11}$ and $bI_c\rho_{11}$ and to insert another battery $bI_c\rho_{11}$ in series with it. These make no difference, for the two batteries $bI_c\rho_{11}$ oppose each other in the collector circuit, so the positive terminal of $aI_b\rho_{22}$ is still at earth potential.

The next step is to replace the $bI_c\rho_{11}$ battery common to both circuits by a resistance and to arrange matters so that the voltage drop produced by the currents I_b and I_c produces the necessary e.m.f. The circuit then takes the form shown in Fig. 6(b). If (a) and (b) are to be identical, then all similar voltages and currents must always be the same for each. The conditions for identity are then easily found by writing the mesh equations and equating the coefficients of the same currents and voltages.

For Fig. 6(a) (or Fig. 4), we have for the first mesh

$$V_b = I_b\rho_{11} - I'_b\rho_{11} + bI_c\rho_{11}$$

and for Fig. 6(b) we have

$$V_b = I_b(\rho_b + \rho_e) - I'_b\rho_{11} + I_c\rho_e$$

Therefore, $\rho_{11} = \rho_b + \rho_e$ and $b\rho_{11} = \rho_e$.

For the second mesh we have for Fig. 6(a) (or Fig. 4)

$$V_c = I_c\rho_{22} - I'_c\rho_{22} - aI_b\rho_{22}$$

while for Fig. 6(b) we have

$$V_c = I_c(\rho_c + \rho_e) - I'_c\rho_{22} - I_b\rho_m + I_b\rho_e$$

hence $\rho_{22} = \rho_c + \rho_e$ and $a\rho_{22} = \rho_m - \rho_e$

Collecting these results, we find that for identity we must have

$$\rho_b = \rho_{11} - \rho_e; \quad \rho_e = b\rho_{11};$$
$$\rho_c = \rho_{22} - \rho_e; \quad \rho_m = a\rho_{22} + \rho_e$$

The resistance ρ_m may be a little confusing at first since it does not appear in Fig. 6 as a resistance. It is, perhaps, better to regard ρ_m as a multiplier for I_b which has the dimensions of a resistance and which when multiplied by I_b, gives the magnitude of the internal e.m.f. of the transistor.

The circuit of Fig. 6, like that of Fig. 4, represents the static characteristics of an *n-p-n* transistor in so far as the linear approximation to those characteristics is valid. The circuit for a *p-n-p* transistor is the same, but with the polarities of all voltages and the directions of all currents reversed.

The usual equivalent circuit is for a.c. conditions only and we could have derived this directly. However, some confusion between the two kinds of junction transistor is avoided if the d..c equivalent circuit is first derived as a stepping stone, and we shall actually find a use later on for the d.c. circuit.

The first step in producing an a.c. equivalent circuit is to produce one which is valid for both d.c. and a.c. We can then get the a.c. one merely by taking away the d.c. part.

Hitherto, the circuits have been, strictly, d.c. ones and we obtain the combined a.c. and d.c. equivalents exactly as we did for the valve by letting each voltage or current be equal to the sum of a mean d.c. component and an a.c. component. Using the subscript "*m*" to denote this mean component and a small letter for the a.c. component, a voltage, say V_b, will become $V_{bm} + v_b$. In Fig. 4, therefore, we replace V_b by $V_{bm} + v_b$, I_b by $I_{bm} + i_b$, V_c by $V_{cm} + v_c$ and I_c by $I_{cm} + i_c$. The currents I'_b and I'_c are pure d.c. quantities and are not affected.

We can now draw the complete equivalent circuits for Fig. 1 as in Fig. 7 and these are valid for both d.c. and a.c. conditions within the limits imposed by the linear approximation. Notice that in both Figs. 1 and 7 the input voltage v_1 is of opposite polarity with respect to earth for the *p-n-p* transistor (b) compared with the *n-p-n* transistor (a). This is done for simplicity, so that the positive half-cycle of input voltage in both cases acts to assist E_b.

Exactly as we did with the valve, we can now drop all the d.c. terms from Fig. 7 to leave only the a.c. ones, and we then get Fig. 8. It is very important to notice that the two circuits (a) and (b) are essentially identical. All the voltage generators of (a) are reversed in polarity in (a) compared with (b), and so are all the directions of the currents. If, therefore, we reverse the polarity of v_1 in (b) so that it is positive

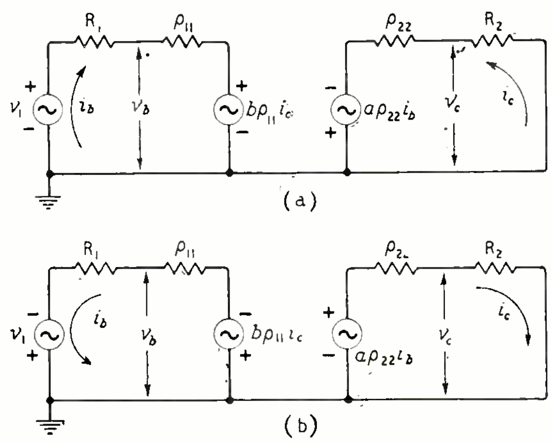


Fig. 8. The a.c. equivalent circuits of Fig. 1 are shown here. Since all voltages and currents in (b) are reversed as compared with (a), the two circuits are identical.

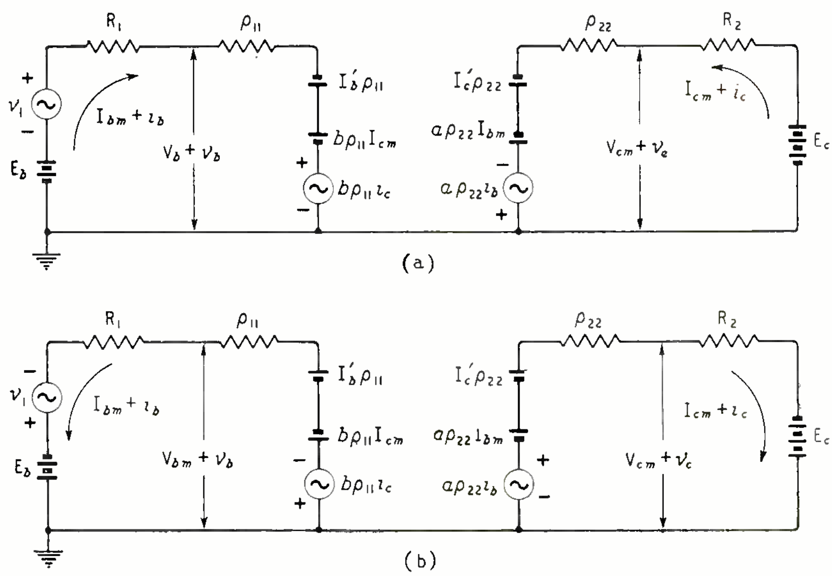


Fig. 7. The full a.c. and d.c. equivalent circuits of Fig. 1 are shown here for (a) an n-p-n transistor and (b) a p-n-p type. The a.c. inputs are of opposite polarity in the two.

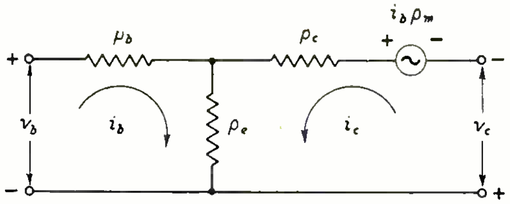


Fig. 9. An alternative equivalent circuit to that of Fig. 8 is shown here. This is the one most often used for the transistor.

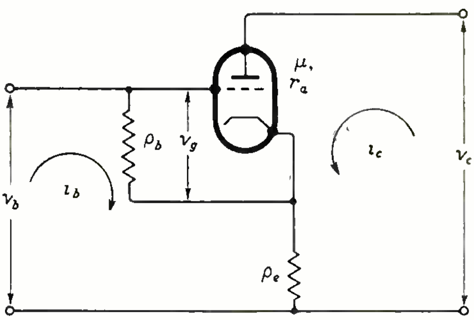


Fig. 10. A valve circuit which has an equivalent circuit the same as that of Fig. 8 and which, therefore, represents a transistor.

to earth as it is in (a), the direction of i_b must be reversed and this will reverse the polarity of the generator $a\rho_{22}i_b$ and hence the direction of i_c. In turn, the polarity of the generator $b\rho_{11}i_c$ will reverse.

It follows that the a.c. equivalent circuit is exactly the same for both *n-p-n* and *p-n-p* transistors.

This equivalent circuit can actually be used to represent, not only junction transistors, but any device whose characteristics can be expressed by two families of curves similar to Fig. 2. It can, therefore, also be used for the point-contact transistor (although it is not always easy to obtain these curves for this device) and for a positive-grid thermionic valve. For a negative-grid valve the grid current is zero, so ρ_{11} is infinite and b is zero; the left-hand half of Fig. 6 then disappears. The right-hand half forms the usual valve equivalent circuit if μv_g replaces $ai_b\rho_{22}$.

There are a great many alternatives to Fig. 8. Some of them are just ordinary circuit transformations of Fig. 8; others are similar but depend on other quantities than ρ_{11}, ρ_{22}, a and b for defining the transistor characteristics. A particularly common alternative to Fig. 8 is shown in Fig. 9; it is the a.c. version of Fig. 6(b). The relations between the two are easily obtained but, as the procedure is exactly the same as for the d.c. circuit and the relations so derived are the same, it is unnecessary to repeat it.

The form of equivalent circuit shown in Fig. 9 is actually the one most used in the literature, although it is usually derived for the earthed-base circuit rather than the earthed-emitter. Generally, the one of Fig. 8 is to be preferred because it leads to simpler design equations. The one of Fig. 9, however, has the merit that it is an obvious equivalent circuit of a thermionic valve plus a pair of resistances. In other words, a real valve circuit can be built which will simulate an earthed-emitter transistor.

In Fig. 9, the elements ρ_c and $i_b\rho_m$ are the same as the equivalent circuit of a valve if $\rho_c = r_a$ and $i_b\rho_m = \mu v_g$. If they are replaced by a valve, ρ_e becomes a cathode resistance and ρ_b a grid–cathode resistance across which v_g is developed by i_b, so $v_g = i_b\rho_b$, and therefore, $\mu = \rho_m/\rho_b$. The circuit thus has the form shown in Fig. 10.

This circuit is a good one as an analogy for an *n-p-n* transistor for its characteristics are obvious to anyone versed in valve circuits whereas those of a transistor are not so readily apparent.

It is instructive to insert some numerical values. A junction transistor may have $\rho_b = 750\ \Omega$, $\rho_c = 45\ \mathrm{k}\Omega$, $\rho_e = 35\ \Omega$ and $\rho_m = 1.5\ \mathrm{M}\Omega$. The equivalent valve may thus have a resistance of 45 kΩ which is quite feasible and a μ of 1,500,000/750 = 2,000, which is rather impracticable, for it means a mutual conductance of 2,000/45 = 44.5 mA/V.

The transistor is thus equivalent to a superlatively good valve spoilt by a very low input resistance. It is so much spoilt, in fact, that the overall gain is no better than that of quite an ordinary valve.

So far, we have said little about the point-contact transistor. In fact, the same method of approach is possible and the same equivalent circuits are applicable. In practice, however, difficulties arise in obtaining characteristics of the same form as those of Fig. 2 because, in the earthed-emitter connection, the point-contact transistor can have negative input and output resistances. It needs careful use in this circuit if it is to be stable.

Because of this, it is usual to plot its characteristics for the earthed-base connection, in which it is inherently stable, and, because this is done for the point-contact transistor, it is quite common to do it also for the junction types. Transistor characteristics and constants are more often published for the earthed-base connection than for the earthed-emitter, however the transistor may be used. It is necessary, therefore, to consider the earthed-base transistor in some detail and this we shall do in Part 3.

(To be continued)

I.E.E. Awards to Authors

THE major premium of the Institution of Electrical Engineers for a paper read or accepted for publication during the last session—the Institution Premium (value £50)—is to be given to Dr. D. M. MacKay, of London University, author of "High-speed electronic-analogue computing techniques." The John Hopkinson premium (£25) goes to Dr. M. J. Kelly and G. W. Gilman (Bell Telephone Labs.) and Sir Gordon Radley and R. J. Halsey (G.P.O.), authors of the paper "A transatlantic telephone cable."

Dr. N. W. Lewis (G.P.O.) is awarded the Blumlein-Browne-Willans premium (£20) for his paper "Waveform responses of television links." The Fahie premium (£10) goes to J. M. C. Dukes (S.T.C.) for "The effect of severe amplitude limitation on certain types of random signal," and the Webber premium (£10) to W. E. Willshaw (G.E.C.), Dr. H. R. L. Lamont (R.C.A.) and E. M. Hickin (G.E.C.) for "Experimental equipment and techniques for a study of millimetre-wave propagation."

The premiums to be awarded for papers presented to the Radio Section are: Duddell (£20) to E. G. Rowe, P. Welch and W. W. Wright (S.T.C.) for "Thermionic valves of improved quality for Government and industrial purposes"; Ambrose Fleming (£10) to Dr. P. E. Axon, C. L. S. Gilford and D. E. L. Shorter (B.B.C.) for "Artificial reverberation"; a £10 premium to H. Page and G. D. Monteath (B.B.C.) for "Vertical radiation patterns of medium-wave broadcasting aerials"; a £5 premium to M. W. Gough (Marconi's) for "Some features of v.h.f. tropospheric propagation," and another £5 premium jointly to R. C. Glass, G. D. Sims and A. G. Stainsby (G.E.C.) for "Noise in cut-off magnetrons."

Transmitting Colour Information

SIGNALLING TECHNIQUE IN THE BRITISH N.T.S.C. SYSTEM

MANY people are of the opinion that when a colour television system is finally adopted for this country it will be a version of the American N.T.S.C. compatible system, scaled down to fit British standards.* The ultimate choice of system largely depends, of course, on the recommendations of the Television Advisory Committee, and they will no doubt have several alternatives to consider when the time comes. One possible candidate, for example, could be the frame-sequential system and another the version of the N.T.S.C. system in which the colour information is transmitted in a different channel (or even band) from the brightness information. Be that as it may, the T.A.C. have already voiced the opinion (some may think quite wrongly) that British colour television ought to be compatible, which is as good as saying, in the present state of the art, that it ought to be something very much like the N.T.S.C. system, with the colour transmitted either inside or outside of the monochrome band. Undoubtedly this would be popular with the B.B.C., because it would involve very little change to their existing black-and-white transmitting equipment—only the addition of colour circuits. It may be significant, too, that the two major demonstrations of colour television so far, by the rival firms Marconi and E.M.I., have both been using compatible systems.

On the assumption that a version of the N.T.S.C. system may well be adopted in Britain (and *Wireless World* is not necessarily in sympathy with the idea), it would perhaps be worth while looking at some of the aspects of the system which have not been fully explained in this journal so far. These are mostly to do with the processing of the colour information for transmission—a business which is quite significant in that it has some bearing on the design of domestic colour receivers. The transmission of the brightness information is not so important because it is virtually the same as the transmission of black-and-white pictures in our existing system—and in fact the brightness channel of colour receivers would look very much like the whole of the present monochrome receivers.

Wireless World has already explained the basic principles of the N.T.S.C. type of system* but it may be as well to recapitulate some of the characteristic features. At the transmitting end the colour information from the colour camera is separated into two main components, a signal conveying the brightness information of the picture and a signal

* See for example "Colour Television on 405 Lines" *Wireless World*, June, 1954

* "American Colour Television," *Wireless World*, November. 1953

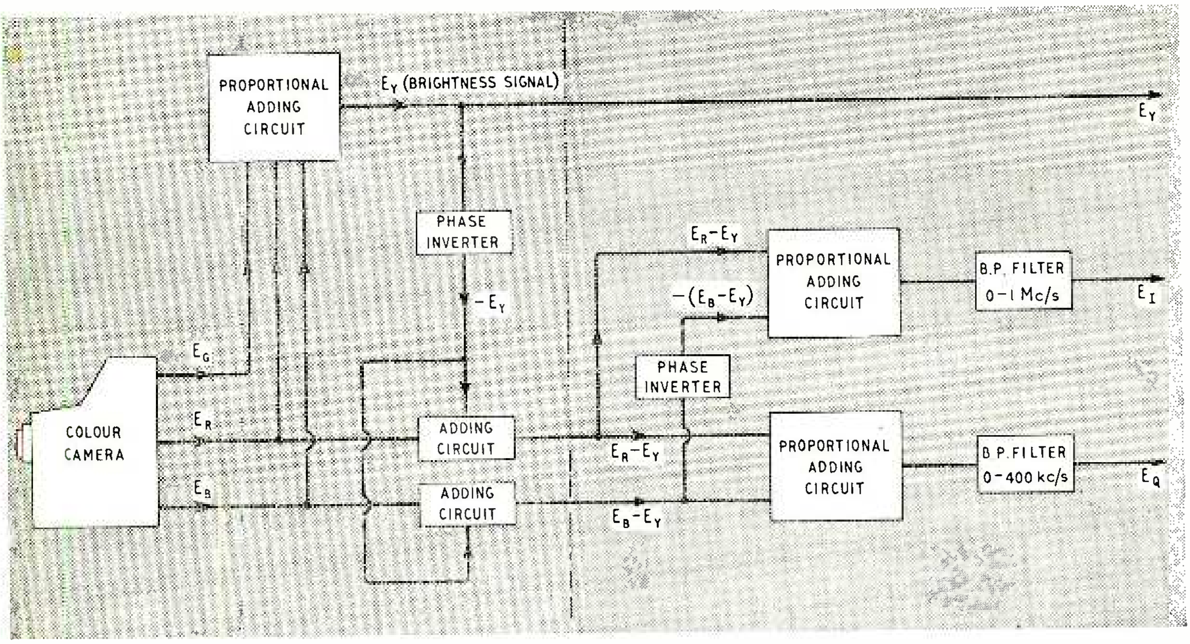


Fig. 1. Block schematic (very simplified) of the transmitting end of the British N.T.S.C. system. The section to the right of the broken line contains the circuits for producing the modified colour-difference signals from the original ones (to the left of the line)

carrying the colour information (i.e. hue and saturation). The brightness signal is received on existing monochrome television sets as a black-and-white picture, while in colour receivers it is recombined with the colour signal to produce a complete colour picture. We explained how the colour information was produced in the form of two colour-difference signals, $E_R - E_Y$ and $E_B - E_Y$ (as shown on the left of Fig. 1), which were transmitted as amplitude modulation on two components of a sub-carrier having a phase difference of 90° between them. The two components were combined, as shown by the vector diagram Fig. 2(a), to produce a single colour signal which carried hue information by phase modulation and saturation information by amplitude modulation. (Fig. 2(b) shows the various phase angles of the colour signal and the colours which they represent.) The sub-carrier was actually suppressed and the remaining sidebands were transmitted within the same band as the brightness signal by a process of frequency interleaving.

This description was actually of an early version of the N.T.S.C. system. The system which is now being used is basically the same, but the two colour-difference signals have been slightly modified. They are now each composed of certain proportions of *both* of the original colour-difference signals. These proportions are arranged so that one modified colour-difference signal conveys colour information ranging from orange to bluish-green (cyan) and the other colour information ranging from yellowish-green to purple. In the British version of the N.T.S.C. system* the orange-cyan signal is allowed a bandwidth of about 1 Mc/s while the yellowish-green-purple signal is restricted to about 400 kc/s.

Human Colour Vision

This modification to the system is actually a method of processing the colour information which takes advantage of the limitations of the eye's colour vision to secure the best possible transmission conditions within the limitations of the signalling channel. Our November 1953 article on the N.T.S.C. system has already explained that the human eye is insensitive to colour in very fine detail and only perceives it in the form of brightness changes. The N.T.S.C. system therefore does not transmit the very fine detail of the picture through the colour channel, but leaves it to the brightness channel, which has the full 3-Mc/s bandwidth available to handle it. With very coarse detail the eye is able to perceive the colours properly, but as the coarse detail is represented by a video signal of low information-content the bandwidth of the colour channel here can be quite small—in fact about 400 kc/s.

In between these two extremes there is a grade of moderately fine picture detail where the eye is only partly effective in its colour perception. It is aware of the existence of colours but cannot distinguish between them properly—in fact it is partly colour-blind. For example, blue and yellow are confused with grey, brown is difficult to distinguish from crimson, and blue is confused with green. Reddish colours, however, remain clearly distinct from blue-greenish colours, and, in fact, the eye tends to interpret all other colours in terms of these two opposites, or mixtures of them. With this moderately fine grade of picture detail, then, colour vision degenerates from being a three-colour process to a two-colour process.

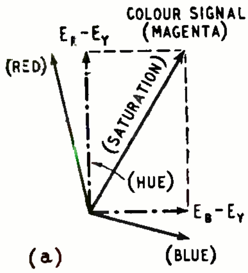
The effect can be illustrated in graphical form on the well-known Maxwell colour triangle, Fig. 3. Here the three primary colours are at the three corners, while other colours produced from mixtures of them can be specified by the spatial positions of points within the triangle. With two-colour vision, this diagram becomes nothing more than a straight line, as shown, running from orange to cyan across the original triangle. All possible colours in this two-colour system can then be specified by distances along the line instead of by spatial positions within the two-dimensional diagram. (It is interesting to note that orange and cyan are the two basic colours which have been found by experience to give the best approximation to reality in two-colour photography.)

The orange-cyan line, then, represents the "working characteristic" of the eye on colour detail of medium fineness. In the British N.T.S.C. system this particular grade of detail is represented by a band of video frequencies of up to about 1 Mc/s. The transmission circuitry is therefore arranged so that colours in the orange-cyan range are conveyed by a particular signal—the modified colour-difference signal, as mentioned above—which is, in fact, allowed this 1-Mc/s bandwidth. The other modified colour-difference signal conveys the remaining range of colours, yellowish-green to purple (also shown in Fig. 3) which, when combined with the orange-cyan range, give complete three-colour reproduction. But as the eye is only sensitive to three-colour reproduction in very coarse detail it is possible to transmit this yellowish-green to purple signal with quite a narrow bandwidth, in fact about 400 kc/s. Thus, considering the system as a whole, one can see that the transmitted picture information is divided into three categories—coarse picture detail (up to 400 kc/s) which is transmitted in full colour; moderately fine detail (up to 1 Mc/s), transmitted in two colours; and very fine detail (up to 3 Mc/s) which is only transmitted as brightness changes as in an ordinary monochrome system.

The actual method of producing the modified colour-difference signals can be seen from Fig. 1. In the first place, the brightness signal, E_Y, which provides the black-and-white picture for existing receivers, is formed by adding together certain proportions of all three primary-colour-component signals from the camera. The colour difference signals $E_R - E_Y$ and $E_B - E_Y$ are obtained, as explained in the November 1953 article, by adding a phase-inverted version of E_Y (that is $-E_Y$) to E_R and E_B, the purpose being to remove the redundant brightness information which exists in E_R and E_B. Green is not transmitted separately because it can be obtained at the receiver by subtracting the sum of the red and blue signals from the brightness (or "white") signal.

More adding circuits are now brought into play to form the modified colour-difference signals from the original ones. First of all the orange-cyan signal. To produce this, 74% of $E_R - E_Y$ is added to 27% of a negative quantity, $-(E_B - E_Y)$, which is obtained by a phase inverter from the positive $E_B - E_Y$ signal. This $-(E_B - E_Y)$ signal in fact represents the opposite or complementary colour of blue, which is yellow, and one can see that 27% of yellow added to 74% of red

* "Colour Television on 405 Lines," *Wireless World*, June, 1954.



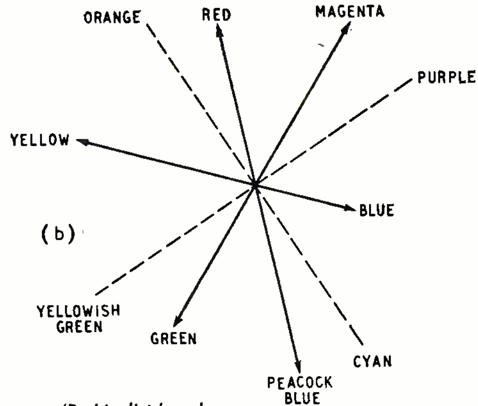


Fig. 2 (a). Vector diagram showing how, in the earlier N.T.S.C. system, the colour signal was produced from two colour-difference signals. In (b) are some of the phase angles taken up by the colour signal and the colours they represent. (Red is displaced from E_R-E_Y because it is a resultant of E_R-E_Y and E_B-E_Y and although E_B is zero the $-E_Y$ makes E_B-E_Y into a minus quantity.)

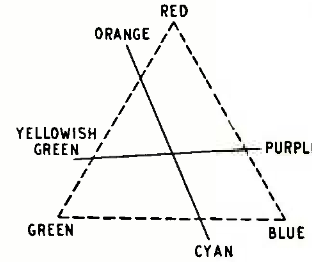


Fig. 3. Maxwell colour triangle with two axes showing the ranges of colours transmitted by the two modified colour-difference signals E_I and E_Q.

will produce orange. Thus the modified colour-difference signal coming out of the adding circuit now represents the orange in the picture (or colours seen as orange) directly, whereas before it was conveyed indirectly by two separate components in the E_R-E_Y and E_B-E_Y primary colour channels.

It is easy to see that yellow and red added together will produce orange, but what about the cyan end of the "working characteristic" in Fig. 3? When colours in this part of the spectrum (or colours which the eye interprets as cyan) appear in the picture E_R-E_Y becomes a negative quantity $-(E_R-E_Y)$, which represents the opposite of red, or peacock blue, while the $-(E_B-E_Y)$ goes back to positive, which of course represents blue. The added proportions of the two then produce cyan, which lies between blue and peacock blue on the colour triangle. In other words, the colour signal vector which represented orange in the first instance, at "11 o'clock" in Fig. 2(b) undergoes a 180° change of phase and appears at "5 o'clock" between blue and peacock blue. For the other modified colour-difference signal (yellowish-green to purple) the two constituents are 41% of E_B-E_Y plus 48% of E_R-E_Y. When these values are positive they add to give the purple ("2 o'clock" on Fig. 2 (b)) and when they are negative they give the yellowish-green ("8 o'clock" on Fig. 2 (b)).

After the two signals are formed they are passed through band-pass filters as shown. The result is that both of them are effective and give three-colour reproduction for video frequencies up to 400 kc/s (coarse picture detail), while at video frequencies between 400 kc/s and 1 Mc/s (moderately fine detail) only the orange-cyan signal is transmitted, giving the two-colour reproduction to which the eye is physiologically restricted in this range. As was mentioned above, the two colour-difference signals in the earlier N.T.S.C. system were transmitted by being modulated on to two components of a sub-carrier, displaced 90° in phase, which were then combined to form a single r.f. signal (Fig. 2 (a)). The modified colour-difference signals in the British system are handled in exactly the same way, the orange-cyan signal being designated E_I and the yellowish-green to purple signal E_Q.

At this point one might be inclined to ask: why bother to restrict the E_Q signal to about 400 kc/s bandwidth when the E_I signal is already causing the final r.f. colour signal to take up a full 1 Mc/s ? The answer to this is bound up with the problem of avoiding mutual interference and cross-talk between the various component signals in the complete transmission channel (see Fig. 4).

First of all it is essential that the colour signal, which is transmitted within the same 3-Mc/s band as the brightness signal, shall have minimum visibility on the screens of black-and-white receivers. One of the expedients necessary to achieve this is to make the colour sub-carrier frequency as high as possible so that the pattern it produces on the screen will have a very fine structure. Now with a high sub-carrier frequency, placed well to the right as in Fig. 4, it is clearly only possible to transmit the lower sidebands of a 1-Mc/s colour signal in full, the upper sidebands being partly removed by the upper limit of the 3-Mc/s pass band. If both E_I and E_Q were given the full 1-Mc/s bandwidth they would both have sidebands like E_I in Fig. 4. Transmission of these two signals on the same sub-carrier would be satisfactory over the small band where double-sideband operation is possible, but beyond this point the missing upper sidebands would have the effect of introducing spurious signals into the E_I channel from the E_Q channel and vice versa. The result on the receiver screen would then be incorrect colour reproduction at the edges of objects.

Overcoming Colour Cross-Talk

By restricting the E_Q signal to a bandwidth of about 400 kc/s, however, this cross-talk problem is overcome, simply because over the range where E_I consists only of single (lower) sidebands (400 kc/s to 1 Mc/s), there is no E_Q signal for it to interfere with. In other words, the two colour-difference signals E_I and E_Q are transmitted together on the same sub-carrier only in the video frequency range where double-sideband operation is possible for both, and consequently no interference occurs between them. The sub-carrier frequency is positioned so that this d.s.b. range is big enough to accommodate the band of video frequencies for which three-colour reproduction is effective. Beyond 400 kc/s a single colour-difference signal is transmitted, E_I, in the form of a set of lower sidebands, and only this one signal is necessary because the viewer's eye cannot perceive anything more than the two-colour information which it conveys. In the British N.T.S.C. system the sub-carrier is placed at 2.66 Mc/s, and

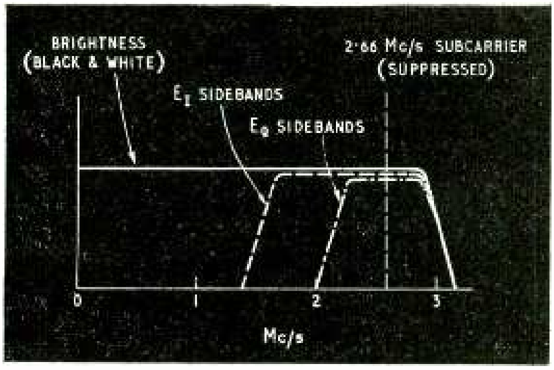


Fig. 4. Frequency characteristic of the 3-Mc/s vision channel of the British N.T.S.C. system, showing how the sub-carrier and its sidebands carrying the colour information are placed relative to the upper limit of the pass band.

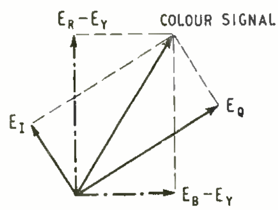


Fig. 5. Vector diagram of the E_I and E_Q signals and their resultant colour signal, showing how the colour signal vector can also be separated into components equivalent to E_R-E_Y and E_B-E_Y. The angles taken up by the colour signal vector with the various colours are the same as in Fig. 2 (b).

this represents a compromise between two conflicting requirements—mitigating the interference pattern on the screens of black-and-white receivers and avoiding colour cross-talk.

Colour information in the British N.T.S.C. system, then (as in the American system), is transmitted not in terms of the well-known primary colours red, green and blue, but by another group of colours which are more suited to the characteristics of the signalling channel (including the human eye). In the earlier system the red, green and blue primary-colour information was converted into two colour-difference signals which were finally combined into a complete colour signal; this represented the hue of the colour by its phase angle and the saturation by its amplitude. The modified primaries in the later system are also transmitted as colour-difference signals in a similar fashion and the transmitted colour signal has the same phase angle and amplitude as before for a given hue and saturation—that is, for video frequencies up to about 400 kc/s. Between 400 kc/s and 1 Mc/s only one of the modified colour-difference signals is in operation, giving two-colour reproduction along the orange-cyan line in Figs. 2(b) and 3. The vector representing the transmitted colour signal then does not rotate through all the positions shown in Fig. 2(b), but rises and falls along the line marked ORANGE-CYAN (in both positive and negative directions).

As far as the receiver is concerned, then, it is presented with a colour signal which is modulated in both phase and amplitude, and from these modulations the original colour information has to be recovered. The technique usually adopted makes use of synchronous detectors. The incoming sidebands are mixed with two local oscillations which have the same frequency as the colour sub-carrier but are displaced 90° in phase (as at the transmitting end). One mixer then recovers the E_I signal as a product while the other recovers the E_Q signal, and from these the original E_R, E_B and E_G primary-colour-component signals are eventually obtained.

It is important, however, that the two local oscillations shall have the same phases as the two sub-carrier components at the transmitting end, otherwise they will not recover the E_I and E_Q signals but something else. The point is illustrated by the vector diagram Fig. 5, which shows the final colour signal and the E_I and E_Q signals from which it is composed. Here, as in Fig. 2(a), the colour signal vector is a resultant formed by the two component vectors E_I and E_Q, and these component vectors indicate the phases which the oscillators at the receiving end must have if E_I and E_Q are to be recovered. It is clear, however, that the resultant vector can be separated into many other pairs of components, apart from E_I and E_Q, all having the 90° phase displacement between them. In practice this can be done at the receiver by altering the phases of the two synchronous-detector oscillators —and, in fact, these phases can be shifted so that the detectors recover not E_I and E_Q but two components equivalent to E_R-E_Y and E_B-E_Y in Fig. 1, the original colour-difference signals.

Thus, at the receiving end, the colour information can be obtained in two different forms, either as E_I and E_Q signals giving wide-band colour information, or as $E_R - E_Y$ and $E_B - E_Y$ signals giving narrow-band colour information. The advantage to be gained by recovering the narrow-band signals is simplicity of receiver design and hence cheapness in manufacture, and most of the present American receivers are, in fact, using this system. Moreover, R.C.A. in America have recently produced an improved colour demodulator for their receivers which not only recovers the $E_R - E_Y$ and $E_B - E_Y$ signals but the $E_G - E_Y$ signal as well, and also gives enough output to drive the tri-colour c.r. tube directly. It uses only one double valve and is undoubtedly a great advance in circuit simplification. At the same time, of course, this type of operation will not give the high-definition colour reproduction that can be obtained by using more elaborate circuitry to recover the E_I and E_Q signals. However, if the colour information is transmitted in the way described above it will be possible to use the cheaper receivers (a real necessity for this country) and at the same time leave the door open for more complex receivers giving better colour reproduction if they are ever wanted.

Broadcast Receiver Sales

AMENDED figures for the sale of broadcast receivers in April (see p. 346, July) have now been issued by the British Radio Equipment Manufacturers' Association, together with the figures for May. It will be seen from the table that the retail sales of television receivers in May dropped by 11,000 (15%) compared with the previous month and by nearly 40% compared with the January figure.

	Sound	Radiograms	Television
January	98,000	35,000	103,000
February	99,000	33,000	98,000
March	95,000	24,000	85,000
April	79,000	16,000	75,000
May	73,000	15,000	64,000

THE CASCODE

By "CATHODE RAY"

—And Its Advantages for Band-III Reception

THE present seems an appropriate time to say something about the cascode, because although it is not at all new it has only just begun to be sold to the public. In fact, the said public, as a class, are still blissfully unaware of the infiltration of cascodes into the privacy of the home. All they know is that they are foresightedly taking steps to re-establish the ascendency over the Jones's that they lost when the Jones's too installed television. These steps consist either in buying a new model fitted for Band III, or a box of tricks to adapt their present model; and they hope that, by the time the Jones's realize that advertisement TV has actually begun, the waiting list for equipment to enable it to be seen will be very long. But foresighted though they may be, unless they are technically minded they still won't realize that they have bought a cascode.

Wireless World readers, however, may be more interested in the why and how of the cascode than in knowing which washing powder makes that dainty woolly newer than new.

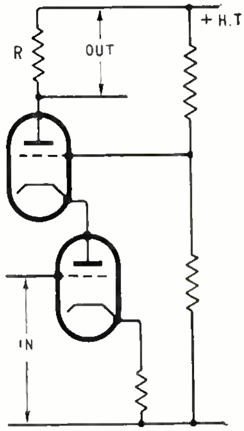
The name "cascode" dates from before the war,* and may perhaps be regarded as an abbreviated form of "casc(aded-triode amplifier having characteristics similar to, but less noisy than, a single pent)ode." But that original arrangement was slightly different from the present form† and was devised for an altogether different purpose, at the extreme opposite end of the frequency scale—zero and thereabouts. The cascode has also been highly recommended for audio frequencies.‡ So altogether it is a versatile creature, and we ought to know something about it.

Fig. 1 shows a cascode arranged as a resistance-coupled low-frequency voltage amplifier. Essentially the same circuit could be used as the amplifier in a voltage-stabilized power unit. Fig. 2 shows a cascode arranged as a v.h.f. amplifier in a Band-III television receiver or adapter. There are all sorts of variations on the same theme, so the first thing we want to settle is the basic theme itself—the minimum that constitutes a cascode.

The short answer is: two stages of amplification, comprising an earthed-cathode triode, cascade-connected to an earthed-grid triode. But perhaps that answer itself needs a little amplification.

First of all, "cascade-connected." That means connected one after the other, as distinct from valves in push-pull and parallel stages, which come two at a time. It is not—in spite of the appearance of Fig. 1—quite the same thing as series connection. In cascade connection, which is the usual way of connecting successive valves in an amplifier, the output of the first provides the input of the second.

Now there are three basic ways of connecting a single valve to make a stage of amplification. These ways can conveniently be named according to the electrode that is earthed; the other two electrodes are those used for input and output respectively. The commonest arrangement of the three is the earthed-cathode, in which the input is led to the grid and the output taken from the anode. The next commonest is the earthed-anode, better known as the cathode follower. It, too, has the input connected to the grid, but the output from the cathode. Lastly, the earthed-grid (called by crypto-Americans



Above: Fig. 1. Circuit diagram of a cascode arranged as a resistance-coupled amplifier.

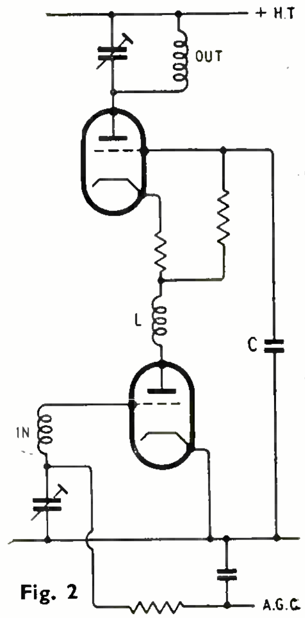


Fig. 2

Above right: Fig. 2. Circuit diagram of a cascode arranged as a v.h.f. amplifier, say for Band III television.

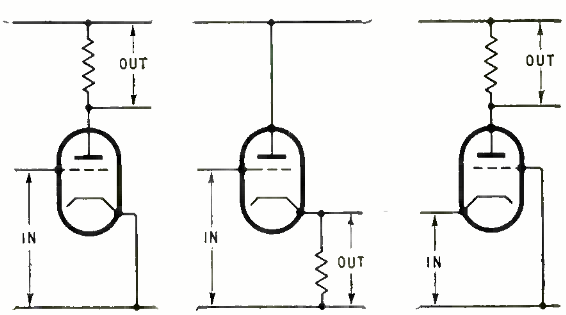


Fig. 3. Essentials of the three ways of connecting a triode as a stage of amplification: (a) earthed cathode; (b) earthed anode; (c) earthed grid.

---

* "Electronic Voltage Stabilisers," by Hunt and Hickman, *Rev. Sci. Inst.* Jan. 1939, p. 6.

† "A Low-noise Amplifier," by Wallman, Macnee and Godsden *Proc. I.R.E.*, June 1948, p. 700.

‡ "Cascode Audio Amplifier has Low Noise Level," by R. L. Price, *Electronics*, March 1954, p. 156.

"grounded-grid"), in which the grid (however did you guess?) is earthed, the input goes to the cathode, and the output comes from the anode. Fig. 3 lines up these three, stripped of all practical details, for inspection.

In a two-valve cascade-connected amplifier, the first stage can be connected in any of these three ways. Each of these three varieties can be subdivided into three, according to the way the second stage is connected. So altogether there are nine possible combinations. When this fact first dawned on my consciousness, I supposed that most of the combinations would be of purely academic interest, only two of three being used in practice; but on going steadily through the lot I found that most, if not all, had been used at some time, for some purpose. For instance, did you know that there was actually a special type of valve—the 6B5—embodying the earthed-anode earthed-cathode combination? Then the earthed-anode earthed-grid combination is the basis of the well-known coupled-cathode or "long-tailed pair," used in many valve voltmeters and oscilloscopes. The earthed-grid earthed-cathode is used in radar and other v.h.f. receivers. But however interesting it might be to explore all nine, the only one on to-day's schedule is, as already mentioned, the earthed-cathode earthed-grid combination.

Coupling Impedance

You will of course want to know why anybody should choose this in preference to the earthed-cathode earthed-cathode, which gives easily the most amplification of any of the nine. But before going into that, let us just make sure that Figs. 1 and 2 really are earthed-cathode earthed-grid cascade combinations and not just the valves connected in series that they appear to be. Looking again at Fig. 3 we see that all three circuits include a resistor (or some other kind of impedance) which performs two roles: providing a path for the steady feed current through the valve, and by its impedance causing the signal current to set up a signal output voltage. This output voltage can then be applied to the input of a following stage. If this following stage is of either the (a) or (b) types, the coupling impedance is still required for the first stage; but type (c) is unique, because not only do its input terminals provide an impedance across which the input voltage can be set up, but the cathode terminal in particular also provides a source of feed current for the first stage. So the coupling impedance can be omitted.

As drawn in Fig. 1, the second or upper valve appears most clearly in its role of coupling impedance and steady-current feeder, corresponding to the resistor in Fig. 3(a). To emphasize its other role of second stage in a two-valve amplifier, I have redrawn Fig. 1 as in Fig. 4. It is now clearly the same as in Fig. 3(c), the only apparent difference being the point to which the grid is connected; and that is the same in principle, being equivalent to earth even though, in order to bias the grid suitably relative to its cathode, it is taken to a source of positive potential. Fig. 4, although its circuit is identical with Fig. 1's, shows more clearly that, while the second valve is in series with the first for current-feed purposes, it is truly in cascade as regards signal amplification.

And now we come to the question of why this arrangement should ever be preferred to the more highly amplifying all-earthed-cathode system. The answer depends on which of the two main applications we have in mind. The chances just now are heavily in favour of Band III being in mind, rather than voltage stabilizers, though we'll come to them too in due course.

At the very high frequencies of Band III it is difficult to generate such massive power for transmitting as on the lower frequencies. The waves, when transmitted, are more rapidly attenuated; and the receiving aerials are necessarily short and therefore limited in collecting ability. So the signal voltage, or rather microvoltage, that can be brought to the input of a receiver is likely to be very small. At the same time it must, for television, be spread over a wide frequency band and so has to compete with a lot of noise of the kind self-generated in circuits and valves. In fact, even though v.h.f. isn't too easy to amplify, the limit is not set by that difficulty so much as by the signal-to-noise ratio that can be achieved. If the signal doesn't succeed at the outset in poking its head high enough above this noise, no amount of subsequent amplification will help it, because the noise is amplified too. So all depends on the first stage of amplification, in which the signal is at its weakest.

Because of the greater difficulties of amplifying v.h.f. signals, there is an obvious inducement to change to a lower frequency as soon as possible. But a frequency-changer stage is at best a comparatively noisy affair, so doesn't make at all a suitable first stage for signals that are already barely strong enough to stand clear of noise. A preliminary stage of amplification, even if it doesn't give very much, and even if it introduces some noise itself, helps the signal to master the greater frequency-changer noise. In case this point is not entirely obvious, let us suppose that a certain frequency changer introduces $6\mu V$ of noise and neither amplification nor loss, and that a stage of amplification introduces five-fold voltage gain and the equivalent of $3\mu V$ of noise at its input. If the incoming signal is $16\mu V$, together with $2\mu V$ noise, the incoming signal/noise voltage ratio is 8 : 1 and its power ratio 64 : 1. After the frequency changer alone the signal would still be $16\mu V$ and the noise voltage $\sqrt{(2^2 + 6^2)} = 6.3$*, so the signal/noise power ratio would be degraded to 6.5 : 1. But if the amplifier were used first, its output would include $5 \times 16 = 80\mu V$ of signal and $5\sqrt{(2^2 + 3^2)} = 18\mu V$ of noise (nearly 20 : 1 power ratio), and the output of the frequency changer following would be $80\mu V$ signal and $\sqrt{(18^2 + 6^2)} = 19\mu V$ noise, making the ratio 18 : 1. This simplified example shows how even a moderate amplification, itself not noiseless, can much improve the net result.

What Valve to Use

Having decided to use at least one stage of amplification at the original frequency, we are then faced with conflicting claims in the choice of amplifier. A r.f. pentode has internal screening which helps to prevent feedback via stray capacitance turning the amplifier into an oscillator, as would inevitably happen with an earthed-cathode triode owing to its anode-to-grid capacitance. On the other hand, a pentode is a good deal noisier than a triode. I went into detail about this noise business in the May and June 1952 issues, so for present purposes it should be enough

* Noise voltages, like a.c. voltages of unequal frequency, have to be added together in this way; see "Total Power" in the March 1952 issue.

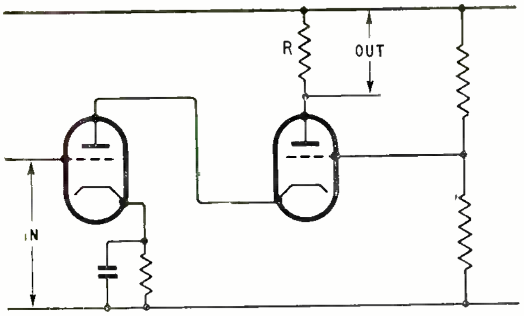


Fig. 4. Rearrangement of Fig. 1 to show more clearly the role of the second valve as an earthed-grid stage.

to say that because the current through a valve consists of separate electrons there is bound to be a small random fluctuation around even the steadiest average, and it is this fluctuation that is referred to as noise. In a pentode the fluctuation is greater than in a triode, because on top of this chance of slightly fewer or more electrons arriving during any instant, there is the chance of whether any particular electron will be intercepted by the second grid or go right on to the anode. Though you might not think so, this extra chanciness adds very considerably to the noise. The average for 10 different kinds of pentodes used for amplification showed 75% greater noise voltage than the average for a number of triodes. So there is a strong inducement to use a triode, if it can be made to amplify at v.h.f.

As we know, it cannot if it is simply connected in the usual earthed-cathode manner. This is where the earthed-grid triode came in, especially during the last world war for 200-Mc/s radar. Unfortunately an earthed-grid triode presents a very low input impedance, even by v.h.f. standards. As we see from Fig. 3(c), it is not much more than the *output* impedance of a cathode follower, and we know that that is very low—approximately $1/g_m$, or say 200Ω if g_m, the "slope" of the valve, is 5mA/V. The only difference between this circuit and a cathode follower is the external anode resistance, which reduces the overall slope by adding to the internal anode resistance, r_a. In a v.h.f. amplifier, the external resistance is the dynamic resistance of a tuned circuit, and is likely to be considerably smaller than r_a. So the input resistance is still very low, and establishing a signal voltage across it costs plenty of signal power. Stage gain is therefore even less than usual for a triode.

The attraction of the cascode is that it combines the low noise of a triode with earthed-cathode input resistance and the high gain and stability of a pentode. And although the circuit diagrams here make it look as if two valves were being used in place of one, in practice the two triodes take the form of one double triode costing about the same as one pentode and occupying the same space and valve-holderage.

The second half of the cascode is an earthed-grid stage as just described, and its low input resistance constitutes the anode load or coupling resistance (R_a) of the first half. So although this first half is an earthed-cathode stage, it is prevented from bursting into oscillation by the fact that its R_a is too low to give enough amplification. When the R_a of a voltage amplifier is much smaller than the r_a of the valve, the voltage amplification (A) is approximately equal to $R_a g_m$. But in this case we know that R_a is approximately equal to $1/g'_m$, where g'_m is the slope of the second triode, as modified by *its* anode load. So the amplification of the first stage is

$$A \simeq R_a g_m \simeq \frac{g_m}{g'_m}$$

The slopes of the two valves in a double triode are (or should be) more or less equal. So even if the load resistance of the second were as much as equal to r_a, g'_m would be half g_m, and A consequently no more than 2. In practice, at v.h.f., it would probably be nearer 1. This doesn't mean that the first stage contributes next to nothing; its real job is to drive the second stage without damping down the input circuit or introducing a lot of noise. It functions, in fact, very like a cathode follower.

The output of the second stage is quite conventional. Fig. 2 shows the whole cascode as arranged for Band-III amplification. Instead of being taken to a tapping on a potential divider, the grid of stage 2 has conventional bias arrangements, but at signal frequency is tied down to earth by C. This modification of Fig. 1 enables automatic gain control to be applied in the customary manner to stage 1. In Fig. 1, a.g.c. bias would be almost completely ineffective in changing the anode current and with it the amplification, because the fixed potential of grid 2 would tend to hold it constant. The only other thing that might perhaps excite curiosity about Fig. 2 is L. Its purpose is to neutralize stray capacitance at the top frequency of Band III, where there would otherwise be a falling off in amplification.

Mathematical Approach

If, as I hope, you like to work things out mathematically for yourself, I can recommend analysing Fig. 1 by writing down the equations—five of them—expressing overall voltage amplification, A; signal anode current, i_a; signal voltages of the two anodes, v_{a1} and v_{a2}; and signal voltage between second grid and cathode, v_{g2}; in terms of the μ and r_a of the two valves, the signal voltage v_{g1} applied to the first grid, and R. If the valves are *not* assumed to be identical, the answer should come out to

$$A = \frac{(\mu_2 + 1)\,\mu_1 R}{R + r_{a2} + (\mu_2 + 1)\, r_{a1}} \quad \ldots \quad \ldots \quad (1)$$

If the valves *zre* identical this simplifies to

$$A = \frac{(\mu + 1)\,\mu R}{R + (\mu + 2)\, r_a}$$

while if μ is large enough for the difference between it and $\mu + 2$ to be neglected,

$$A \simeq \frac{\mu R}{R/\mu + r_a}$$

which compares with

$$A = \frac{\mu R}{R + r_a}$$

in a conventional single-triode amplifier. These results prove what we have already gathered, that the v.h.f. amplification of the cascode as a whole is not noticeably greater than would be given by one of its valves connected as an ordinary stage *if there were no such thing as Miller effect to upset its working.* But there is, and the addition of the second triode overcomes it without having to fall back on the noisy pentode.

Looking at things from different viewpoints is usually a help in understanding them; and having considered the cascode as two successive conventional stages in an amplifier, we may now care to think of it as a single unconventional stage. The difference between pentode and triode characteristics can be expressed in one way by saying that the pentode has a very much larger internal resistance r_a, which is the same thing as saying that its anode current is very little affected by its anode voltage. Putting a load resistance in series with the anode therefore has hardly any effect on the amount of anode current. This is not so with a triode, however. When its anode current is increased by making the grid less negative, any anode load resistance causes the anode voltage to drop, and this cuts down the increase that would otherwise have taken place.

With this in mind, consider Fig. 1 again. The first (lower) valve has an anode load resistance consisting of the other valve plus R. If the grid of this other valve had a fixed bias relative to its cathode, the action would be as just described. But because the grid is tied to a fixed potential, the drop in cathode potential caused by any increase in anode current is equivalent to making the grid less negative, which operates to maintain the increase in anode current. Since the cathode potential cannot alter much without drastically altering the anode current in this way, it tends to stay nearly constant. This is the same thing as the lower valve's anode voltage staying nearly constant, regardless of changes in anode current induced by changes in its grid voltage. So the system as a whole behaves something like a pentode, in two ways: the anode current has been made to depend almost exclusively on the voltage of the first grid regardless of the presence or absence of R; and the potential of the electrode next to that grid—the first anode—has been made to stay nearly constant, and so to simulate the screen grid in a pentode, which keeps the amplifier stable.

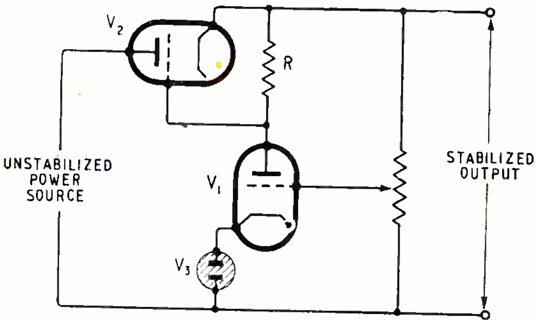


Fig. 5. Essentials of the usual type of voltage stabilizer.

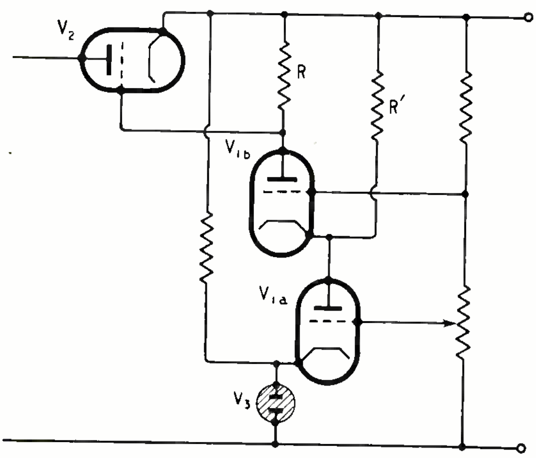


Fig. 6. Modified cascode substituted for V_1 in Fig. 5. The modification consists of R′, which raises the amplification of the stage by increasing the anode current and consequently the g_m of V_{1a}.

Voltage Stabilizer Application

There is no reason, of course, why the cascode cannot be used at lower radio frequencies than v.h.f., or even audio frequencies, but amplification of lower r.f. is not usually limited by valve noise, and a pentode gives more amplification. For a.f. it is an interesting question whether, on balance, the cascode is better than the two valves of a double triode connected in the ordinary way as two earthed-cathode stages. Coming at last to the amplifier used in the usual type of voltage stabilizer, there is much more to be said for the cascode. Most of it has been said very well by V. H. Attree,* who has devised a modification that looks like establishing the cascode as undisputed king of this situation.

Just to make sure that we are both thinking about the same "usual type of voltage stabilizer," Fig. 5 is an outline diagram, for identification, in which V_1 is the amplifier in question. The greater the amplification of this stage, the more effective the stabilizer. So the choice of valve is almost invariably a pentode. To extract a reasonable proportion of the valve's potential amplification, the resistance R must be large. But the voltage across it, being the bias for V_2, is normally quite small, which means that the valve is working under conditions (to wit, low g_m) that throttle most of its amplification. If two stages were used, the output voltage would be of the wrong polarity and the stabilizer would become an unstabilizer. Two stages, that is to say, connected in the usual earthed-cathode manner. But this difficulty does not apply to the cascode, because its second stage, being earthed-grid, does not reverse the polarity. The criticisms that have just been made about the pentode would go for the cascode too, if it were as per Fig. 1. But Mr. Attree has pointed out that when μ_1 and μ_2 in our equation (1) are large (because a high-μ double-triode has been chosen), and R and r_{a2} are neglected in comparison with μr_{a1}, the thing reduces to

$$A \simeq \frac{\mu_1 R}{r_{a1}} = g_{m1}R$$

So the amplification depends hardly at all on the g_m of the second triode and almost entirely on that of the first, and it doesn't matter if the current through R and the second valve is small, so long as it is large enough for a good big g_m in the first. The modification therefore consists of an extra resistor to pass more current through this valve.

The circuit (less all frills) is as Fig. 6. With this improvement, the voltage amplification of the cascode can easily be well over 1,000, which makes the stabilizer incorporating it a very good stabilizer.

---

* "A Cascode Amplifier Degenerative Stabilizer," *Electronic Engineering*, April 1955, p. 174.

ELECTRONIC TELEPRINTING

A NEW electron-image tube that can translate coded signals from teleprinter tape or other sources into clearly defined letters and figures at speeds up to 100,000 words per minute for high-speed photographic recording has recently been developed by R.C.A. In operation the tube simulates the process of typesetting by selecting letters and figures one by one from a "font" and placing them in luminous form on the 5-in circular tube face, either in lines or in any pattern desired. The "font" is actually a lantern slide external to the tube, bearing a chart of letters and figures. An image of this is projected on to a photo-emissive cathode at one end of the tube which emits a stream of electrons in a corresponding pattern. The electron stream is then accelerated forward in the tube by a potential of 100V applied to the conductive wall coating and focused by an external coil providing an axial magnetic field.

The selection of letters and figures in the required order is accomplished by a small aperture of 0.04-in diameter at the neck of the tube which permits only one character at a time to pass through. As the electron stream pattern carrying all the letters and figures moves towards this aperture, a magnetic deflection coil (mounted inside the focus coil) shifts the stream so that only the desired character passes through and travels towards the tube face. Another set of coils then focuses and deflects the character to its proper place on the phosphor screen.

As many as 4,000 characters have been produced clearly in a single pattern on the 5-in tube face. The size of the letters and figures on the screen can be enlarged, however, by the second set of coils if required.

The deflection coils for selecting and positioning the characters contain windings for both vertical and horizontal deflection, as in television. In the teleprinting application these coils are supplied with suitable steps of current in accordance with the coded information which is "read off" (by photo-electric means) from the teleprinter tape.

When the new tube achieves commercial form its initial applications are likely to be in electronic message transmission and in computing systems. Later it may be developed for electronic typesetting.

COLOUR TELEVISION STUDIO, claimed to be the first one built specifically for colour, and recently put into operation by the National Broadcasting Company of America at Burbank, California. An elaborate lighting system with 2,400 controls permits the pre-setting of lighting for ten scenes and also ten changes of lighting within any one scene. An unusual feature is an "audience pit" which accommodates the studio audience below floor level to avoid interference with the cameras.

RANDOM RADIATIONS

By "DIALLIST"

"Night Starvation"

EVEN in what passes nowadays for summertime, the mains voltage in some localities is liable to fall somewhat after, say, 8 p.m. or a little later. If the fall is not very great and the television receiver is in tip-top form, the effects of this may be hardly noticeable; but with a bigger fall or a set which has been in use for some time without renewals or replacements this "night starvation" can lead to picture shrinkage, with the typical black borders. When that happens the first thing that I suspect is the h.t. rectifier, particularly if it's of the metal type. Metal rectifiers are sound and reliable components, but they don't last for ever and it pays to renew them when tests show that their output is appreciably down. I'd estimate about two years or perhaps a bit more as their normal useful life in an average family set.

A Radio-link Problem

THE temporary East Anglian television transmitter at Tacolneston reradiates the London transmissions which it receives direct. This has been leading recently to spots of bother caused by r.f. interference from a Continental sound-broadcasting station. I haven't yet been able to find out what station it is. Under certain conditions the interference is fairly mild, merely causing a certain amount of "fish netting" on the picture. But it can at times be bad enough to blot out the picture and to make the accompanying sound almost unintelligible. To prevent viewers in the Norwich area from snowing dealers under with complaints about the misbehaviour of their perfectly guiltless receivers the B.B.C. has very wisely devised a means of letting them know when it's the transmission that is to blame: vertical white bars sent out every so often indicate to the viewer that interference is affecting the transmission.

A Monitoring Suggestion

This idea might, I think, be carried a good deal further, for TV receivers are often blamed by their users for doing things that they can't help doing. Some of the O.B. cameras, for example, "ring" quite severely, producing pronounced white outlines to the right of dark objects. And this effect can be made worse than ever if a relay is made over a long landline. An occasional word from the announcer about this might save viewers from worrying about their sets and servicemen from having to make unnecessary journeys. I've a feeling that some, at any rate, of the monitoring should be done with ordinary domestic receivers. Those in charge would then be able to see whether any transmission was likely to cause the sets of Smith, Jones, Brown and Robinson to play up and a word of explanation (and of comfort) could be issued at suitable moments. You know the kind of thing I mean: the sync isn't always able to lock one of the scans—or maybe both of them—properly; a change of camera means a fall in the brightness level, or *vice versa.*

Over-Simplified?

Yes; I know that these things wouldn't happen if TV sets were a little more elaborate—and, therefore, a little more expensive. But, domestic receivers being what they are, the plain and inescapable fact is that they *do* happen. And that brings me to the warning given recently to the radio industry by Harold Bishop, to whom I offer my humble felicitations on his well-deserved Birthday Honour. What he said in effect was that there are limits beyond which simplification and price reduction cannot reasonably be carried by television receiver manufacturers. And there couldn't be a truer word spoken. Many people feel that these things have been taken too far already. Bringing down prices is fine from one point of view but it's a far from unmixed blessing if it entails, for example, lack of d.c. restoration and d.c. amplification, plus synchronizing arrangements so poor that the picture won't lock unless the signal is bang up to the mark. Myself, I believe that large numbers of folk would gladly pay a bit more for sets that didn't suffer from these shortcomings and whose pictures remained without flutter when aeroplanes were passing by.

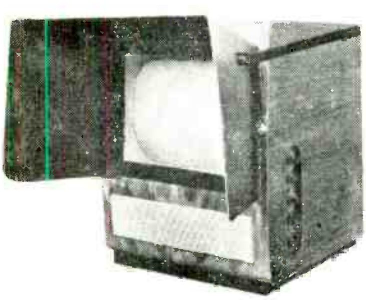
The Tape-Recorder Cult

THE tape-recorder is, I suppose, the lineal descendant of the Dictaphone and other similar machines designed originally purely for office use. To-day, tape recording has become a hobby whose addicts are every bit as enthusiastic as were the fans of the early days of wireless. To the musical it is of course a great joy to be able to make a record (I nearly wrote "recording"!) of any outstanding broadcast and to have it available when wanted. I must have been quite an early user of the

Dictaphone. Years ago I used to answer a vast number of letters. It was, as you may imagine, the greatest possible convenience to be able to get a few off my chest whenever I felt so minded by dictating my replies into the machine. Once, though, there was a sad mishap. While on a fishing holiday in Devon I recorded a big batch and posted the wax cylinders to my typist. Light-hearted P.O. sorters must have had fun and games with the parcel, for it arrived with all the records in more or less powder form. That, anyhow, couldn't happen with tape.

Balanced or Unbalanced

WHEN television broadcasting was in its youth, I think I'm right in saying that the great majority of receivers were designed for use with balanced twin aerial feeders. To-day all (or very nearly all) use co-axial feeders. I'm told that this means a small reduction in manufacturing costs; if so, I wonder whether it's worth it. Interference seems to become worse and worse and a good deal can be picked up by a co-axial feeder, even though its metallic sleeve is earthed. But balanced twin, with earthed metallic screen and correct impedance matching, picks up little or none; use it and, if need be, a mains suppressor and you'll get no interference except what is actually picked up by the aerial itself. Some time ago I was using an "H" aerial over 100ft from the nearest road and nearly 60ft above its surface. Motor-car interference was a nuisance with a coaxial feeder in use; a change to balanced twin, with the necessary alterations to the receiver and careful impedance matching made all the difference in the world.



TELEVISION SCREEN MASK for shielding the tube face when viewing in daylight or with the room lighting on. Made from compressed fibre material with a light-absorbent inside lining, it is fixed to the front of the set by rubber suckers and secured by an elastic strap. Available from Vendoma (TV), Station Buildings, Preston Park, Brighton, in sizes for 12-in, 14-in, 15-in and 17-in receivers.

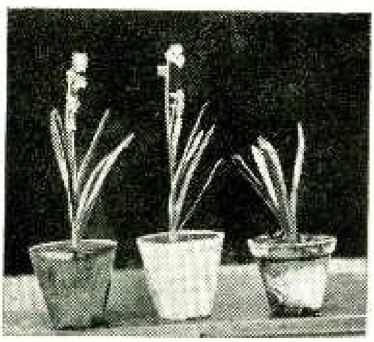
UNBIASED | By FREE GRID

Peccavi

IN the June issue I mentioned that I was going to try to accelerate the growth of plants in my garden by exposing them to the radiations of an r.f. oscillator. I had been interested in an item of news received from the U.S.A. which said it had been noticed that in the neighbourhood of high-powered television transmitters a veritable jungle of luxuriant undergrowth had sprung up.

I found I was quite mistaken in thinking that there was anything new in this as I have been sent several photographs (one of which is reproduced) and data concerning the growth of r.f.-nurtured plants as far back as 1939. The two hyacinths on the left of the picture received radio treatment (50 Mc/s) and flowered 15 days earlier than the untreated one shown with them. I can only say I feel ashamed of my own ignorance.

In the June issue I also discussed early talking machines and a reader has tried to put me on the penitent's stool for this by implying that I said that needles and not sapphires were *invariably* used with disc records. To



Electronics in the garden.

prove me wrong he has sent me an Edison sapphire-using disc but adds "I see that, with true legal caution, you have left yourself a loophole."

What I certainly did *not* know was that some *disc* machines used a screwed rod to propel the sound box across the record. I thought that with discs this was invariably done by the needle running in the groove as in modern machines. This is not so, however, and the makers of the record took pride in announcing that the grooves were too shallow to have the task thrown on them of pushing the sound box along; records are made of sterner stuff nowadays.

Mummified Music

I WAS very impressed by the demonstrations given in the Royal Festival Hall in May of the degree of hi-fi which can be achieved in mummified music by modern methods of recording and reproduction. It is given to a very few to be able to listen to a chronologically and topographically side-by-side comparison of the real thing and an embalmed version of it. Despite the fact that the hall was packed to capacity, the audience was very small compared with the number who would have liked to be there.

It is unthinkable that there should not be a repeat performance in a few months' time and I have been trying to think of a method whereby a larger audience could be reached. Mrs. Free Grid made the tom-fool suggestion that the B.B.C. should be asked to put it on the air. Apparently it did not occur to her that the music-mangling properties of the ordinary domestic wireless receiver would reduce the living and the mummified performances to the same low level; in fact, the embalmed version could be made to sound better than the real thing, for special recordings could be made to compensate to some extent for the deficiencies of the average set.

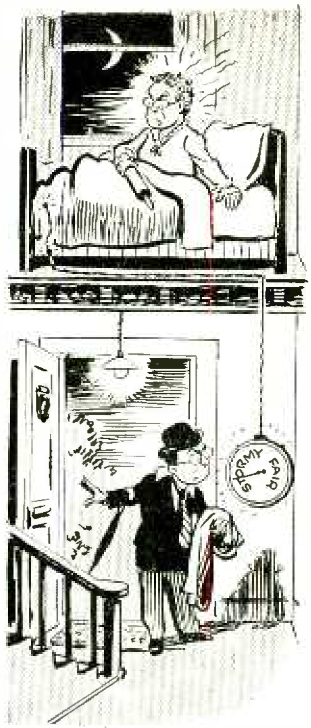
In a few years' time when there will be a hi-fi receiver in every listener's home it will be a different thing. But even to-day the number of f.m. set owners is certainly much greater than the seating capacity of the Royal Festival Hall. To hear the programme on v.h.f. would certainly not be the same as hearing it in the flesh.

All the same, I for one am willing to agree not to apply for a ticket for the next demonstration but to listen at home and let my seat be occupied by somebody less fortunate than myself who is at present beyond the reach of v.h.f. either for geographical or financial reasons. I, therefore, appeal to all other f.m. people to make a similar offer and to the organizers of the demonstration to approach the B.B.C. in the matter.

Electronic Morphimeter

I WAS interested to learn that an electronic device has been developed for gauging the depth of sleep or unconsciousness by measuring the skin resistance, which apparently varies in step with it. Surely this should have many applications other than the medical one mentioned. Apart from its obvious use in the boxing ring where it would enable the referee to see at a glance the exact condition of a recumbent pugilist it supersedes the existing form of baby alarm first described in this journal nigh on thirty years ago.

This old type alarm, as you may



Further outlook unsettled.

remember, consisted of a mike suspended over the cot so that the nasty noises emitted by a baby are conveyed to the doting parents below. With this new device the changing resistance of the baby's skin as it approaches bawling point could obviously be caused to operate the alarm, thus obviating the mental trauma which a well-known psychiatrist has stated that babies receive when their immediate wants are not anticipated.

I would like to point out, however, that this idea of a morphimeter is not quite as new as it seems. The varying skin resistance on which its action depends is caused, I understand, by the fact that the rate of metabolism in the body changes according to the degree of unconsciousness. This changing rate of metabolism not only varies the skin resistance but has the same effect on the dielectric constant of the body.

Long years ago I fixed up a capacitor, the two electrodes of which were the bedspring and the wire mesh of an electric blanket which Mrs. Free Grid always uses. Her body was, of course, the dielectric and I found that the capacitance of my crude device varied according to the depth of her sleep. I put this to practical use by causing it to operate an indicating meter downstairs so that on those occasions when I was detained late at the office I could avoid creeping upstairs to bed until I was assured that she was really sunk in a deep sleep.

AVO VALVE Characteristic METER Mk III

The AVO Valve Characteristic Meter Mark III offers the Radio Engineer far more than is generally implied by the words "a valve tester".

This compact and most comprehensive Meter sets a new high standard for instruments of its type. It will quickly test any standard receiving or small transmitting valve on any of its normal characteristics under conditions corresponding to a wide range of D.C. electrode voltages.

A new method of measuring mutual conductance ensures that the instrument can deal adequately with modern valves of high slope and short grid-base such as are commonly used in T.V. receivers.

List Price
£75

A comprehensive Instruction Book and detailed Valve Data Manual are provided.

PROVIDES all necessary data to enable Ia/Va, Ia/Vg, Ia/Vs, etc., curves to be drawn.

MEASURES mutual conductance up to 30mA/V.

DETERMINES inter-electrode insulation with heater both hot and cold.

GIVES direct measurement of "gas" current.

TESTS rectifying and signal diodes under reservoir load conditions.

COVERS all normal heater voltages up to 117V.

CIRCUIT improvements provide accurate setting and discrimination of grid voltage over the full range to 100V negative.

A relay protects the instrument against damage through overloading the H.T. circuits and also affords a high measure of protection to the valve under test.

The instrument is fitted with a hinged fold-over lid which protects the valve holders when not in use.

Regd. Trade Mark

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.

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

V.C.4.

RELAYS

SERIES
595 H

HERMETICALLY SEALED

SERIES 595 H

This is a hermetically sealed version of our series 595 Relay, which is already well known to the aircraft industry.

The armature design reduces the effects of shock, vibration and acceleration ; a spring type armature hinge eliminates backlash, friction and risk of displacement.

COIL: In all standard voltages up to 110 V. D.C. Working range between plus 10% and minus 20% of rating.

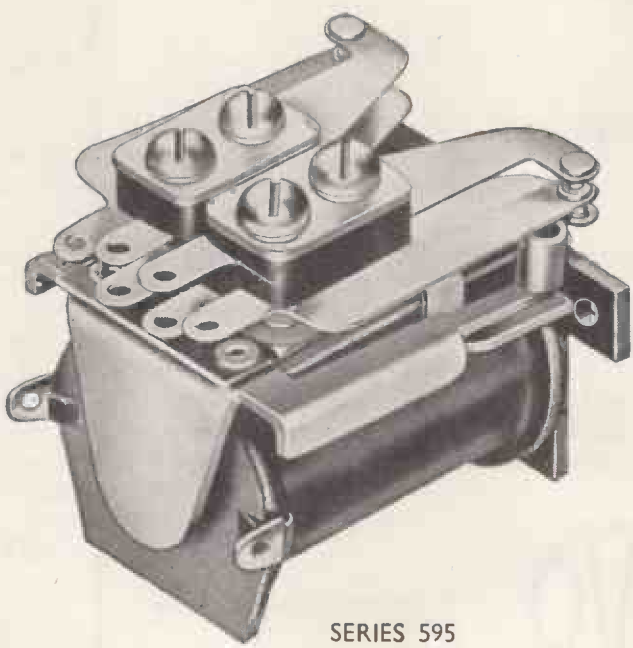
CONTACT COMBINATIONS: up to 2 pole changeover.

BASE: International octal.

WEIGHT: $3\frac{1}{4}$ ozs.

DIMENSIONS :

Diameter—$1\frac{11}{16}$" overall.
Height — $2\frac{5}{8}$" overall.



SERIES 595

MAGNETIC DEVICES LTD
NEWMARKET

MD4A

RECTIFIERS *to meet your* HIGH VOLTAGE *requirements*

XENON RANGE

. . . quick heating-up time . . . freedom from effects of ambient temperature . . . any mounting position . . . suitable for fixed and mobile equipment.

MERCURY VAPOUR RANGE

. . . zirconium coated anode . . . minimum bombardment of cathode . . . extremely long life.

ABRIDGED DATA (All Half-wave Rectifiers)

	Type No.	British Services Type No.	Base	Vf (V)	If (A)	P.I.V. Max. (kV)	ia (pk) Max. (A)	Ia (av) Max. (A)	Ambient Temperature Range (°C)
XENON	RR3—250	CV1835	4-pin UX	2.5	5.0	10 / 5	1.0 / 2.0	0.25 / 0.5	−55 to +75
XENON	RR3—1250	CV2518	B4F	5.0	7.1	10	5.0	1.25	−55 to +70
MERCURY VAPOUR	RG1—240A	CV1626/1072	British 4-pin	4.0	2.7	6.5	1.25	0.25	+10 to +40
MERCURY VAPOUR	RG3—250	CV1625	Medium Edison Screw	2.5	5.0	10	1.0	0.25	+10 to +40
MERCURY VAPOUR	RG3—250A	CV32	4-pin UX	2.5	5.0	10	1.0	0.25	+10 to +40
MERCURY VAPOUR	RG3—1250	CV1629/152	Goliath Edison Screw	4.0	7.0	13	5.0	1.25	+10 to +40
MERCURY VAPOUR	RG4—1250	CV5	Goliath Edison Screw	4.0	11	13	5.0	1.25	+10 to +40
MERCURY VAPOUR	✻ 872A	CV642	B4F	5.0	7.5	10	5.0	1.25	+10 to +40

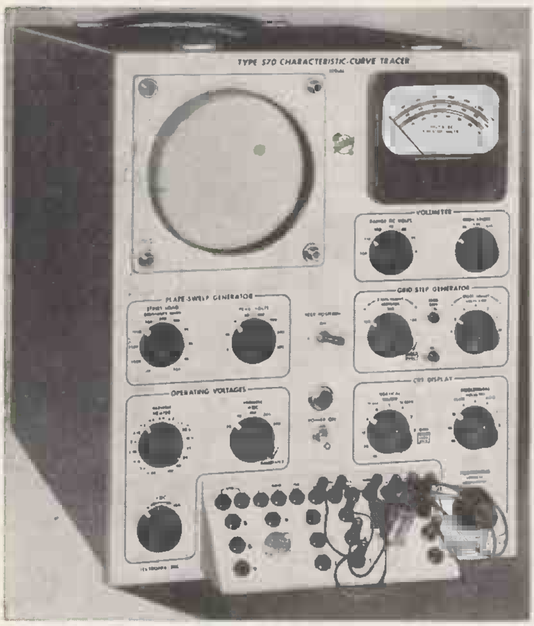
✻ Supplied for replacement purposes

Mullard

MULLARD LTD · COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT
CENTURY HOUSE SHAFTESBURY AVENUE LONDON W.C.2

MVT 159

NEW CHARACTERISTIC-CURVE TRACER...*Type 570*



Pictures Dynamic Vacuum-Tube Characteristics

The Tektronix Type 570 Characteristic-Curve Tracer presents an accurate graphic analysis of vacuum-tube characteristics under almost any conceivable operating conditions. Circuit design can now be tailored to more closely fit the operating characteristics of available tubes. Tubes can be selected faster and more accurately for circuits requiring other than average vacuum-tube operating characteristics. Two-socket arrangement with front-panel switching permits rapid comparisons between any two tubes, or two sections of the same tube. You can also make rapid comparisons with pre-selected curves outlined on a crt mask. Patch-cord connector system with socket-adapter plates gives you complete control of operating-condition setup. Various socket-adapter plates furnished and wide range of heater voltages available fit the requirements of practically all receiving-type vacuum tubes.

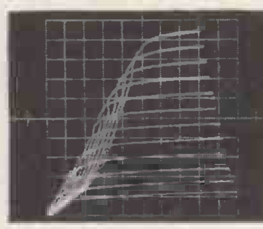


Fig. 1
Plate current—plate voltage

Fig. 3
Grid current—plate voltage.

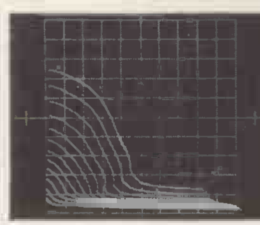


Fig. 2
Screen current—plate voltage

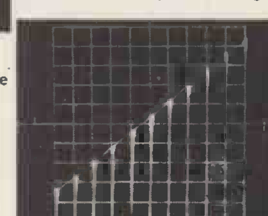


Fig. 4
Plate current—grid voltage

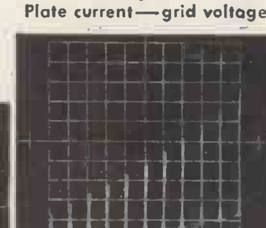


Fig. 5
Screen current—grid voltage

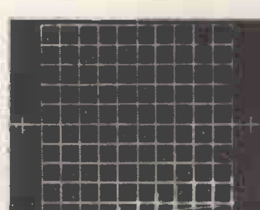


Fig. 6
Grid current—grid voltage

Displays Families of Curves on CRT Screen

Choice of four to twelve characteristic curves per family — with as many as eight positive-bias curves per family.

Plots All Important Characteristics

Plate current against plate voltage.
Plate current against grid voltage.
Screen current against plate valtoge.
Screen current against grid voltage.
Grid current against plate voltage.
Grid current against grid voltage.

Calibrated Controls

Accurote current and voltage readings directly from the crt screen.

Wide Display Range

11 current ranges from 0.02 ma/div to 50 ma/div.
9 voltage ranges from 0.1 v/div to 50 v/div.
11 series-load resistors from 300 ohms to 1 megohm.
7 grid-step values from 0.1 v/step to 10 v/step.

Price—$925

f.o.b. Portland (Beaverton), Oregon

Type 570—£357, delivered in Britain, plus duty if applicable.

Please call your Tektronix Field Engineer or Representative for complete specifications, or write direct.

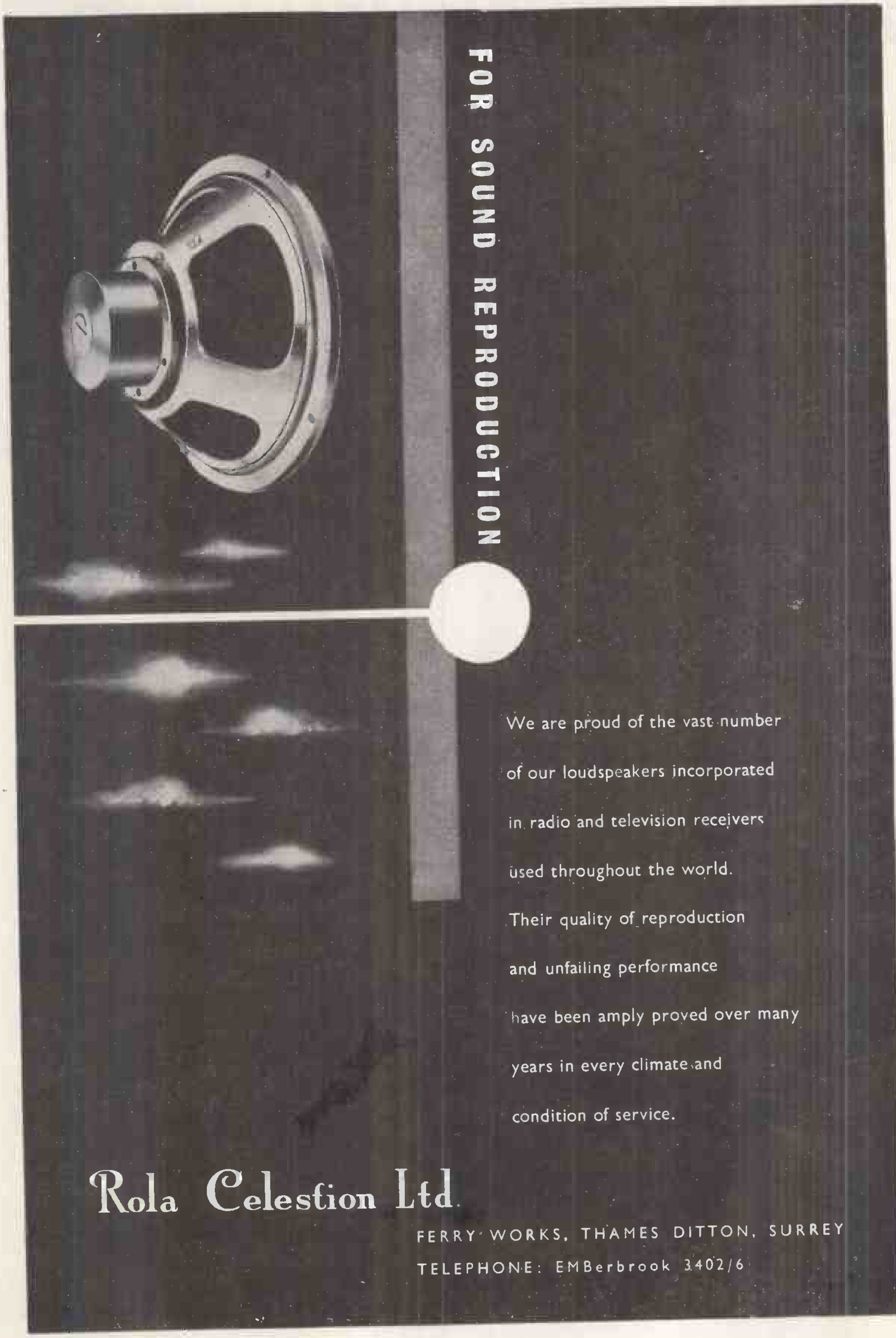
Series of pentode characteristic curves with grid voltage changing 2 volts/step from +16 v to below zero, illustrating Type 570 operation with eight positive-bias curves per family. Vacuum tube is a 6AQ5, under these conditions: Plate load... 300 ohms, peak plate voltage... 100 v, screen-grid voltage... 100 v, vertical scale ... 10 ma/division, horizontal scale, fig. 1, 2, and 3... 10 v/division, fig. 4, 5, and 6... 2 v/division.

Represented in London by Livingston Laboratories, Ltd., Archway 6251

Tektronix, Inc.

P. O. Box 831D, Portland 7, Oregon

CYpress 2-2611 **Cable: TEKTRONIX**


FOR SOUND REPRODUCTION
We are proud of the vast number of our loudspeakers incorporated in radio and television receivers used throughout the world. Their quality of reproduction and unfailing performance have been amply proved over many years in every climate and condition of service.
Rola Celestion Ltd.
FERRY WORKS, THAMES DITTON, SURREY
TELEPHONE: EMBerbrook 3402/6

OHMS? RATING? TOLERANCE?

... it's easy with

LAB TESTED

Continuous Storage Units

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.

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%					

THE LAB (TESTED) CONTINUOUS STORAGE UNITS

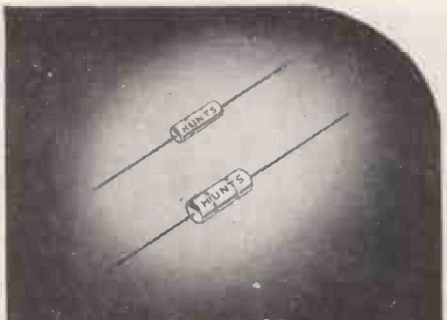
are available from your normal source of supply, but more detailed information and literature can be obtained from:

THE RADIO RESISTOR COMPANY LIMITED

50 ABBEY GARDENS · LONDON · N.W.8 Telephone: Maida Vale 5522

REVOLUTIONARY

in design— and performance!



TYPE W97

HUNTS "THERMETIC" MIDGET METALLISED PAPER CAPACITORS WITH A TRUE HERMETIC SEAL

FULLY APPROVED TO JOINT SERVICES STANDARD R.C.S.136/A CATEGORY 40/100, CLASS H.1.

TEMPERATURE RANGE: −100°C to +100°C

The W97 capacitor, although of diminutive size, is an extraordinarily robust unit. Most miniature units are prone to weakness in end connections and general mechanical flimsiness. Such undesirable features are eliminated in the W97 by the special processes used and extreme care in manufacture.

CAPACITOR UNIT

A single metallised paper is used to wind this unit which is made possible by the use of Hunt's Patent covering the "castellated" pattern. Recent development by Hunt on a special impregnating material gives the unit remarkable brackets of operating temperature.

CASING

Hunt's patented double metal tube, sealed with the special "Thermetic" compound, provides positive closure on the casing and lead entry, ensuring positive hermetic sealing.

INSULATION OF CASING

The capacitors are supplied without an insulating medium on the case. If specially requested they can be supplied with an approved plastic sleeve which increases the dimensions by 0.07" in length and 0.03" in diameter.

TERMINATIONS

The terminations are of 24 gauge tinned phosphor bronze wire having a nominal length of 1½". Special attention is paid to the retinning of the wires after the capacitor is fully processed. Connection is made to the unit by applying copper spray to the metallising. The pigtail is soldered to this bond giving a perfect connection of exceptional strength.

INDUCTANCE

W97 "Thermetic" Midgets have a very high self resonant frequency—the following figures are quoted as a guide. 50 pF at 600 volts, which is the lowest capacitance in the range, has a self resonant frequency of 280 megacycles. At the other end of the range, 0.04 µF 200 volts, which is the maximum capacitance, it is 8.5 megacycles.

INSULATION RESISTANCE

This is measured at working voltage at a temperature of 20°C. The minimum capacitance in the range, 50 pF at 600 volts, has an insulation resistance greater than 2,000,000 megohms. The maximum capacitance in the range 0.04 µF at 200 volts, has an insulation resistance greater than 25,000 megohms. The intermediate capacitances are approximately pro rata.

POWER FACTOR

Less than 2% at 1,000 cycles per second at 20 C.

CAPACITANCE TOLERANCE

Standard ± 20%. Closer tolerances are available, for capacitances exceeding 500 pF.

TYPE W97 STANDARD RANGE

LIST NO.	CAP µF.	DIMENSIONS (inches) L.	D.
	200 volts D.C.	Wkg.	
BM7	0.002	0.610	0.135
BM8	0.004	0.610	0.135
BM11	0.004	0.500	0.180
BM9	0.005	0.610	0.135
BM12	0.005	0.500	0.180
BM13	0.01	0.500	0.180
BM14	0.02	0.610	0.180
BM15	0.03	0.610	0.260
BM16	0.04	0.610	0.260
	400 volts D.C.	Wkg.	
BM4	0.0004	0.610	0.135
BM5	0.0005	0.610	0.135
BM6	0.001	0.610	0.135
BM18	0.002	0.500	0.180
BM19	0.003	0.500	0.180
BM20	0.005	0.610	0.180
BM21	0.01	0.610	0.260
	600 volts D.C.	Wkg.	
BM25	50 pF.	0.500	0.180
BM1	0.0001	0.610	0.135
BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
BM27	0.0002	0.500	0.180
BM28	0.00022	0.500	0.180
BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
BM33	0.002	0.610	0.260
BM34	0.003	0.610	0.260
BM35	0.004	0.610	0.260

W97 IS A 'MUST'
for the
MAKERS OF ELECTRONIC EQUIPMENT

A. H. Hunt (Capacitors) Ltd, Wandsworth S.W.18 · BAT 1083
And in Canada: HUNT CAPACITORS (Canada) Ltd., AJAX, ONTARIO.

REGISTERED TRADE MARK
HUNTS
CAPACITORS
THE TRADE MARK OF RELIABILITY

Valves for Industry
R.F. Heating

The increasing use of R.F. Heating in industry has shown the need for units to provide outputs between 10 and 50 kW

To meet this demand, the English Electric Valve Company have developed two new valves for R.F. generators of 10 kW and upwards. These new products are not modifications of valves used for communications, but are designed expressly for operation under the less favourable conditions imposed by factory use. They are rugged and will withstand severe overloads; they are low in first cost and have a long service life. Both types are available in air-cooled or water-cooled versions and a suitable range of rectifying valves for use in conjunction with them is also available.

'ENGLISH ELECTRIC'

Type	Maximum Operating Frequency at Full Rating (Mc/s)	Cathode	Dimensions (*maximum*) Length mm.	Dimensions (*maximum*) Diameter mm.	Filament Volts	Filament Amperes	Maximum Anode Voltage kV.(D.C.)	Maximum Anode Dissipation (Kilowatts)	Useable Emission (Amperes)	Amplification Factor	Mutual Conductance (mA/V)
BR. 1102	50	Th.	483	241	8·2	230	12·0	20·0	45	42	20·0
BW.1102	50	Th.	473	152	8·2	230	12·0	20·0	45	42	20·0
BR. 1103	100	Th.	356	203	6·0	120	8·5	10.0	16	25	8·3
BW.1103	100	Th.	343	116	6·0	120	8·5	10·0	16	25	8·3

NOTE: CATHODE:—Th. *denotes* THORIATED TUNGSTEN. BR. *denotes* AIR-COOLED. BW. *denotes* WATER-COOLED.
Technical data sheets are available on request.

ENGLISH ELECTRIC VALVE CO. LTD. EE *Waterhouse Lane, Chelmsford Telephone: Chelmsford 3491*

AP 300-20

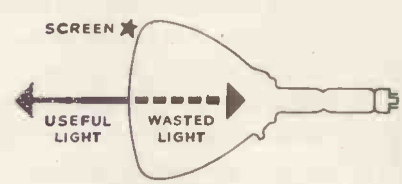
This ALUMINIZED Picture tube gives

60% brighter pictures more contrast extra tube life

AN Ediswan Mazda aluminized picture tube gives a picture 60% brighter and more contrasty than is possible with an ordinary tube.

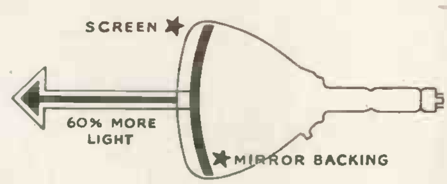
In addition, Ediswan aluminizing protects the screen from ion burn and, with the new Ediswan ion trap tetrode gun to protect the cathode, tube life is increased.

Ediswan production methods, which include the special in-line vacuumizing system, ensure a higher, more uniform standard of lasting efficiency. For complete satisfaction demonstrate and recommend Ediswan Mazda aluminized picture tubes.



WITHOUT ALUMINIZING

Without aluminizing, tubes waste half their light (see diagram above). To counteract this the brilliance must be increased and the tube life is shortened.



WITH EDISWAN ALUMINIZING

Ediswan aluminized tubes have a mirror backing to the screen. All the light is thus thrown forwards giving brighter, clearer pictures and extra life.

RV9

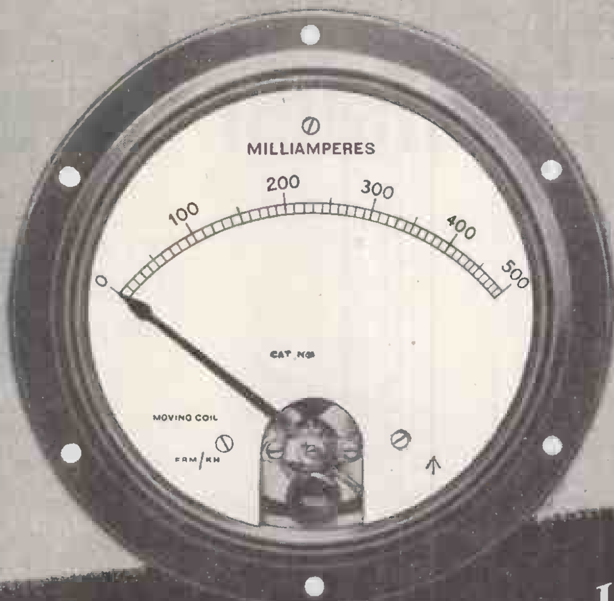
EDISWAN
MAZDA

ALUMINIZED CATHODE RAY TUBES

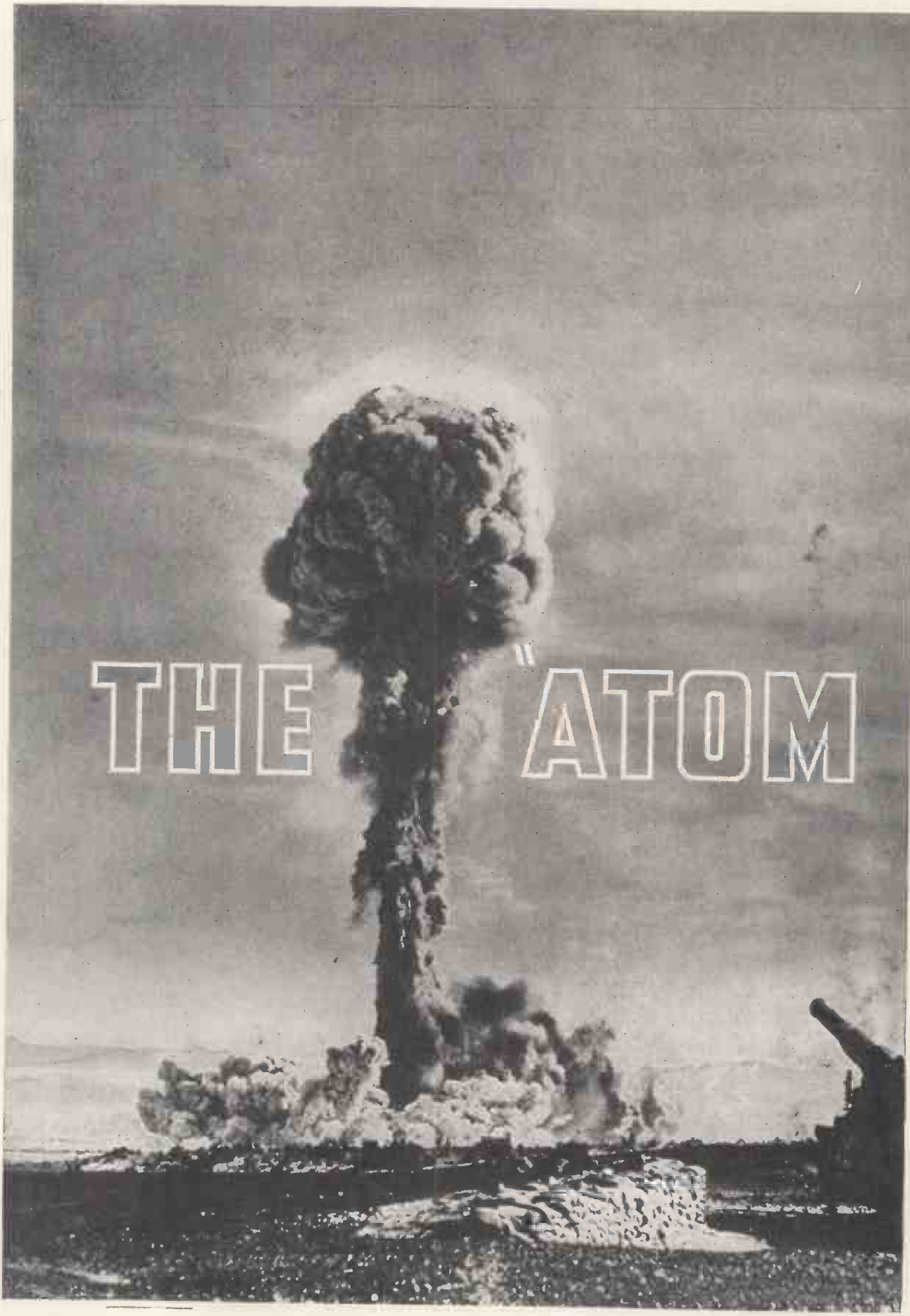
THE EDISON SWAN ELECTRIC COMPANY LIMITED, 155 Charing Cross Road, London, W.C.2 and Branches.
Member of the A.E.I. Group of Companies.

NATION WIDE SERVICE

6 fully equipped cathode ray tube service depots provide better, quicker tube testing should the need arise. Stocks of tubes are available in 26 Ediswan Offices. Only Ediswan give such complete backing to the Trade.


MILLIAMPERES
0
100
200
300
400
500
MOVING COIL


B.C.C. V.H.F. Mobile Radio
Tilbury
SEVENOAKS
Hadlow
Paddock Wood
Staplehurst
Cranbrook


THE ATOM

A NEW TECHNIQUE IN HIGH SPEED WAVEFORM MONITORING

BANDWIDTH:
10 kc/s to 300 mc/s

INPUT IMPEDANCE OF EACH PROBE:
Approx. 1 pf (input element of variable capacity divider)

MAXIMUM SENSITIVITY:
Full Scale Deflection for 1 Volt input

TIME SCALE:
Variable from .05 microsecs to 5 microsecs

RECURRENCE RATE OF MONITORED WAVEFORM:
100 c/s to 10 kc/s

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

PREVENTION OF JITTER:
A circuit is incorporated for providing a stable display when a monitored waveform is jittering with respect to its driving pulse.

HIGH SPEED RECURRENT WAVEFORM MONITOR TYPE 500

The wide bandwidth and high sensitivity of the instrument as well as the very high input impedance result from the use of a sampling technique. During each recurrence a measurement is made of the instantaneous amplitude of one point in the waveform. This measurement is amplified and applied to the cathode ray tube as one co-ordinate of a graph of the waveform. During subsequent recurrences, instantaneous measurements are made of different points, resulting, after about 100 recurrences, in a complete graph

Please write for further information.

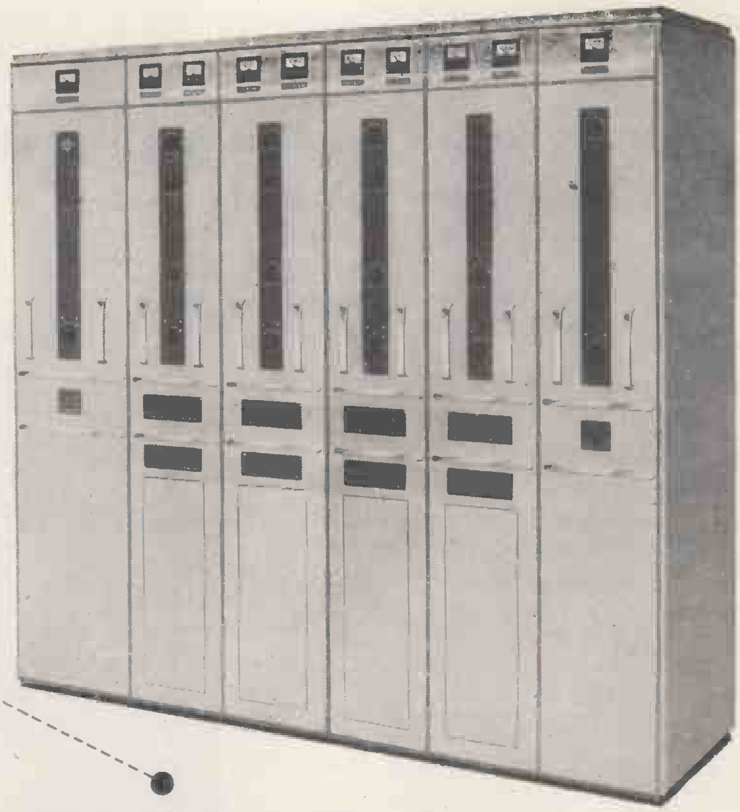
METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

Member of the AEI group of companies

Leading Electrical Progress

43428

R/E401



2-3 kW Channelised Transmitter

The GFT.560/2 is a 2-3 kW channelised transmitter with a frequency range of 1.5-30 Mc/s. It consists of three basic cabinets—r.f. unit, modulator unit, and power supply unit–combinations of which can be used to provide multi-frequency working as well as a number of different types of emission. The wave change facilities of the transmitter are both rapid and reliable—a valuable asset when the operating frequency is changed many times each day. The GFT.560/2 is fully tropicalised, and its unit construction facilitates future expansion of the initial installation, should the need arise.

For use in conjunction with the GFT.560/2 there are ancillary units that enable the transmitter to be remotely controlled over a two wire telephone circuit: operational adjustments are dialled to the transmitter.

The versatility and reliability of this new Mullard transmitter make it particularly suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. A team of Mullard communication engineers is available to advise on the use of the GFT.560/2 in such applications.

ABRIDGED DATA *Frequency Range* 1.5—30 Mc/s *Frequency Stability* To Atlantic City 1947 standards *Power Output* 3kW. c.w., 2kW m.c.w. or r/t *Types of Emission* c.w., m.c.w., telephony, frequency shift A,1, A2, A3, F1 *Output Impedance* 600 ohms balanced twin feeder *Power Supply* 400V, 50-60 c/s, 3-phase.

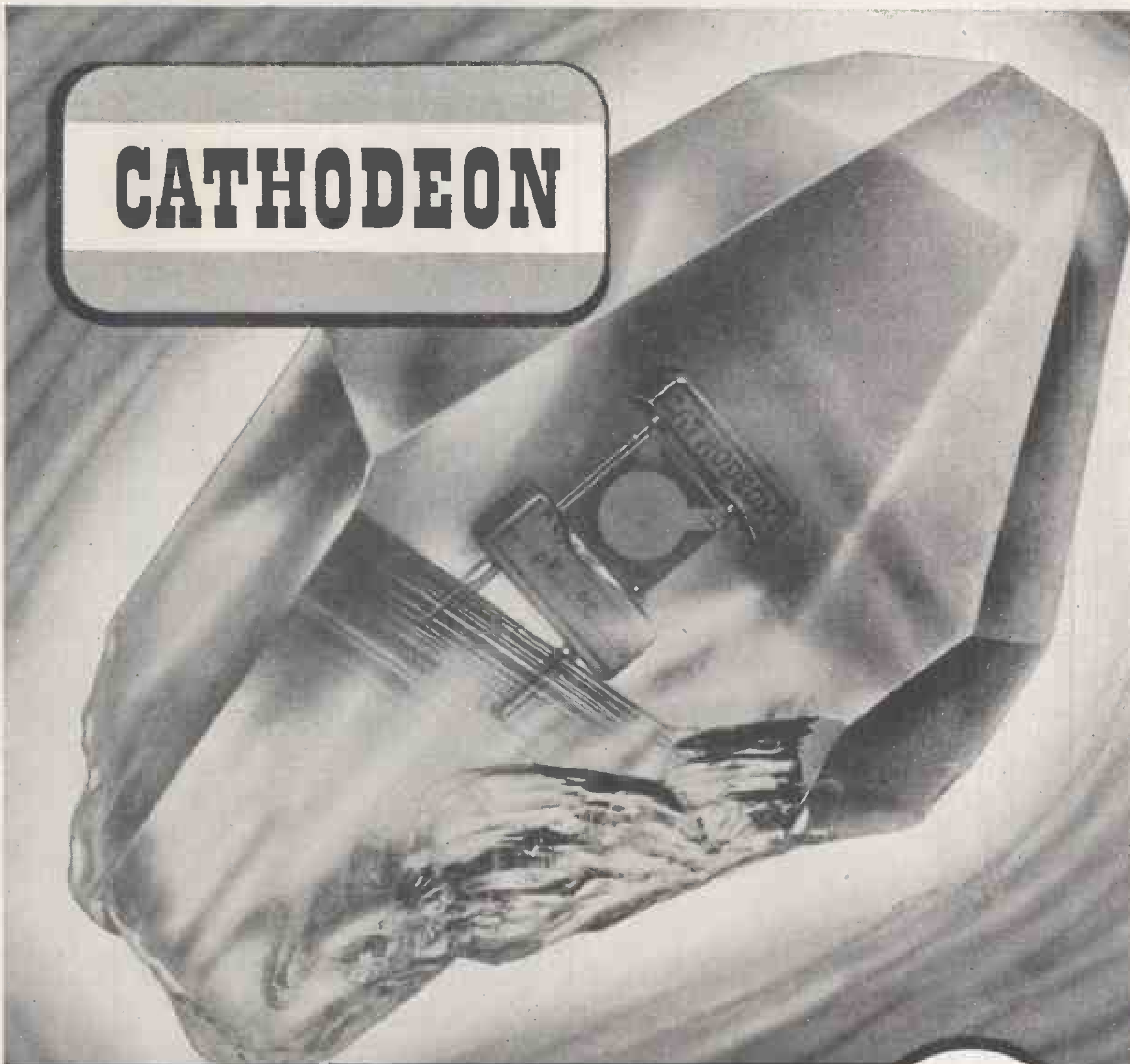
Mullard Mullard

SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LIMITED · EQUIPMENT DIVISION · CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON · WC2

(MI469)

CATHODEON



Quartz Crystals

FOR RELIABLE FREQUENCY CONTROL

Prompt Delivery, all types, 2,000—20,000 kc/s

When ordering 10X replacements, why not use our hermetically sealed Type 2XL?

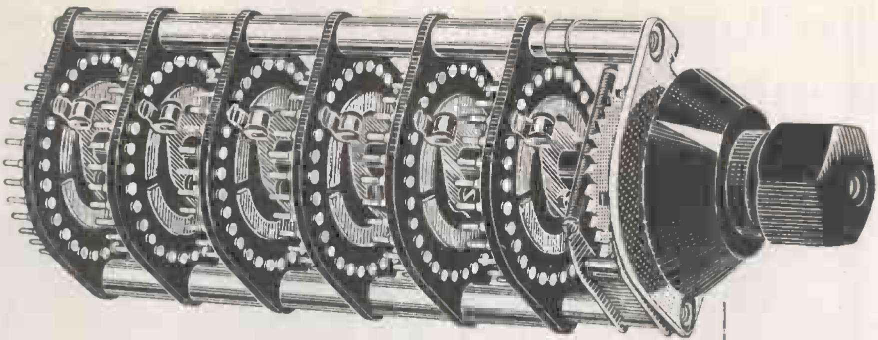
CATHODEON CRYSTALS LIMITED

LINTON · CAMBRIDGESHIRE · Telephone LINTON 223


Garrard
301
TRANSCRIPTION MOTOR
Features that the enthusiast will appreciate are the suppression of switch clicks, the extra heavy balanced turntable, and the very fine degrees of speed control available. Each of the nominal speeds, 78, 45 and 33⅓ r.p.m. can be adjusted by approximately 2½%. Wow and Flutter have been reduced to less than 0.2% and less than 0.05% respectively. The model is equipped for dual voltage ranges of 100 to 130 and 200 to 250 volts, 50 or 60 cycles according to the motor pulley fitted. The 301 is finished in quality grey tone enamel, is fully tropicalised and is supplied complete with plastic stroboscope, special grease, all fixing screws, washers, template and instruction manual.
Supplies are limited, see your dealer now.
GARRARD ENGINEERING AND MANUFACTURING CO. LTD.
GARRARD

PAINTON

By Appointment to the Professional Engineer



PAINTON WINKLER SWITCH

VOLTAGE RATING: 250 volts A.C./D.C. (maximum).

CURRENT RATING: 0.5 amp. (maximum).

Switching up to 29 positions (single-pole) per bank, or up to 30 positions per bank for 360° rotation.

SINGLE, DOUBLE, THREE-POLE or FOUR-POLE.

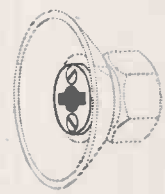
Painton Winkler Switches can be supplied for either 'Make-before-Break' or 'Break-before-Make' operation.

1-6 BANKS OPERATED FROM A COMMON SHAFT.

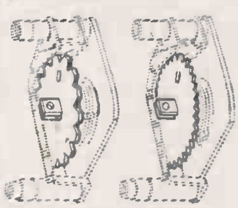
Each switch has an adjustable stop device, by which the switch can be set to the number of positions required.

AVERAGE CONTACT RESISTANCE: BETTER THAN 0.004 OHMS.

The distinctive Painton knob type K21, with the 'adjustable skirt' feature has been specially designed to operate Painton Winkler Switches.

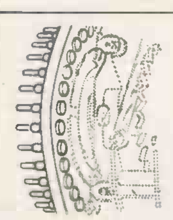


The white pointer can easily be lined up with dial markings. The friction-plate can be loosened by two screws, allowing the skirt of the knob to rotate.

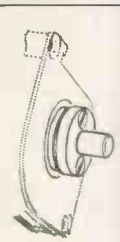


'Break-before-Make' or 'Make-before-Break' operation.

The 'direct-link' wiper provides a low capacity and inductance connection between the individual contact studs and the collector ring, and because the wiper is freely pivoted a constant and even contact pressure is obtained.



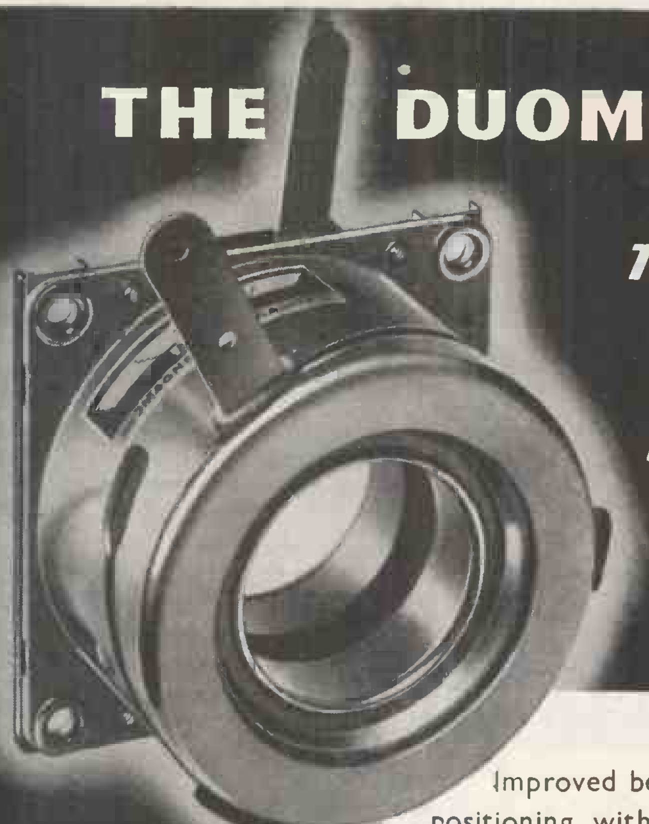
The contact studs are moulded into the nylon-filled phenolic resin panel, and though normally Silver-plated, can be specially Rhodium-plated if required. The rigid stems of the contact studs are tinned to facilitate soldering connections.



The number of operating positions can be altered. Two stop plates can be adjusted by loosening a friction-plate clamped by two screws.

PAINTON
Northampton England

THE DUOMAGNETTE



THE LATEST ELAC FOCALISER

Improved beam focus and picture positioning with minimum effect on scan coils and ion trap assemblies.

- **Fitted with latest type dual "Magnadur" sintered Oxide Magnets.**
- **Magnets DO NOT ROTATE during adjustment.**
- **Friction damping ensures smooth positive movement without backlash.**
- **Rapid and easy adjustment of focus and picture position.**

RETAIL PRICES IN U.K.

Type FD12/90 (Low flux)	....	**22/6**
Type FD13/90 (Medium flux)	....	**23/-**
Type FD14/90 (High flux)	....	**25/-**

Leading the field in T/V components

ELAC

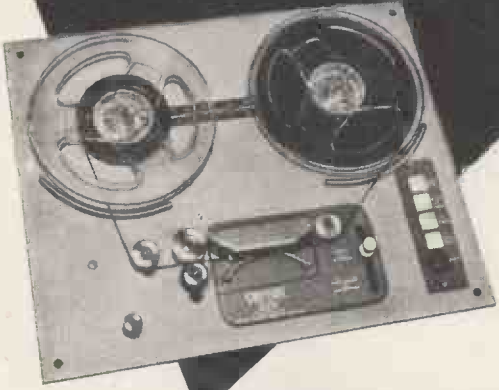
ELECTRO ACOUSTIC INDUSTRIES LIMITED

Stamford Works, Broad Lane, Tottenham, N.15

Telephone : TOTtenham 0505-7

TRUVOX

TAPE RECORDER COMPONENTS AND ACCESSORIES



TAPE DECKS MARK IIIU SERIES

Technically identical with the world-famous Deck supplied, in bulk, to Recorder Manufacturers. With B.S.S. sense of tracking, it is fully approved for playback of pre-recorded tapes. List Price remains at 22 gns.

Details of complete recorders incorporating the TRUVOX Tape Deck are available on request.

A TRUVOX PRODUCT

The full range of Truvox Tape Recorder Components and Accessories is listed below—send for fully descriptive leaflets.

TAPE DECKS · AMPLIFIER · RADIO JACKS · FOOT CONTROL · TELEPHONE ADAPTOR · MONOSET & STETHOSET HEADPHONES · CORNER DIFFUSION SPEAKER

TRUVOX LIMITED

Sales Office: 15, LYON ROAD, HARROW, MIDDX.
Tel.: Harrow 9282

Tech. & Service Depts.: 328, THE BROADWAY, STATION ROAD, HARROW, MIDDX. Tel.: Harrow 4455

an open *Invitation* to all manufacturers *of*

Photo Flash Equipment

Deaf Aids

Private Telephone Installations

Amplifiers

D.C. Power Units

Spot Welding Equipment

Test Gear

Magnetisation Equipment

You are invited to regard the TECHNICIANS at DALY as a part of your own technical staff. Non-standard components are invariably a source of worry, therefore the Electrical Industry find the DALY " made-to-measure " service for individual requirements specially helpful and a great time-saver.

For URGENT problems a telephone request will bring us post haste to your factory for consultation without obligation—and you will find our readiness to help both valuable and economic.

DALY ELECTROLYTICS for ELECTRONICS and COMMUNICATIONS . . . MOTOR START . . . RADIO and T.V. . . . are in great demand throughout the world ; send for appropriate pamphlet.

DALY

ELECTROLYTIC CAPACITORS

CONDENSER SPECIALISTS FOR OVER 20 YEARS

DALY (CONDENSERS) LTD., WEST LODGE WORKS, THE GREEN, EALING, LONDON, W.5

Phone : EALing 3127-8-9. Cables : DALYCON, LONDON

A *New* MARCONI

FM SIGNAL GENERATOR

TYPE TF 1077/2

FREQUENCY RANGE 19.7 to 102.5 Mc/s DEVIATION up to 100 kc/s

"MARCONI INSTRUMENTATION"

a technical bulletin published quarterly, is freely available on request. Ask for your name to be placed on the mailing list.

MARCONI INSTRUMENTS

SIGNAL GENERATORS · BRIDGES · VALVE VOLTMETERS · Q METERS · WAVEMETERS
FREQUENCY STANDARDS · WAVE ANALYSERS · BEAT FREQUENCY OSCILLATORS

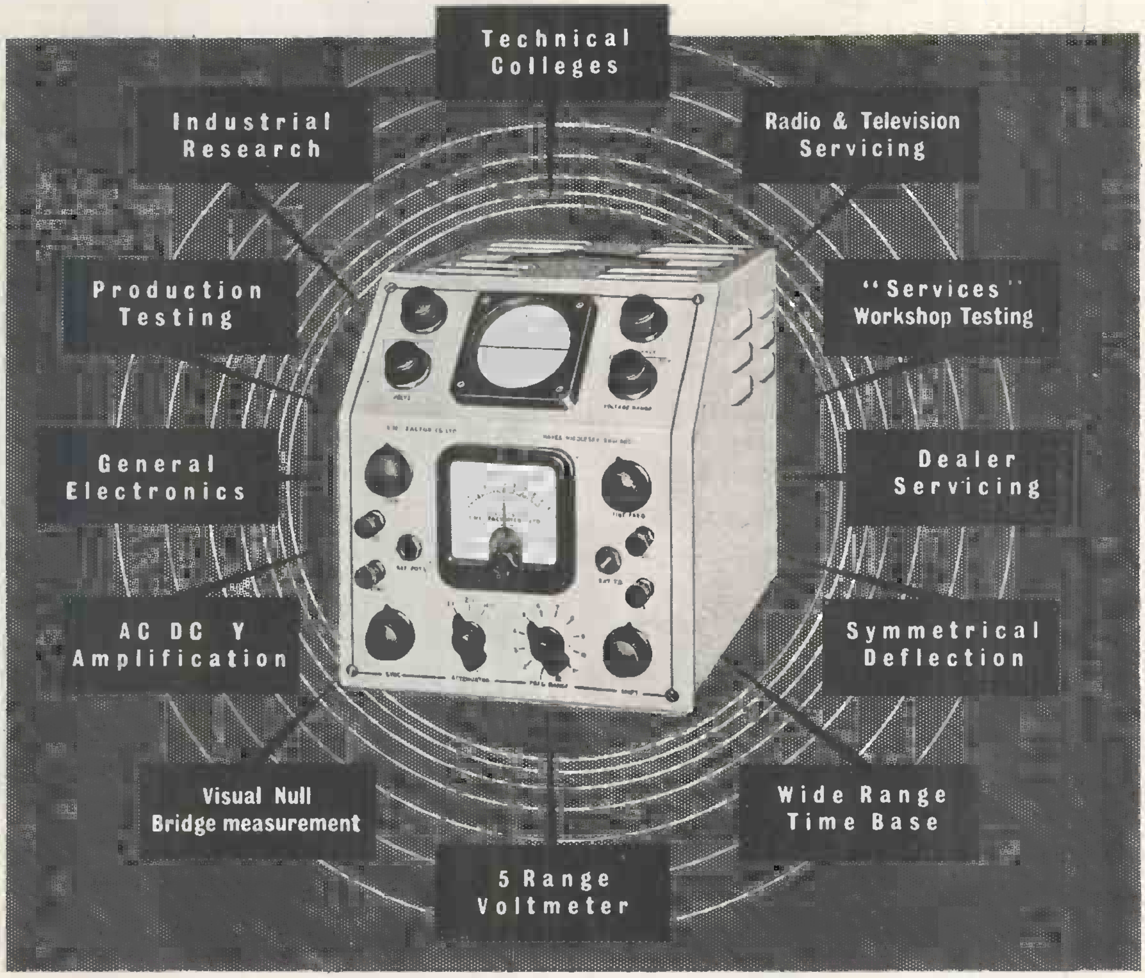
MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · Telephone: ST. ALBANS 6160/9

30 Albion Street, Kingston-upon-Hull. Phone: Hull Central 16144. 19 The Parade, Leamington Spa. Phone: 1408

Managing Agents in Export:
MARCONI'S WIRELESS TELEGRAPH CO. LTD. · MARCONI HOUSE, STRAND LONDON, W.C.2.

TC66

E·M·I NEW MINIATURE MEASURING OSCILLOSCOPE TYPE W.M.I.



SPECIFICATION

ELECTRICAL

Supplies: 110, 120 and 200 to 250 volts A.C. 50/60 c/s. (200-250 volts in 10V steps) 90 watts. **Cathode Ray Tube:** 2½" (6.35 cms.) diameter, green phosphor, medium persistence. **Voltmeter:** Centre zero reading with 4" scale. **Voltage Measurement:** From 0.2 volt to 500 volts A.C./D.C., positive or negative, in 5 ranges. **Y Amplifier:** Single stage push-pull. D.C. coupled. **Deflection Sensitivity:** 1cm/volt. **Bandwidth:** 1-3 Mc/s. **Input Circuit:** D.C. or A.C. coupled. **Maximum input:** 500 volts A.C./D.C., positive or negative. **Attenuators:** 2 : 1, 10 : 1, frequency compensated. **Input Shunt Resistance:** 1 megohm. **External reference potential:** Up to 500 volts, positive or negative. **Time Base:** Internal or External. **Repetition frequency:** 3 c/s to 120 kc/s in 12 ranges. **Horizontal sweep speed:** 0.025 cm/milli-second to 0.5 cm/micro-second. **Synchronisation:** External or Internal. **Saw tooth waveform** available for external use, amplitude 160 to 200 volts.

PHYSICAL

Dimensions: Height 9¼" (23 cms.); Width 8¼" (20.5 cms.); Depth 11½" (29 cms.). **Weight:** 22½ lbs. (9.80 kgs.).
Finish: Silver Grey Hammer.

PRICE £49

For further details apply to:

E·M·I ELECTRONICS LTD

HAYES · MIDDLESEX · ENGLAND · TELEPHONE SOUTHALL 2468 (Ext. 655, 857 & 858)

EE.3

HARTLEY-TURNER SOUND EQUIPMENT

Introducing

THE HARTLEY-TURNER "315" LOUDSPEAKER

Here is the latest product from H. A. HARTLEY COMPANY LIMITED. After many months of tests we are now proud to announce our new "315" Loudspeaker.

This is a 12in. diameter unit with a frequency range from 20 c/s to 15 Kc/s obtained from a special coil and cone assembly. The voice coil impedance is 4 ohms and the power handling capacity is 15 watts. The frequency response is substantially flat over the range 30 c/s—18 Kc/s.

The speaker employs a die cast frame and is manufactured to the same exacting specifications that have made Hartley-Turner products renowned throughout the world.

Modern methods of production enable us to offer this new speaker at

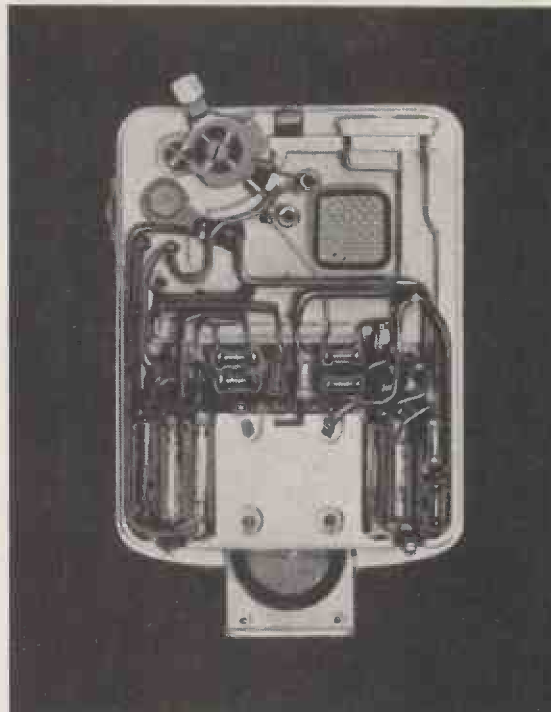
10 GUINEAS

Full details sent free on request to:

H. A. HARTLEY CO. LTD.
152, HAMMERSMITH ROAD, HAMMERSMITH, LONDON, W.6.
Telephone: RIVerside 7387

MULTITONE

SPECIALIZE in equipment for the DEAF and for PHYSIOTHERAPY



Actual Size of the A.V.C. Instrument (Covers removed).

AUTOMATIC VOLUME COMPRESSION

now available in the sub-miniature 4-stage

Transistor "MINUET" Hearing Aid

Multitone were the first to introduce A.V.C. in Hearing Aids in 1936. It has proved essential for:—

1. Cases of deafness with recruitment (Non-linear deafness).
2. The Quality-Conscious deaf who are unable to tolerate overload distortion.

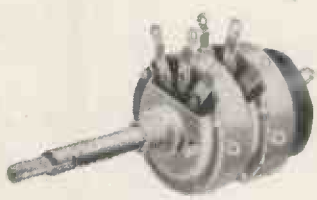
With the Minuet, two degrees of compression can be selected by the user. In addition the instrument is adjusted during fitting to take variations in individual optimum volume requirements.

Weighs only 1½ ounces complete with battery

Inquiries should be addressed to
MULTITONE ELECTRIC CO. LTD.
223-227 St. John Street, London, E.C.1.
PIONEERS IN SOUND AMPLIFICATION

WHY ENGINEERS SPECIFY EGEN potentiometers—

Egen Potentiometers are based on long experience of requirements of television and electronic equipment manufacturers. In design, dependability, accuracy and freedom from wear they are *outstanding*, but, above all, they are completely NOISELESS.



DUAL POTENTIOMETERS with concentric operating spindles. The new Egen Dual Potentiometers incorporate all these outstanding design features — multiple contact rotors, smooth easy movement, thorough screening between sections, plus a convenient soldering tag for earthing screened connections on each metal case. Switch and Potentiometer soldering tags are of high-grade brass heavily silver plated for easy soldering; they are positively located and withstand soldering heat and bending without loss of rigidity. Control spindles can be supplied to suit customers' requirements.

PRE-SET POTENTIOMETERS. Completely enclosed in high-grade phenolic mouldings. Solder tags heavily silver plated for quick soldering. Fully insulated spindles with integral control knobs. Tapped for 2-hole 6 B.A. fixing on ¾" centres. Type 126, wire-wound. Type 127, carbon.

STANDARD CARBON POTENTIOMETERS. Made by an entirely new method ensuring a highly stable resistance element, which is also very durable. Silent and smooth in operation, these controls offer both mechanical and electrical reliability. Soldering tags are heavily silver plated to resist oxidisation, and the mains switch has an efficient quick make-and-break action.

PRE-SET RESISTOR. This has a wire-wound resistance element, traversed by a nickel-silver slider. Adjustment is effected by a worm drive spindle fitted with a knurled and slotted knob. This component is smooth and noiseless in action and is designed to meet the many and varied requirements of the Electronic Industry. Egen pre-set resistors can be supplied in multi-bank assemblies to suit individual requirements. There are also twin-track models, and types with an electrically divided slider, giving adjustment on two resistors with one operation.

EGEN ELECTRIC LTD. Charfleet Industrial Estate, Canvey Island, Essex · Phone: Canvey Island 691/2

MAINS TRANSFORMERS

FULLY INTERLEAVED

SCREENED AND IMPREGNATED. ALL GUARANTEED

ALL PRIMARIES ARE 200/250 v. Half Shrouded.

HSM63 (Midget). Output 250-0-250 v. 60 m/a., 6.3 v. at 3 amps., 5 v. at 2 amps.	16/3
HS63. Output 250-0-250 v. 60 m/a., 6.3 v. at 3 amps., 5 v. at 2 amps.	16/6
HS40. Windings as above. 4 v. at 4 amps., 4 v. at 2 amps.	16/6
Output.	
HS2. 250-0-250 v. 80 m/a.	19/–
HS3. 350-0-350 v. 80 m/a. 19/-. **HS30.** 300-0-300 v. 80 m/a.	19/–
HS2X. 250-0-250 v. 100 m/a., 21/-. **HS75.** 275-0-275 v. 100 m/a.	21/–
HS30X. 300-0-300 v. 100 m/a., 21/-. **HS3X.** 350-0-350 v. 100 m/a.	21/–

Fully Shrouded

FSM63 (Midget). Output 250-0-250 v. 60 m/a., 6.3 v. at 3 amps., 5 v. 2 amps.	16/9
Output	
FS2. 250-0-250 v. 80 m/a.	21/–
FS30. 300-0-300 v. 80 m/a. 21/-. **FS3.** 350-0-350 v. 80 m/a.	21/–
FS2X. 250-0-250 v. 100 m/a. 23/-. **FS75.** 275-0-275 v. 100 m/a.	23/–
FS30X. 300-0-300 v. 100 m/a. 23/-. **FS3X.** 350-0-350 v. 100 m/a.	23/–
All the above have 6.3 4-0 v. at 4 amps., 5-4-0 at 2 amps.	
FS43. Output 425-0-425 v. 200 m/a., 6.3 v. 4 amps., C.T. 6.3 v. 4 amps., C.T. 5 v. 3 amps. Fully shrouded	47/6
FS50. Output 450-0-450 v. 250 m/a., 6.3 v. 2 amps., C.T. 6.3 v. 4 amps., C.T. 5 v. 3 amps. Fully shrouded	67/6
F35X. Output 350-0-350 v. 250 m/a., 6.3 v. 6 amps., 4 v. 8 amps., 4 v. 3 amps., 0-2-6.3 v. 2 amps. Fully shrouded	65/–
FS160X. Output 350-0-350 v. 160 m/a., 6.3 v. 6 amps., 6.3 v. 3 amps., 5 v. 3 amps. Fully shrouded	44/–
FS43X. Output 425-0-425 v. 250 m/a., 6.3 v. 6 amps., 6.3 v. 6 amps., 5 v. 3 amps. Fully shrouded	63/6
HS6. Output 250-0-250 v. 100 m/a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. For receiver R1355. Halfshrouded	26/6
HS150. Output 350-0-350 v. 150 m/a., 6.3 v. 3 amps., C.T. 5 v. 3 amps. Half shrouded	27/9
F36. Output 250-0-250 v. 100 m/a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. Fully shrouded	29/6
FS120. Output 350-0-350 v. 120 m/a., 6.3 v. 2 amps., C.T. 6.3 v. 2 amps., C.T. 5 v. 3 amps. Fully shrouded	29/9
PRI/1. Output 230 v. at 30 m/a., 6.3 v. at 1.5/2 amps.	21/–
FS150X. Output 350-0-350 v. at 150 m/a., 6.3 v. at 2 amps., C.T. 6.3 v. at 2 amps., C.T. 5 v. at 3 amps. Fully shrouded	31/6

The above have inputs of 200/250 v.

OUTPUT TRANSFORMERS

MIDGET OP. 5,000Ω to 3Ω	3/9
8,000Ω to 3Ω	3/9
OP10. 10/15 watts output. 20 ratios on Full and Half Primary	17/9
OP30. 30 watts output, 20 ratios on Full and Half Primary	25/9
Williamson's O.P. Transformer to Author's specification	£4/13 6
Chokes for Williamson's Amplifier, 30 H. at 20 m/a.	16/6
10 H. at 150 m/a.	32/–

FILAMENT TRANSFORMERS

All 200/250 v. Input.

F3. 6.3 v. @ 3 amps.	9/6
F4. 4 v. @ 2 amps., 7/6. F6. 6.3 v. @ 2 amps.	7/6
F6X. 6.3 v. @ 0 3 amps., 5/6. F12X. 12 v. @ 1 amp.	8/–
FU6. 0-2-4-5-6.3 v. @ 4 amps., 10/–. F12. 12.6 v. tapped 6.3 v. @ 3 amps.	16/6
F24. 24 v. tapped 12 v. @ 3 amps.	23/6
F29. 0-2-4-5.6.3 v. @ 4 amps., 18/9. FU12. 0-4-6.3 v. @ 3 amps.	17/6
FU24. 0-12-24 v. @ 1 amp.	17/6
F5. 6.3 v. @ 10 amps. or 5 v. @ 10 amps., or 12.6 v. @ 5 amps., or 10 v. @ 5 amps.	34/–
F6/4. Four windings at 6.3 v. tapped 5 v. @ 5 amps. each, giving by suitable series and parallel connections up to 6.3 v. @ 20 amps.	51/6

Quotations, etc., stamped addressed envelope please.

C.W.O. (add 1/6 in £ for carriage).

Export enquiries invited.

H. ASHWORTH (Dept. W.W), 676, Gt. Horton Road, Bradford 7, Yorks.

FLEXIBLE REMOTE CONTROL OUTFITS

Our experience in the industrial field has indicated that there is a definite need for this type of outfit offering facilities for making prototype flexible remote controls as required.

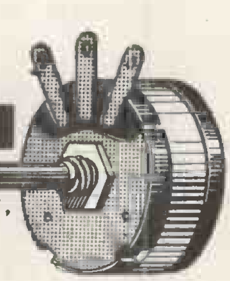
The two gauges of Remote Control flexible shafts in these outfits cover the range of torque loadings required for ● volume controls ● all types of wave change switches ● condensers ● all controls likely to be met in electronic, radio and television equipment.

These outfits are reasonably priced and comprise :

No. 130 (.130 in. dia.) for remote controls up to 4 in. in length	..	**£7. 0. 0**
No. 150 (.150 in. dia.) for remote controls up to 6 in. in length	..	**£7.10.0**

(For use without flexible casing)

THE S.S.White CO. OF GREAT BRITAIN LTD
INDUSTRIAL DIVISION



The S. S. White Company will be pleased to advise which Outfit is most suitable for specific applications.

A detailed Parts List is available upon request.

BRITANNIA WORKS, 25-31 ST. PANCRAS WAY, LONDON, N.W.1. *Telephone : EUSton 5393*

R.C.2.

See it at the RADIO CENTRE

... any one of these popular Tape Recorders ...

Playtime *PLUS*

"PLAYTIME-PLUS" is complete and ready to use with a self-contained wide range amplifier and high flux elliptical loudspeaker. It is simple to operate, using a single joystick control for all operations.

The smallest lightweight COMPLETE Tape Recorder giving a FULL HOUR'S PLAYING TIME.

For only 35 gns. complete, the Playtime-Plus gives quality and performance second to none. Fitted in an elegant 2-tone suitcase only 12½ in. × 10 in. × 5½ in., the total weight is less than 20 lb. For A.C. mains. Recording level indicator ensures perfect recordings.

35 gns.

Complete with microphone and tape.

PLAYTIME

26 gns.

Or complete with High Fidelity microphone and spool of tape for £31 4. 6.

For High Fidelity playback through that favourite radio or amplifier, the "Playtime" is superb. The frequency response is limited only by that of the playback medium. Completely self-contained for recording ; simple joystick control for all functions; ONE HOUR'S PLAYING TIME. High Fidelity twin track recording heads. Powered by specially designed motor. For A.C. mains 220/250 v.

EDITOR TWO-SPEED

The smallest mains-operated fully-automatic two-speed recorder with 7 in. spools. INDEPENDENT BASS and TREBLE controls for recording and playback ; two hours' playing time at 3¾ in. per sec. IDEAL FOR USE WITH PRE-RECORDED TAPES. Fitted in handsome two-tone case with attractive gilt fittings. For 200/250v A.C.

Hi-Fi model with additional 10 in. speaker built in detachable lid .. 49 gns.

45 gns.

Complete with microphone and tape.

EDITOR SUPER TWO-SPEED

De luxe version of the "Editor" incorporates mixing and monitoring facilities and single knob control super tape deck. Sufficiently powerful to meet any volume requirement. Fitted in padded simulated crocodile case with continental gilt fittings.

Hi-Fi model with additional 10 in. speaker built in detachable lid .. 60 gns.

55 gns.

Complete with microphone and tape.

All these and other proprietary brands of Tape Recorders available from stock

BUY ON THE **M.O.S. PERSONAL CREDIT PLAN**

Send 15 per cent deposit with your order, with remainder spread over any period up to 18 months. All proprietary brands of equipment advertised in this Journal are available from us under the M.O.S. Personal Credit Plan.

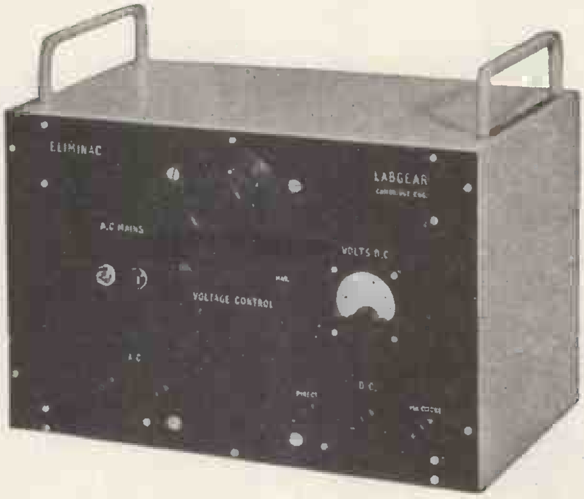
E. & G. **MAIL ORDER SUPPLY CO.**

The Radio Centre

33, Tottenham Court Road · London · W.1 · Tel. MUS 6667

M·O·S

A Laboratory substitute for the accumulator to provide an adjustable source of pure D.C.



The LABGEAR ELIMINAC

B.2027

INPUT .. 200/250 V. 40/60 c/s
OUTPUT .. 0-12 V. 5A. Max.

VARIAC CONTROLLED.

LOAD	RIPPLE
1 amp.	0.02%
2 ,,	0.05%
3 ,,	0.09%
4 ,,	0.14%
5 ,,	0.20%

Additional A.C. output 0-20 volts at 10 Amps Variac controlled. Built-in M/C meter. Size : 14½ in. x 12 in. x 11 in. Weight : 50 lbs.

PLEASE WRITE FOR LEAFLET JS 2027

Labgear (Cambridge) Ltd.

WILLOW PLACE, CAMBRIDGE, ENGLAND *'PHONE 2494-5*

NEW ARCOLECTRIC SIGNAL LAMPS

For Low Voltage or Mains

Illustrated are a few signal lamps taken from our wide range. The insulation of every Arcolectric signal lamp will resist a flash test of 1,500 volts A.C. The S.L.90 illustrated here is a typical Arcolectric low voltage signal lamp-holder. It is designed to accept popular M.E.S. bulbs. The bulb is accessible from front or rear of panel. The domed plastic lens surrounded by a polished chrome bezel gives a most attractive panel appearance. This holder can be fixed in a single ¾" hole. The mains voltage signal lamp SL88/N is supplied complete with an M.E.S. neon tube and a suitable series resistance.

Write for Catalogue No. 129


S.L.88/N


S.L.90


S.L.86


S.L.82


S.L.92

ARCOLECTRIC SWITCHES · LTD

CENTRAL AVENUE, WEST MOLESEY, SURREY . TELEPHONE: MOLESEY 4336 (3 LINES)

EDDYSTONE

V.H.F. COMMUNICATIONS RECEIVERS

MODEL 770R – 19 Mc/s. to 165 Mc/s. CONTINUOUS
MODEL 770U – 150 Mc/s. to 500 Mc/s. CONTINUOUS

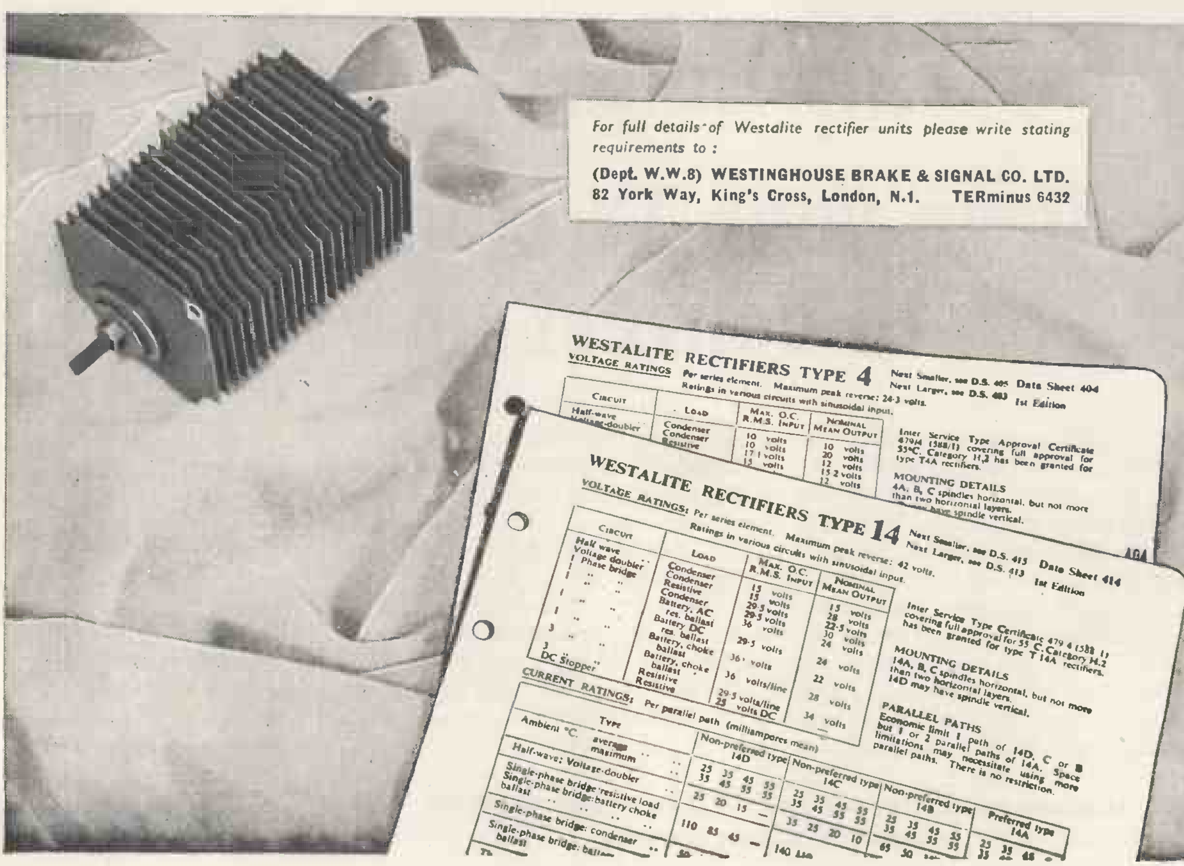
FOR MONITORING, FIELD TESTS, LABORATORY PURPOSES ETC.

- Highly efficient signal frequency circuits.
- Substantial diecast rotary coil turret.
- Excellent frequency stability and selectivity.
- Accurate re-setting and ease of handling.
- High sensitivity and excellent signal-to-noise ratio.
- For AM and FM.
- Robust construction and outstanding reliability.
- "S" Meter. Noise Limiter.
- Preferred type valves.
- Finest workmanship.

- A. C. operation. 110-250 volts. 40-60 cycles.
- Dimensions 16¾" x 15" x 8¾".
- Weight 60 lbs.

PLEASE WRITE FOR FULL SPECIFICATION TO THE MANUFACTURERS.

STRATTON & CO. LTD., ALVECHURCH ROAD, BIRMINGHAM, 31



Perfection in Miniature

HIVAC THE SCIENTIFIC VALVE

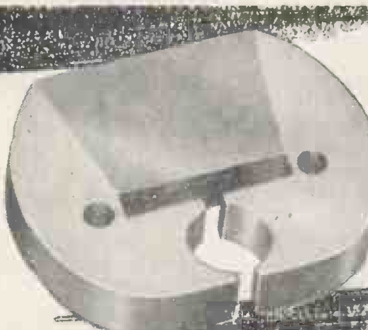
HIVAC INDICATOR LAMPS

The Ruislip location, already one of the most modern and best equipped valve factories in the world, has been further extended and is now also the Head Office of

Hivac Limited

Telephone : Ruislip 3366 *Cables : HIVAC, RUISLIP*

STONEFIELD WAY, VICTORIA ROAD, SOUTH RUISLIP, MIDDLESEX



MUREX 'SINCOMAX' PERMANENT MAGNETS *are used in* WEIR ELECTRICAL INSTRUMENTS

A further example of the use of Murex 'Sincomax' Magnets where a high energy product with high magnetic stability is essential.

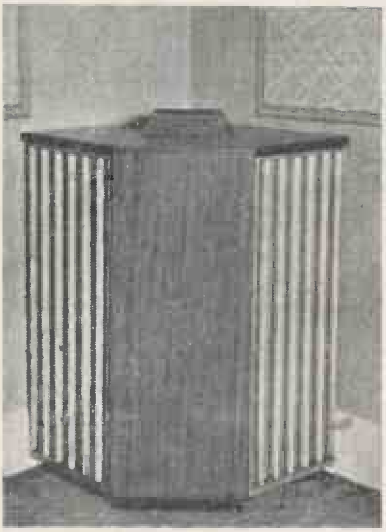
Murex 'Sincomax' Magnets with an alloyed bond between magnet and soft iron, continue to give accurate and reliable service in this and many other applications.

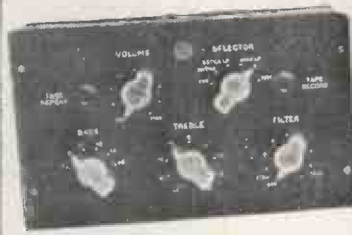
MUREX LIMITED *(Powder Metallurgy Division)*
RAINHAM • ESSEX • *Rainham, Essex 3322*
Telex : London 8632.
Telegraphic Address : Murex, Rainham, Romford Telex.
LONDON SALES OFFICE: CENTRAL HOUSE, UPPER WOBURN PLACE, W.C.1 *EUSton 8265*

Photograph of a 3½" Moving Coil D.C. Microammeter by courtesy of The Weir Electrical Instrument Co. Ltd.

RD JUNIOR —"Designed exclusively for home High Fidelity systems"

CORNER HORN AND AMPLIFIER/CONTROL UNIT





Designed to form the nucleus of all but the most ambitious home high fidelity installations, the general performance of the RD JUNIOR is in keeping with the standard which has come to be expected of the modern high fidelity amplifier. It is, however, the many unique and novel features which have been incorporated in the design which distinguish it from its contemporaries and place it in a class apart, unrivalled by any other equipment approaching it in price.
Outstanding amongst these features is the inclusion of an INDEPENDENT LOW PASS FILTER, virtually essential when dealing with worn records or bad radio transmissions, but normally only associated with the highest priced equipment. Exclusive features include "Impedance Plug" loudspeaker matching and the provision of four alternative Panel and Control Knob colours.
Anticipating the use of an FM Unit a second radio input is provided, whilst the availability of ample spare power avoids the added expense of an additional power pack.
An unusually high standard of materials and workmanship combine to provide absolute reliability, a factor reflected in the unconditional TWO-YEAR GUARANTEE covering both units.

PRICE £26 COMPLETE

Primarily designed to house the exceptional Goodmans Axiom 102 speaker, the Junior Corner Horn combines excellent bass response with virtually perfect treble diffusion to provide a standard of performance far superior to that suggested by its modest price. Compact in size it is the ideal reproducer for domestic use and the perfect companion for the RD JUNIOR amplifier.

BASIC PRICE, less speaker and side panels, £18/17/6 (carriage extra).
Louvred side panels £3 per pair. Goodmans AXIOM 102 £9/18/1 incl.
Illustrated literature post free on request.

12-page Illustrated Booklet post free on request.

Available from Specialist Dealers in London and the Provinces or, if in any difficulty, please apply direct. Agents in the majority of overseas countries.

Trade and Export enquiries invited.

ROGERS DEVELOPMENTS Co.

"Rodevco House," 116, Blackheath Rd., S.E.10. TIDeway 1723

GECALLOY CORES

FOR RADIO and T.V. APPLICATION

GRADE M.E.

Low cost cores for frequencies up to 50 Mc/s.

GRADE M.F.

High quality cores for frequencies up to 300 Mc/s.

Write for List No. GRC 5303/6

SALFORD ELECTRICAL INSTRUMENTS LTD.

PEEL WORKS • SILK STREET • SALFORD 3 • LANCS

A SUBSIDIARY OF THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

come to the PERMANENT AUDIO FAIR

The radio show is coming shortly, but many enthusiasts may be unable to visit it, for one reason or another. This doesn't mean that they need to miss seeing all the new equipment, because here at Classic we have our own show on all the time*, with all that is newest and best, available for *comparative demonstrations.*

*Open 9 a.m.-5.30 Monday to Saturday. Wednesday close 1 p.m.

	Cash Price	Deposit
PICK-UPS		
Ferranti Diamond Styli	£24 6 8	£3 16 8
Leak Diamond Styli	£20 19 9	£3 15 0
Lowther Diamond Styli	£16 16 7	£2 11 0
Tannoy pick-up complete	£20 9 6	£3 9 6
AMPLIFIERS AND FM UNITS		
Quad Mark II	£42 0 0	£6 6 0
Quad F.M.	£28 17 6	£4 7 6
Leak TL 12 Mark II	£45 3 0	£7 7 0
Leak F.M. (provisional price)	£33 10 0	£5 0 0
Tannoy	£63 0 0	£9 9 0
Pye	£42 0 0	£6 6 0
Dynatron F.M.	£24 0 0	£3 10 0
Goodsell F.M. T 402	£18 15 2	£3 9 2
LOUDSPEAKERS		
Lowther T.P.1	£96 0 0	£14 8 0
Tannoy Autograph	£131 5 0	£31 5 0
Tannoy Junior..............	£100 16 0	£15 16 0
Tannoy York 12in.	£37 15 0	£8 14 0
TAPE RECORDERS		
Ferrograph 3¾-7½ i.p.s.	£79 16 0	£12 0 0
Ferrograph 7½-15 i.p.s.	£90 6 0	£13 10 0
Grundig TK 12	£73 10 0	£11 2 0
Grundig TK 820	£102 18 0	£15 9 0
Grundig Stenorette..........	£38 5 0	£5 14 0
MSS PMR 25X	£150 0 0	£22 10 0
EAP Elizabethan	£50 8 0	£7 10 0

Balance payable in each case over 6, 9, 12, 18 or 24 months.

We also have a number of shop-soiled and secondhand items of Hi-Fi and TR equipment at attractively reduced prices. Send for special list post free.

for fair play all the time

CLASSIC

ELECTRICAL COMPANY LIMITED

HI-FI, TR, VHF SPECIALISTS

352-364 LOWER ADDISCOMBE RD., CROYDON, SURREY

Telephone: ADDiscombe 6061

M. R. SUPPLIES Ltd.

For the right goods at the right price. Full and fair descriptions. Immediate delivery, carefully packed. Prices nett.

HIGH DUTY MAINS TRANSFORMERS (5¼ kvA.). Very fine offer of £40 units ex. Philips. Brand new, ex. cancelled order. Primary tapped 200/250 v., 50 c. 1 phase. Secondary providing taps up to 180 volts 30 amps (or 360 volts 15 amps). Taps;—4, 8, 12, 16, 20, 42, 68, 90 120, 140 and 180 volts (two identical secondary windings). Dimensions;—13in. high by 10in. width by 19in. length, weight approx. 1 cwt. Double-wound, tropical specification. We have 25 only at **£12/10/-** each nett, ex. this address. Suitable for use with high-current rectifiers, mains isolation, and general laboratory use. We prefer that these be picked up from here but can quote for despatch. Suitable rectifiers for above, if required, are in stock.

L.V. HIGH CURRENT TRANSFORMERS (ex. above cancelled order). Brand new. Prim;—200/250 v. 50 c. 1 ph. Sec.;—Two identical windings of 1 volt 40 amps. Windings in parallel produce 1 volt 80 amps. A few at 28/6 (despatch 2/6).

AIRCRAFT LANDING LIGHTS, with geared motor traverse. Operation from 12/24 volts. Diameter of lamp; 8in., with fine parabolic reflector and 240-watt lamp. Lamp automatically lights at end of traverse. We have sold a number for theatricals, flood lighting, boats, cars, garages, etc., at the bargain price of **55/-** each (cost over £15). Despatch 5/- U.K. These are brand new in original packing.

SYNCHRONOUS TIME SWITCHES. 200/250 v. 50 c. Can be set to switch on and off at any desired time of the day. Load capacity 4 amps A.C. (250 v.). In wall mount metal housing with glass window. Secondhand, perfect, **58/6** (des. 2/6). The finest bargain in first-grade Time Switches.

ROTARY TRANSFORMERS (Perm. magnet field—for stepping up or down). Three commutators, 6 and 12 volt to 250 v. D.C., 65 mA., or will deliver 6 or 12 volts from 200/250 v. D.C. mains for model railways, or 200/250 v. D.C. from car battery for electric razors. Very handy units, in new condition, **12/6** (des. 2/-).

STUD SWITCHES, with 20 stud taps, make before break, 5in. sq. by 2in. deep, with laminated switch arm, brand new, boxed, **9/6** (des. 1/-).

DUAL ELECTROMAGNETIC COUNTERS. Operation 20/24 v. D.C. (or 50 v. A.C.) and fitted with manual re-set. Each contains two separately energised counters each counting up to 9999—speed up to 1,000 operations per minute. In cylindrical housing 3¼in. dia. by 5in. deep, suitable for panel mount. Brand new, each in moisture-proof pack, **37/6** (des. 2/6).

MAINS MOTORS. Best capacitor/induction type, for 230/250 v. 50 c. 1 ph. (capacitor fitted to motor) 1,425 r.p.m. reversible. One-quarter H.P. **£4/18/6** (des. 5/-). Also One-half H.P., same type, ball bearings, **£7/5/-** (des. 7/6). These are brand new.

F.H.P. GEARED MOTORS—we are the largest stockists in London and we invite interested firms to send for our nett list GM/355 giving full details of many models from stock. Final speeds from 1 r.p.m. to 160 r.p.m., final torques from 3 lbs./ins. to 75 lbs./ins. Prices from **£5/17/6**. Dimensional drawings available.

SMALL GEAR BOXES. Double worm gear, 300/1 reduction. In die-cast housing 2⅜ × 2⅜ × 2in. Final shaft ¼in. dia. by 1¼in. proj. Ball bearings, transmission up to 1/10th H.P., **45/-** (des. 1/6).

PUSH-BUTTON SWITCHES. Two-button, push-on, push-off. Diamond H, capacity 5 amps (250 v.), **2/6** (des. 6d.).

Details on request;—Philips Variable Transformers, Stuart Electric Pumps, B.P.L. Measuring Instruments, Thermostats, Extractor Fans.

M. R. SUPPLIES, Ltd., 68 New Oxford St., London, W.C.1

Telephone : MUSeum 2958

S.G.Brown

LIGHTWEIGHT HEADPHONES FOR LADIES

Specially designed for use with dictation and recording machines.

These Headphones are extremely light in weight—*only* 3½ *ounces.* They can be worn for long periods without the slightest discomfort. They do not disarrange the hair and are designed to ensure long and reliable service.

S. G. Brown provide Headphones and associated equipment for all known purposes. Brochure 'W' sent on request.

S.G.Brown, Ltd.

SHAKESPEARE STREET, WATFORD, HERTS.

Telephone : Watford 7241

SUPERIOR RADIO SUPPLIES

OFFER CONSTRUCTORS TWO FIRST CLASS RECEIVERS

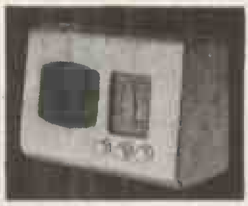
The SUPEREX 55 ATTACHE PORTABLE

BUILDING COST £7.15.0 plus 3/6 P. & P.

- Really outstanding quality.
- Four Valve Battery Superhet.
- Long and Medium Wave-Lengths.
- Perfect Reception in All Areas.
- Rexined Cabinet 10¼in. × 8½in. × 5in.
- Very Simple Construction.

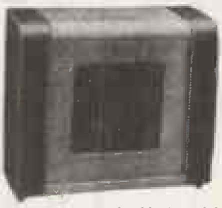
Send 1/6 for Superex "55" Construction Booklet and Price List.

The "SYCAMORE" CABINET ASSEMBLY



A handsome cabinet finished in clear polished sycamore, size 12in. × 7in. × 5in. Suitable for building a modern three valve plus rectifier receiver. Complete with a ready drilled tin plate chassis, dial and back plate, drum, spring, drive spindle, three knobs, fixing brackets, pointer. Price 30/- plus 2/6 P. & P. Please Note: Regret no circuit diagram available with this cabinet assembly.

EXTENSION SPEAKER CABINET



A really smart rexine covered cabinet available in twin colours: Grey and Wine, Grey and Blue, Grey and Green. Please state second choice when ordering. 5in. Speaker Type. Price 16/6, plus 1/6 P. & P. 6½in. or 8in. Speaker Type. Price 19/6, plus 1/6 P. & P.

The "SUPERIOR FOUR" T.R.F. RECEIVER

BUILDING COST £6.17.6 Inc. Postage.

- A.C. Mains 200-240 volts.
- Long and Medium Wave-Lengths.
- Well Tried Reliable Circuit.
- Uses 7in. × 4in. Elliptical Speaker.
- Handsome Cabinet 10in. × 10½in. × 5in.
- All Parts Available Separately.

Send 1/6 for Construction Booklet and Price List.

TERMS: Cash with order or C.O.D. Extra charge for C.O.D. U.K. and N. Ireland only.

(WWAg) 37, HILLSIDE, STONEBRIDGE, LONDON, N.W.10. TEL.: ELGAR 3644

Shop open 9 a.m. to 6 p.m. Monday to Saturday. 1 p.m. Thursday.

UNIVERSAL ELECTRONICS

OUR RANGE OF QUALITY EQUIPMENT IS MOST COMPREHENSIVE

Whether new or used, it is all guaranteed to be in perfect condition

RECEIVERS

All receivers are in good working order and condition unless stated. Hallicrafters Portable, mains or battery receiver, as new, £50. SX28, 550 kc/s.-42 Mc/s., £45. SX24, 550-42 Mc/s., £28. S20R, 550-42 Mc/s., £25. S20, £20. S29, A.C./D.C. portable battery 550-32 Mc/s., £25. S38 A.C./D.C. 110-250 v. 550-30 Mc/s., £20. Also in stock S27, 30 Mc/s.-150 Mc/s., S27CA, 150-230 Mc/s., HT11A Marine 12 v. radiotelephones. HRO receivers junior and senior types with all coils and power supplies from £27, complete. National NC44, NR100, NC81X, NC200. National NC173, 550-32 Mc/s., as NEW, £65. Marconi CR100. 60 kc/s.-30 Mc/s. reconditioned, £32; RME 69, £35. Eddystone receivers: Types 640, 1.2-30 Mc/s., £22/10/-; 740, 550 kc/s.-32 Mc/s., £35; 750, £48; 680, £65; 670, £35; 504, £25. Hammarlund Super Pro, £45. RCA receivers, AR88D and LF from £55. Set of three dials for model D, £1/10/-. Many other makes in stock.

MANUALS

For RECEIVERS AR88D-LF, AR77E, R107, Marconi CR100, S20R, SX24, SX28, B2, TX/RX, HROs, etc., photostatic copies .... per copy £1 7 6

BRITISH TEST EQUIPMENT

AVO model 7, as NEW, £15. Avo 40, £12/10/-. AVO Roller panel Valve tester, £10. Evershed Wee Meggers, 500 v., £12/10/-. Bridge types in stock. Marconi Signal Generators. TF144G. TF390G. TF517. Cossor Double Beam Scopes, from £35. Many other instruments in stock.

SERVICE AND REALIGNMENT
of all British and U.S.A. types
COMMUNICATIONS RECEIVERS
to makers' specifications AT LOW COST

U.S.A. MICROWAVE TEST GEAR

No technical manuals for sale. Please write for prices.
TS45 3cm. Signal Generator. TS3. S band power frequency meter. TS13. X band signal generator. TS14. S band signal generator. TS120. X band pulsed signal generator. TS34. Radar Synchroscope. TS36. X band power meter. TS69. 300-100 Mc/s. frequency meter. TS127. 300-700 Mc/s frequency meter. TS174 (V.H.F. version of BC221) 20-250 Mc/s. TS175. 80-1,000 Mc/s. GENERAL RADIO type 804B. 8-300 Mc/s. signal generator, £70.
Ferrio type 32A. Radio noise and field strength meter.
All laboratory equipment may be inspected by appointment.

RECEIVERS · KLYSTRONS · MAGNETRONS

U.S.A. type. APR4 Receiver complete. 30-1,000 Mc/s., APR5, 1,000-6,000 Mc/s. Klystrons 723/AB 3 cm. 707A, 707B, 2K28, 2K33 (1.5 cm.), CV129.
Magnetrons. 725A, 2J32, 2K33, 2K25, 2J36, 2J39, 2J54, 2J22, TR cells 1B24, and many other items of equipment covering HF. VHF, UHF and centimetric bands.

ANNUAL HOLIDAYS

Note: We are closing from July 22 to August 6 inclusive.

★ U.S.A. FREQUENCY METERS TYPE BC221

125 kc/s-20 Mc/s. Complete with calibration charts.
Available from stock. CONDITION PERFECT.

SPECIAL OFFER in TEST METERS

Taylor Universal Meter 83A, resistance range up to 10 M, 5000 v., output range included. Contained in polished wooden box. Excellent condition, price £9/10/- each. Ferranti A.C./D.C. Universal Meter. Small compact unit in case, £4/17/6, plus carriage.

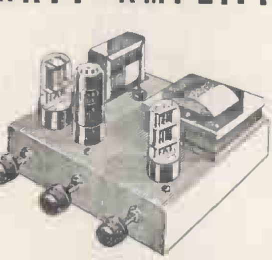
22 LISLE STREET, LEICESTER SQ., LONDON, W.C.2.

Shop hours, 9.30 a.m. to 6 p.m. OPEN ALL DAY SATURDAY. *Thursday 9.30 a.m. to 1 p.m.*

Write, Call or Telephone GERrard 4447 and 8410 (Day) MEAdway 3145 (Night)

PREMIER RADIO COMPANY

4-WATT AMPLIFIER



MAY BE BUILT FOR **£4.10.0** Plus 2/6 Pkg. & Carr.

Valve line-up 6SL7, 6V6 and 6X5, FOR A.C. MAINS 200/250 VOLTS. The twin triode 6SL7 is used for preamplification and also for a comprehensive tone control circuit, which includes two very wide range and continuously variable tone controls for bass and treble. The output Valve is of the beam type and feeds 4 watts into a specially designed output Transformer which is suitable for either 3 ohm or 15 ohm Speakers. Negative feed-back is applied from the secondary of the output Transformer over the whole Amplifier to the input stage giving an excellent frequency response. Due to the high gain and wide range tone controls any type of pick-up may be used. Overall size 9 × 7 × 5in. Price of Amplifier complete, tested and ready for use, £5/5/-, plus 3/6 pkg. and carr.

INSTRUCTION BOOK, 1/- (Post Free) which includes Assembly and wiring diagram, also a detailed Stock List of priced components.

QUALITY ENTHUSIASTS

Electrostatic H.F. Speaker type LSH75 gain of 20 db over the range of 7-18 kcs., inherent capacity 800 pf., maximum polarising voltage 300 D.C., operative A.C. voltage 60, suitable for outputs of up to 5 watts, size 2¾in. × 2½in. × ½in., price 12/6.

Type LS100, details as above, inherent capacity 1100 pf., suitable for outputs of up to 20 watts, size 5in. × 3in. × ½in., price 21/-.
Will add sparkle to the top response of any equipment.

RECTIFIERS

E.H.T. Pencil Type S.T.C.

Type K3/25	650 v.	1 mA.	4/7
,, K3/40	3.2 kV.	1 mA.	6/-
,, K3/45	3.6 kV.	1 mA.	8/2
,, K3/50	4 kV.	1 mA.	8/8
,, K8/100	8 kV.	3 mA.	14/8
,, N3/160	12 kV.	1 mA.	21/6
,, K3/180	14.4 kV.	1 mA.	24/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/-
,, RM2	125 v.	120 mA.	4/6
,, RM3	125 v.	125 mA.	5/6
,, RM4	250 v.	250 mA.	18/-

L.T. Type Full Wave

12 v. 1 amp.	8/-
12 v. 2 amp.	10/9
12 v. 4 amp.	19/6

A RANGE OF BAND 3 AND F.M. AERIALS IS NOW AVAILABLE

Teletron Ferrite Rod Aerials. Medium Wave 8/9. Medium/Long Wave 12/9.

Corner Reflex Cabinet for Goodmans Axiom 150 to specification £12/10/-, pkg. and carr. 15/-.

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium with four sides:

7 × 5½ × 2in.	4/-	10 × 9 × 3in.	7/-
7 × 3½ × 2in.	3/9	12 × 10 × 3in.	7/9
9½ × 4½ × 2in.	4/3	14 × 10 × 3in.	7/11
10 × 8 × 2½in.	5/6	16 × 10 × 3in.	8/3
12 × 9 × 2½in.	7/-	16 × 8 × 2½in.	8/-
14 × 9 × 2½in.	7/6		

ALUMINIUM PANELS 18 s.w.g.

7 × 6in.	1/3	7 × 4in.	1/-
9½ × 6in.	1/8	9½ × 4in.	1/5
10 × 9in.	2/2	10 × 7in.	1/11
12 × 9in.	2/8	12 × 7in.	2/5
14 × 9in.	3/2	14 × 7in.	2/11
16 × 9in.	3/8	16 × 7in.	3/5
20 × 9in.	4/8	20 × 7in.	4/5
22 × 9in.	5/2	22 × 7in.	4/11

CABINETS—PORTABLE

Model PC/1
Brown Rexine covered 15/11
Overall dimensions 15in. × 13½in. × 5in.
Clearance under lid when closed 2½in.

Model PC/2
Grey Lizard Rexine covered 45/-
Overall dimensions 15in. × 13in. × 6in.
Clearance under lid when closed 3in.

Model PC/3
Rexine type covering in various cols., 69/6.
Overall dimensions 16¾in. × 14½in. × 10¾in.
Clearance under lid when closed 6½in.

All the above Cabinets are supplied with Panel, Carrying Handle and Clips.

Packing and Postage 2/6.

FREQUENCY MODULATION

V.H.F. Tuning Unit type UT340 permeability tuned, coverage 86-103 mcs. stage gain Aerial to output of 1st I.F. (contained in Unit) approximately 350. Maximum frequency drift 0-70 degrees centigrade 30 kcs. Radiation less than 26 microvolts per metre, price 59/5 (including tax). Valve UCC85.

I.F. type U.F.376 inter-stage, 10.7 mcs., Q-110. Coupling factor unity price, 7/-.

Ratio Filter type URF377 Q1-75, Q2-105, price 10/6.

Overall bandwidth of the above Units 200 kcs.

Complete Handbook containing full details of construction and point-to-point wiring diagrams including also details of F.M. Aerials 2/6 post free.

★QUALITY CRYSTAL PICK-UP ROTHERMEL TYPE U48 26/-. Plus 1/6 Pkg. and Carr.

The New "PREMIER PORTABLE" TAPE RECORDER

USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6

COMPLETE 39 GNS CASH

Packing & Carriage 1 gn.
(Including Reel of Scotch Boy Tape and Microphone)

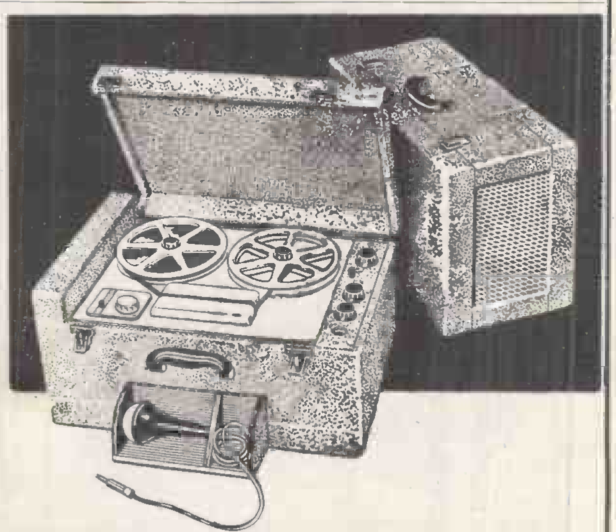
H.P. Terms: Deposit £10/8/- and 12 monthly payments of £2/16/-.

or **Complete Kit** Including All Parts, Valves, Speaker Cabinet, Tape Unit, Reel of Scotch Boy Tape, Rewind Spool and Microphone at **£37.4.0** plus pkg. & carr. 15/-.

H.P. Terms: Deposit £9/7/9 and 12 monthly payments of £2/11/-.

SPECIFICATION

- ★ TWO SPEEDS 7½in. AND 3¾in. PER SECOND.
- ★ THREE SPECIALLY DESIGNED RECORDING MOTORS.
- ★ 1,200FT. TAPE REELS PROVIDING PLAYING TIMES OF 1 HR. AND 2 HRS.
- ★ DROP-IN TAPE LOADING.
- ★ EASY FORWARD OR REWIND WITHOUT REMOVING TAPE.
- ★ ONE KNOB DECK OPERATION.
- ★ 7-VALVE HIGH QUALITY AMPLIFIER.
- ★ INDEPENDENT TREBLE AND BASS CONTROLS.
- ★ MAGIC EYE RECORD LEVEL INDICATOR.
- ★ AMPLIFIER MAY BE USED FOR RECORD REPRODUCTION OF HIGH QUALITY.
- ★ COMPARTMENT FOR HOUSING MICROPHONE.
- ★ SPECIALLY DESIGNED MICROPHONE BY A LEADING MANUFACTURER.



SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW :—

Amplifier (built, wired and tested with Speaker). £14/15/-, plus postage and carriage 7/6.
Hire purchase terms, Deposit £3/15/- and 11 monthly payments of £1/2/-.
Amplifier Kit (including Speaker). £11/-/- plus packing and carriage 5/-.
Hire Purchase terms, Deposit £3/-/- and 9 monthly payments of £1/-/-.
New Lane 2-speed Tape Unit Mark 6. £18/10/- plus packing and carriage 7/6.
Hire Purchase terms, Deposit £4/11/9 and 12 monthly payments of £1/5/6.
Portable Cabinet (rexine covered). £4/19/6, plus postage and carriage 5/-.
Microphone, £2/15/-, plus postage and carriage 1/-.
Reel Scotch Boy Tape MC2-111 (1,200ft.), £1/15/-, plus packing and carriage 1/-.
Instruction Booklet. 2/6. Post free.

PREMIER RADIO COMPANY

WILLIAMSON AMPLIFIER KIT 15 gns.

plus 7/6 p. & p.

H.P. Terms:

Deposit £3.18.9 & 12 monthly payments of £1.1.8

This Kit is absolutely complete and all components are guaranteed exactly to author's specification.

WILLIAMSON OUTPUT TRANSFORMER

Author's Specification 3.6 ohms secondaries **£4.10.0**

MAINS TRANSFORMER SP425A (Completely Shrouded)

This Transformer has an additional 6.3 v. 3 A. and is capable of supplying an extra 50 mA. for Pre-amp or Feeder unit **£2.12.6**

WILLIAMSON CHOKES

12H 150 mA. Fully shrouded **19/6**

30H 20 mA. Fully shrouded **11/9**

METERS

Full Scale Deflection	External Dimensions in.	Movement	
3.5 A.	2½ × 2½	R.F. Thermo.	7/6
20 A.	2½ round	M/C	8/6
40 A.	2½ round	M/C	8/6
500 mA.	2½ round	M/C	10/6
30 A.	2½ × 2½	M/C	8/6
50 mA.	2½ × 2½	M/C	7/6
20 V.	2½ × 2½	M/C	6/6
1 mA.	2½ round	M/C	22/6

CRYSTAL MICROPHONE INSERTS

Ideal for tape recording and amplifier. No Matching transformer required, **8/6 post free**

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 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. @ 1-2 a. 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. 19/6

350-0-350, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a. 19/6

200-230-250 output 3 v.-30 v., @ 2 a. 17/6

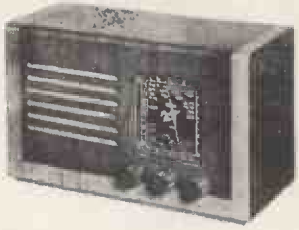
E.H.T. primary 230 v., secondary 1.75 Kv., 2 × 4 v. tapped 2 v. 37/6

E.H.T. TRANSFORMER, primary 210 v., 230 v., 250 v., secondary 4 Kv. and 2 v. £3/7/6

E.H.T. TRANSFORMER, primary 210 v., 230 v. 250 v., secondary 5Kv. and 2 v. £3/12/6

Build these NEW PREMIER DESIGNS

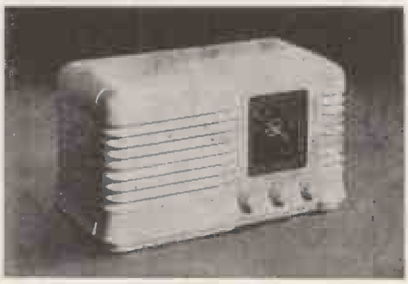
3-BAND SUPERHET RECEIVER



MAY BE BUILT FOR **£7.19.6** Plus 2/6 Pkg. & Carr.

Latest type Superhet Circuit using 4 valves and metal rectifiers for operation on 200/250 volts A.C. mains. Waveband coverage — short 16-50 metres, medium 180-550 metres, and long 900-2,000 metres. Valve line-up 6K8 freq. changer, 6K7, IF, 6Q7, Detector AVC and first AF, 6V6 output. The attractive cabinet to house the Receiver size 12in. long, 6½in. high, 5¼in. deep can be supplied in either WALNUT or IVORY BAKELITE or WOOD. Instruction Book. 1/- post free, which includes assembly and wiring diagrams, also a detailed stock list of priced components.

TRF RECEIVER



MAY BE BUILT FOR **£5.15.0** Plus 2/6 Pkg. & Carr.

The circuit is the latest type TRF using 3 valves and Metal Rectifiers for operation on 200/250 A.C. mains. Waveband coverage is 180-550 metres on medium wave and 800-2,000 metres on long wave. The dial is illuminated and the Valve line-up is 6K7 H.F. Pentode, 6J7 Detector and 6V6—Output. The attractive Cabinets to house the Receiver size 12in. long, 6½in. high, 5¼in. deep, can be supplied in either WALNUT or IVORY BAKELITE or WOOD.

INSTRUCTION BOOK 1/- (post free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.

ALL-DRY BATTERY PORTABLE RADIO RECEIVER

MAY BE BUILT FOR **£7.8.0** Plus 2/6 Pkg. and Carr.

4 miniature Valves in a Superhet Circuit covering medium and long waves. Rexine covered Cabinets 11½in. x 10in. x 5½in. in two contrasting colours. Wine with Grey Panel, or Blue with Grey Panel, please state choice when ordering. **THE SET MAY BE USED EVERYWHERE**—*home, office, car or holidays.* **INSTRUCTION BOOK. 1/6 (Post Free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.**

DECCA MODEL 33A RECORD PLAYER

ADAPTABLE FOR STND. OR L.P.

Includes crystal pick-up with sapphire stylus and a light-weight plastic spring balanced arm. Heavy gauge pressed steel case with brown enamel finish in good quality for operation on A.C. mains 200/250 v. 50 c.p.s. Supplied complete with single head (either standard or long playing.) **£4/19/6.** Extra Head can be supplied. Plus Pkg. and Carr. 5/-.

DECCA MODEL 37A. Appearance as above (Model 33A) lever speed change 33⅓ r.p.m. and standard, crystal turnover Head. **£6/19/6.** Plus packing and carr. 5/-.

LOUDSPEAKERS

ELAC ELIPTICAL 7" × 4" 21/10

PLESSEY 12" 37/6

ELAC—2½in. dia. Moving Coil, 15 ohm imp. 15/-

ELAC—8in. dia. Moving Coil 3 ohms imp. 19/6

PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) with Pentode Transformer 22/6

PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) 19/6

PLESSEY—10in. dia. Moving Coil, 3 ohms imp. 23/6

GOODMANS—12in. dia., Moving Coil, 15 ohms. Plus 5/- packing and carriage £8/12/6

VITAVOX—K12/20 12in. dia., Moving Coil 15 ohms. imp. £11/11/-

Plus 5/- packing and carriage.

3-SPEED AUTOMATIC RECORD CHANGER

Made by World-famous manufacturer. The Unit designed to play 12in., 10in. and 7in. Records intermixed in any order at 33⅓, 45 or 78 r.p.m. Capacity 10 records. New reversible dual stylus crystal Pick-up has extended frequency range. For use on 100/125-200/250 volts 50 cycles. A.C. mains. **LIMITED QUANTITY ONLY.** Plus packing and carriage 5/-. **BRAND NEW,** guaranteed and in manufacturers' original carton.

£9.19.6

LIST PRICE £16/10/-.

BARGAIN OFFER

DARK SCREEN FILTER IN TRIPLEX GLASS 16" x 18" SUITABLE FOR ALL TUBES UP TO 17" 10/-, PLUS PACKING & POSTAGE 1/6d. LATEST TYPE RUBBER ESCUTCHEON SUITABLE FOR 17" RECTANGULAR TUBES AT A SPECIAL PRICE OF 10/-, PLUS PACKING & POST. 1/6d.

LATEST TYPE 3-SPEED SINGLE PLAYER

By famous manufacturer with crystal turnover head, for use on 100-250 v. 50 cycle A.C. mains. **£7/19/6.** Plus pkg. & carr. 5/-.

ACCUMULATORS

2 volt 10 amp. (by famous maker) 4/11

2 volt 16 amp. 5/11

MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA. and 4 mA. Scale dimensions 2½in. Overall dimensions 2½in. dia. 1½in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermocouple, reversing scale and recalibrating the meter, a high grade test instrument with any range above the basic F.S.D. may be built up. Price 2 mA., 5/9, 4 mA., 4/9.

MICROPHONES

LUSTRAPHONE: Moving Coil: High Impedance, Stand Type; £5/15/6—Hand Mike £6/6/-.

RONETTE—Crystal Mike Incorp. the Filter Cell Insert: High Impd. Ball Type, £2/10/-.

CRYSTAL MICROPHONE—Rothermel 2AD56. Especially recommended. £2/15/-. Table stands for all the above, 10/6 and 17/6.

ACOS. High impedance Crystal Microphone, type 35-1, 25/-.

ACOS. High Impedance Crystal Microphone, type 33-1, £2/10/-.

ACOS. "MIC30" impedance Crystal Microphone £2/10/-. (This Microphone can be used as either Hand or Desk type.)

SPECIAL OFFER

Acos Microphone type 22-2 complete with Stand ......39/6 Plus Postage & Packing 1/-

MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver, 4/11, plus 6d. pkg. and carr.

Germanium Crystal Diodes. G.E.C. wire ended, 2/6. 24/- doz.

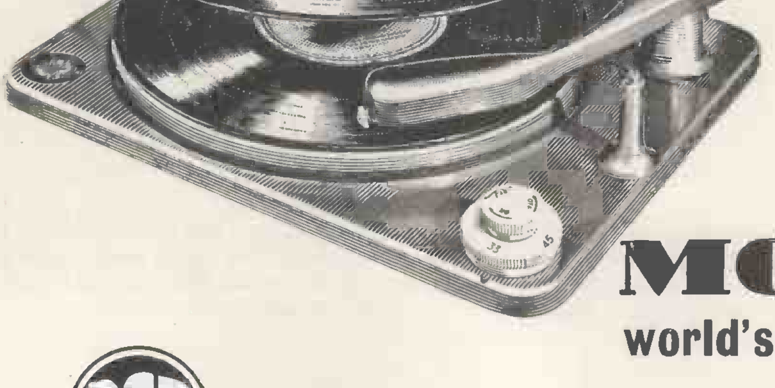
The answer to set designers' headache

Who ever heard of a set designer with no headaches ? We haven't. But we do know of many with considerably fewer headaches since they discovered the Monarch Automatic Record Changer.

Many manufacturers have, in fact, found the Monarch to be so completely reliable they have eliminated their own tests !

Any designer with more than his fair share of headaches would do well to examine the Monarch carefully. His critical appraisal will reveal a changer with many virtues, no vices—and no headaches.

The Monarch is now fitted as standard equipment by the majority of the world's leading set makers.



special features

- ★ Exclusive 'Magidisk' automatically selects 7 in., 10 in. and 12 in. records, intermixed.
- ★ Plays up to 10 records at 33⅓, 45 or 78 r.p.m.
- ★ High compliance crystal cartridge fitted with dual sapphire styli.
- ★ 'Rotocam' centralized control is simple, foolproof and trouble-free.
- ★ Independently tested Monarchs have completed equivalent of over 90 years' faultless performance.

MONARCH

world's finest autochanger

BSR

BIRMINGHAM SOUND REPRODUCERS LTD · OLD HILL · ENGLAND

A 89

Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
HUGH S. POCOCK, M.I.E.E.
Editor:
H. F. SMITH

AUGUST 1955

In This Issue

Editorial Comment 353
Colour Television Standards 355
Short-wave Conditions 355
World of Wireless 356
Inexpensive Wave Analyser. *By M. G. Scroggie* 360
Letters to the Editor 367
Band II F.M. Tuner Unit. *By L. Hampson* 368
New Navigational Aids 375
The Automatic Factory 378
Wide Range Electrostatic Loudspeakers—3. *By P. J. Walker* 381
High-Fidelity Home. *By Richard Arbib* 385
Transistor Equivalent Circuits—2. *By W. T. Cocking* 388
Transmitting Colour Information 393
The Cascode. *By "Cathode Ray"* 397
Electronic Teleprinting 401
Random Radiations. *By "Diallist"* 402
Unbiased. *By "Free Grid"* 404

VOLUME 61 NO. 8
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR
OF PUBLICATION

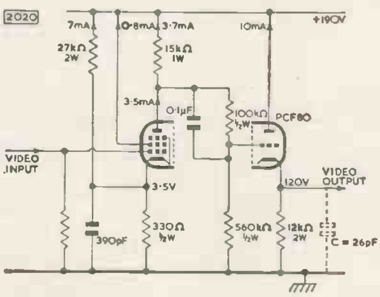
PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas, £1 7s. 0d. U.S.A. $4.50. Canada $4.00. BRANCH OFFICES: *Birmingham:* King Edward House, New Street, 2. *Coventry:* 8-10 Corporation Street. *Glasgow:* 26B Renfield Street, C.2. *Manchester:* 260 Deansgate, 3.

VALVES, TUBES & CIRCUITS

32. A HIGH GAIN VIDEO AMPLIFIER

The gain of a video amplifier with a given bandwidth, using a high slope r.f. pentode, is limited by the output or load capacitance. A typical cathode compensated circuit using an EF80, with a bandwidth of 3Mc/s (6dB), a maximum video output voltage of 50V, and a load capacitance of 26pF, has a gain of 11. The gain can be increased and the bandwidth maintained if the effective load capacitance is reduced by means of a cathode follower. The practical circuit shown in Fig. 1 has a gain of 22. A Mullard PCF80 triode pentode combines the functions of video amplifier and cathode follower in one envelope.

FIG 1



Video Amplifier

The cathode of the pentode (Fig. 1) is held at about +3.5V by the pentode cathode current and the bleed current through the 27kΩ resistor. With the screen grid at 190V this gives an anode current of 3.5mA. The permissible anode current swing is limited by the maximum screen grid dissipation rating of 0.5W, therefore the output voltage is limited to about 80V. The dynamic characteristic of a typical PCF80 pentode shows that the corresponding maximum limit of the anode current is 8.8mA. The effective slope is 1.5mA/V, therefore the gain $g_m R_l$ = 1.5mA/V x 15kΩ = 22.5.

Cathode Follower

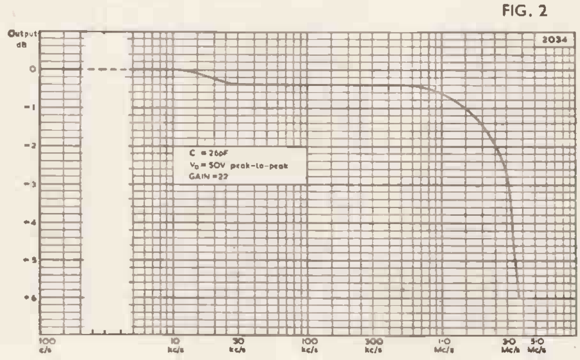
The total capacitive load of a video stage is made up, in a typical good design, approximately as follows: Video output 4pF, C.R.T. 8pF, Synchronising separator 6pF, Noise suppressor 2pF, Strays 6pF = 26pF.

If the total gain of the stage is to be greater than 20 and a cathode follower output (with a gain less than 1) is to be used, the amplifier must have a higher gain—say 25. To achieve this the output capacitance must be less than 11pF. With a cathode follower the capacitive load of the amplifier is reduced to: Video output 4pF, Cathode follower input 3pF, Strays 3pF = 10pF, which is within the 11pF limit. The overall response is limited by the cathode follower, which must be capable of developing an output voltage of at least 50V across a capacitive load of 26pF.

Cathode Current Requirements

The cathode current has two components: a current which maintains the signal across the cathode resistor, and a transient current which charges the output capacitance. The valve must supply both currents. If it failed to do so the cathode voltage would not follow the grid voltage. If the cathode cannot rise at the same rate as the input the valve will run into grid current, and the positive going edge of the signal will be distorted. Alternatively, if the cathode cannot fall at the same rate as the input, the valve will be cut off and the negative going edge will be distorted. In general the second alternative is worse, as cut-off is an absolute limit to change in the cathode current. The onset of grid current does not preclude further change if the source impedance of the driver stage is reasonably low. As each input pulse has two transients associated with it the total current swing is the maintenance current plus twice the transient current. To prevent cut-off the standing cathode current must exceed the sum of the transient and maintenance currents.

FIG. 2



Derivative Correction

It is possible to compensate for a poor fall time in a cathode follower by adding to the output a voltage proportional to the derivative of the video input signal. This voltage, which can be obtained by the inclusion of a resistor in the triode anode circuit, may be a.c. coupled to the c.r.t. grid when the cathode follower is driving the c.r.t. cathode. The derivative correcting voltage is thus added in the correct phase. It is found that this arrangement increases the contrast of the high definition bars of test card 'C' and improves the vertical edges; but it tends to produce ringing and 2.5Mc/s oscillation, therefore the use of derivative correction with this circuit is not recommended.

Performance

In a 21-inch tube receiver the recommended circuit (Fig. 1) gives a composite video output up to 80V before there is any visible sign of cathode follower overload. The frequency response, measured with a sine wave input and a 50V peak-to-peak output, is shown in Fig. 2. The stage gain is 22.

Further notes on the circuit are available with reprints of this advertisement. Reprints of all advertisements in the Valves, Tubes and Circuits series may be obtained free from the address below.

Use

BRIMAR

Teletubes
Radio Valves
and
Special
Components

- METAL RECTIFIERS
- BRIMISTOR CURRENT SURGE RESISTORS
- GERMANIUM DIODES
- TRANSISTORS

for best results specify **BRIMAR**

Standard Telephones and Cables Limited FOOTSCRAY · KENT *FOOtscray 3333*

acos quality crystal microphones

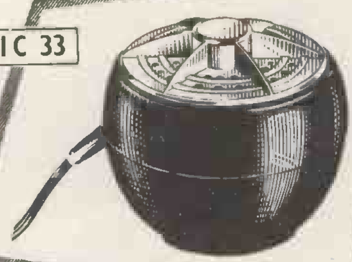
at reasonable prices

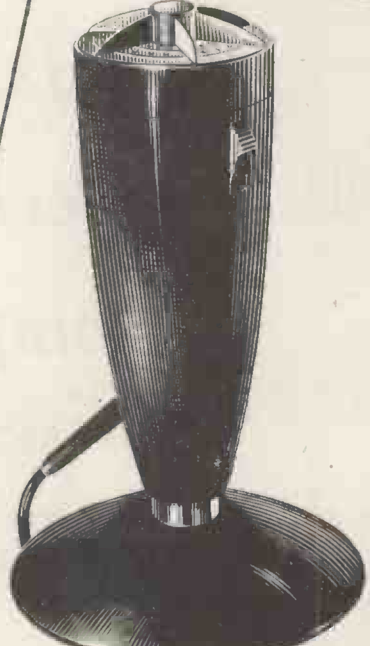
For tape and disc recording, P.A. and amateur radio.

MIC 33

A crystal hand or desk omni-directional microphone for the high quality public address and tape recording field, incorporating a specially designed acoustic filter giving a response flat from 30 to 7,000 c/s.

RETAIL PRICE: £2-10-od.





MIC 36

A handsome omni-directional instrument of high sensitivity and a substantially flat response from 30 to 7,000 c/s. Alternative models, with or without switch, are available with suitable adaptors for floor or table stands or for hand use.

RETAIL PRICE: £3 - 3 - od. without switch or £3 - 8 - od. with switch.

MIC 35

A general purpose hand microphone of robust construction with substantially flat response from 50 to 5,000 c/s. Suitable for recording apparatus. Public Address equipment etc.

RETAIL PRICE £1 - 5 - od.

. . . always well ahead

We shall be at
THE RADIO SHOW
STAND No. 201

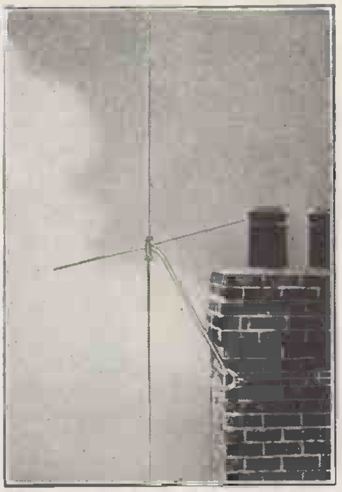
ACOS devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

GD

"BELLING-LEE" NOTES

AERIALS FOR THE V.H.F. BROADCAST BAND II FREQUENCY MODULATED



The period of experimental B.B.C. transmissions from Wrotham has passed.

From now onwards the Wrotham transmitter will send out three programmes, the Home, the Light and the Third, on Band II. These transmissions will be frequency modulated and will require horizontal aerials which are in the position of maximum response when broadside on to the transmitter. The B.B.C. V.H.F. programmes will eventually practically cover the country, and this will allow listeners to enjoy a quality of reception hitherto unobtainable. The next transmitters to come into operation will be Pontop Pike (Newcastle) and Divis (Belfast) in that order. In many difficult locations listening will become a pleasure for the first time. New or modified receivers will be required and these will have built-in general purpose aerials. However, tentative field trials indicate that, in many cases, and certainly at distances in excess of 40 miles from the transmitter, particularly in hilly country, a better aerial will be required. In a number of cases a "Lofrod" loft aerial will be satisfactory but at these distances many listeners will require an outdoor aerial and in really difficult locations a 3-element or an horizontal "H" will be necessary. Above we illustrate V.H.F. stubs attached to a dipole. These may also be fixed to any of our aerials of the parasitic element type.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.

Written 20th June, 1955

DIPLEXER TUNED FILTER

For use with band III aerials, adaptors, and combined band I/band III aerials

L.B.38

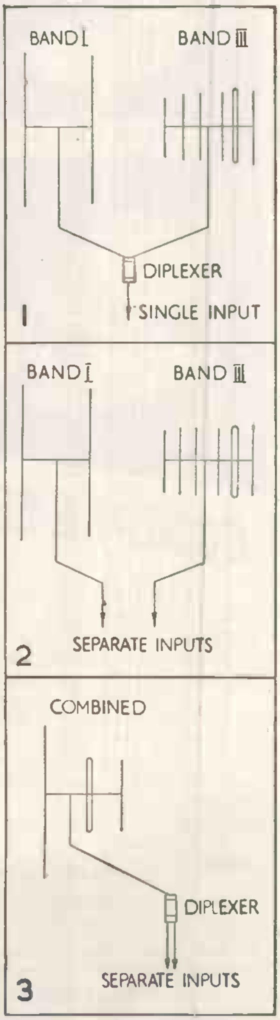
If a television receiver has a single input socket, and if separate band I and band III aerials are being used, viewers can either put up with the inconvenience of changing over the aerial every time they switch to the other programme or they can terminate both aerials into a diplexer and connect the socket output from this to the receiver input. Both signals are available at the receiver, but when the selector switch is tuned to one programme, the receiver does not have to contend with interference picked up on the temporarily unwanted aerial. If the feeders from the two aerials are just bunched and connected to the receiver input, there might be ghosting interference from both aerials instead of from only one, impaired signal strength due to mis-match, troubles due to standing waves on the feeders, or other interaction.

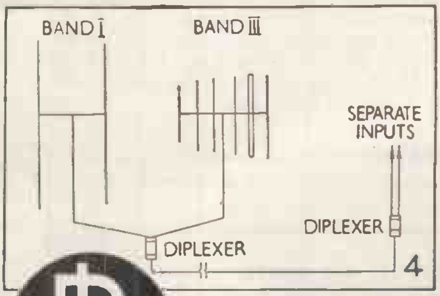
1 A diplexer is necessary where separate band I and band III aerials are fed to a receiver having a single input for both frequencies.

2 A diplexer is not needed where separate band I and band III aerials are fed to a receiver having separate input sockets.

3 A diplexer is only required with combined band I/band III aerials, or aerials fitted with adaptor units, where the receiver has separate inputs.

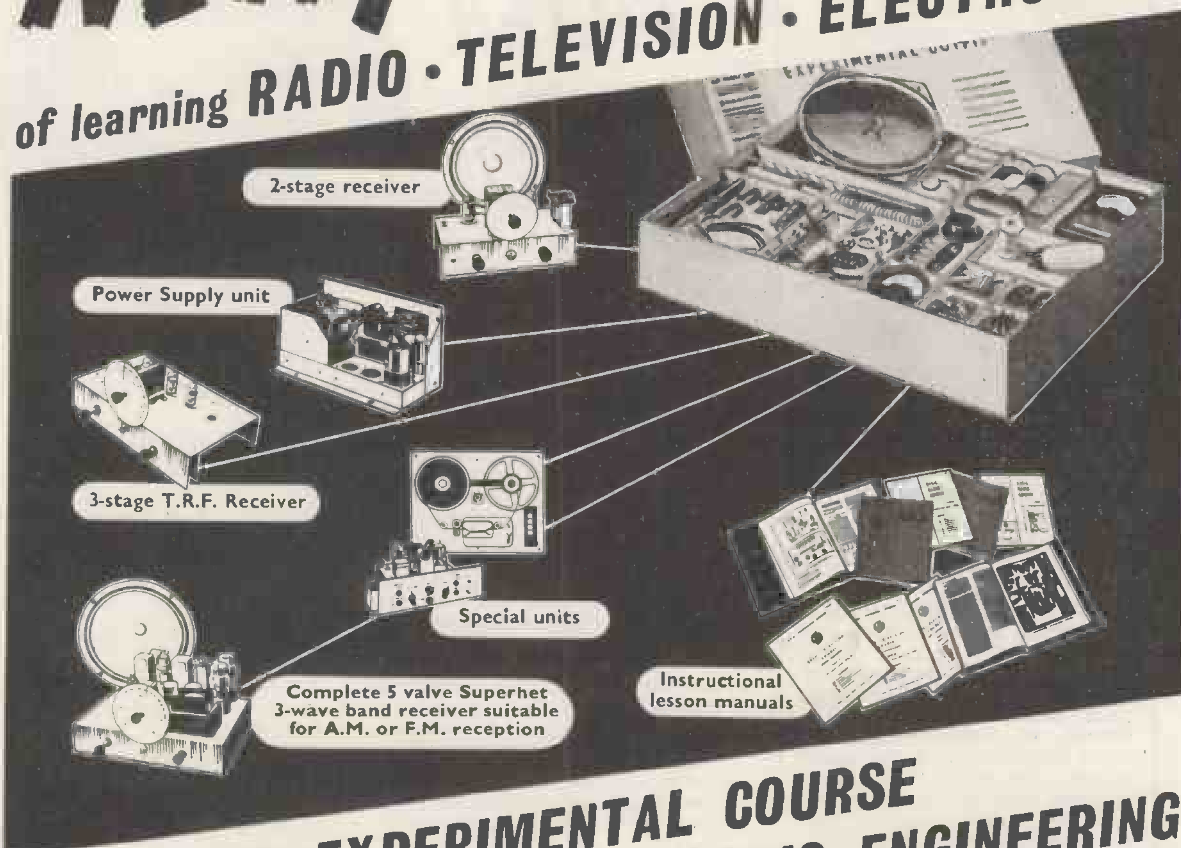
4 On long cable runs, it is often more economical to fit a diplexer at each end, utilising a single feeder low-loss cable.





BELLING & LEE LTD
GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND

NEW! THE PRACTICAL WAY of learning RADIO • TELEVISION • ELECTRONICS



COMPLETE EXPERIMENTAL COURSE in RADIO ENGINEERING and SERVICING

An entirely new series of courses designed to teach Radio, Television and Electronics more quickly and thoroughly than any other method. Specially prepared sets of radio parts are supplied and with these we teach you, in your own home, the working of fundamental electronic circuits and bring you easily to the point when you can construct and service radio receivers, etc.

Whether you are a student for an examination; starting a new hobby; intent upon a career in Industry; or running your own business — these Practical Courses are ideal and may be yours at very moderate cost.

With these outfits, which you receive upon enrolment and which remain your property, you are instructed how to build basic Electronic Circuits (Amplifiers, Oscillators, Power Units, etc.) leading to designing, testing and servicing of complete Radio and Television Receivers.

FILL IN COUPON FOR FREE PROSPECTUS

NEW TELEVISION COURSE including a complete set of equipment dealing with the design, construction and servicing of a high quality television receiver.

Courses (with equipment) also available in *record reproduction, tape recording and many other engineering subjects.*

COURSES FROM 15/- PER MONTH

EMI INSTITUTES

An educational organisation serving the E.M.I. Group of Companies which include
"HIS MASTER'S VOICE," MARCONIPHONE, COLUMBIA, ETC.

To E.M.I. INSTITUTES,
Dept. 127T, Grove Park Road, London, W.4.
Please send me your FREE book on Practical Courses.

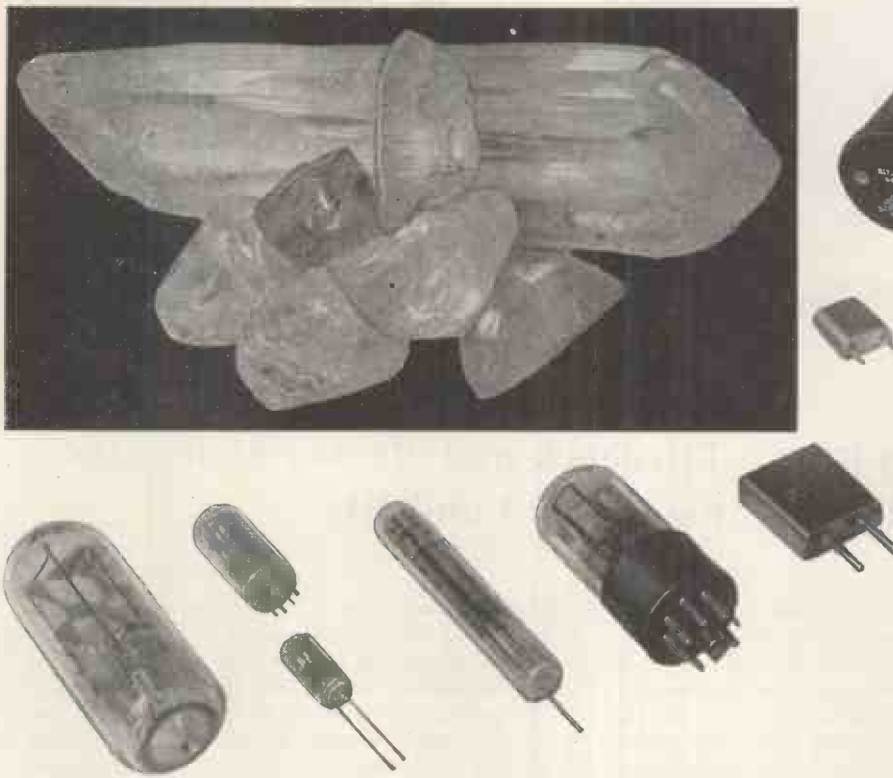
Subject(s) of interest ____________

NAME ____________

ADDRESS ____________

AUGUST/55 IC.68

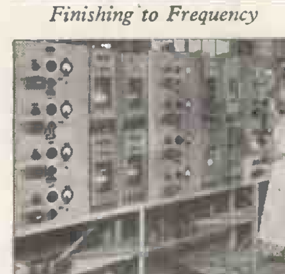
MARCONI CRYSTALS for Stability and Precision



Surface Grinding

Planetary Lapping

Finishing to Frequency



Testing–Grid Current Recording

FREQUENCY RANGE 1·6 Kc/s TO 55 mc/s

The experience gained in manufacturing quartz crystals to the stringent requirements of our own apparatus and those of the Services, enables us to offer a comprehensive range of crystals covering the frequency band 1.6 Kc/s to 55 mc/s. Years of intensive research and development work in this field guarantee the reliability and quality of this Marconi Product.

Lifeline of communication

MARCONI

MARCONI'S WIRELESS TELEGRAPH CO. LTD., CHELMSFORD, ESSEX Telephone: Chelmsford 3221

CR2

ANNOUNCEMENT

FM RECEIVER ALIGNMENT GENERATOR MODEL 1324

This Alignment Generator will be available next month to provide the Service Engineer with a compact test set with which all essential alignment procedures on FM Broadcast Receivers may be undertaken.

Accurate trimming for correct overall and IF response curves is easily carried out and facilities will be provided for discriminator alignment and checks on its sensitivity and distortion.

COSSOR Model 1322

Telecheck and Marker Generator for Bands I and III

Model 1322—used in conjunction with a cathode ray oscillograph—provides equipment for the display, measurement and correct adjustment of RF and IF response curves of television receivers. This entirely new instrument comprises a swept oscillator covering the Television BANDS I and III (5-75 Mc/s. and 155-225 Mc/s.) and a frequency marker oscillator so that precise calibration of the oscillograph display may be made; accuracy of the frequency of the marker pips being verified by reference to an internal crystal. The alignment oscillator is set to the video carrier to which the receiver is tuned and the sweep (either 1 Mc/s. or 10 Mc/s.) is automatically derived from the time base voltage of the display oscillograph. The response of the " strip " under test to the frequency band applied is then presented on the screen of the cathode ray tube. The RF output of Model 1322 is available at 80 ohms and is adjustable from a maximum of 40 millivolts to a minimum of 25 microvolts through a coarse and fine attenuator.

TELECHECK CONVERTER FOR BAND III Model 1321

This adaptor provides owners of Model 1320 " Telecheck " with an extension of the frequency range of the original instrument into the BAND III television channel. Thus, alignment procedures adopted for BAND I RF/IF " strips " are available also for BAND III receivers. A selection of the desired BAND is made by means of a switch. Pattern generator facilities for picture time base linearity checks have been retained. Model 1321 Adaptor is designed for permanent attachment to the standard " Telecheck " providing a neat, light and compact unit. Mounting is effected by four screws and the inter-connecting wiring is carried in a single insulating sleeve.

COSSOR INSTRUMENTS LIMITED

Write for illustrated leaflets about both these instruments:

Dept. 1, COSSOR HOUSE, HIGHBURY GROVE, LONDON, N.5.

CI.60

Telephone CANonbury 1234 (33 lines *Telegrams: Cossor, Norphone, London* *Cables: Cossor. London.*

Marconi Double Diversity Telegraph Recording Unit

TYPE HU.12

Shown here is the HU.12, in the bench mounting cabinet where it fits on top of the power unit. It can also be built into a standard rack which houses the associated receivers.

The HU.12 unit is designed for use with two suitable receivers of frequency shift or on-off telegraph transmissions in double diversity. The combined AF outputs of the receivers are converted into double current signals to operate an undulator, relay or other 'space-mark' type of equipment requiring a current up to 30 mA. No receiver modification is necessary except, perhaps, adjustment of the BFO frequency.

Satisfactory recording is possible should the first oscillator drift up to ± 800 c/s.

FEATURES :-

- **Electronic path diversity selector for FSK will function when difference between paths exceeds 4 db.**
- **Alternative DC output suitable for a low resistance undulator (20+20 ohms) is provided.**
- **Neon indicators for visual tuning of FSK reception.**
- **Front of panel control for pre-set 'mark' and 'space' current adjustment, filter selection and signal bias.**

Over 80 countries now have Marconi equipped telegraph and communication systems. Many of these are still giving trouble free service after more than 20 years in operation.

Lifeline of communication

MARCONI

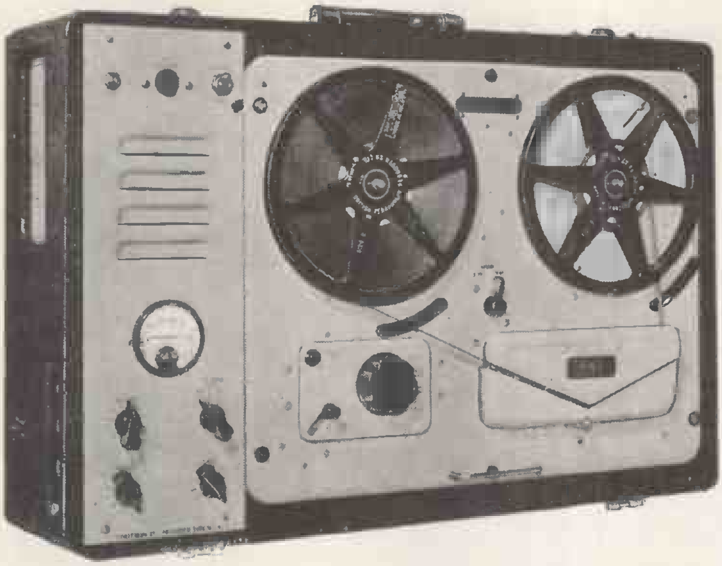
COMPLETE COMMUNICATION SYSTEMS

Surveyed, planned, installed, maintained

MARCONI'S WIRELESS TELEGRAPH CO. LTD., CHELMSFORD, ESSEX

Partners in Progress with The 'ENGLISH ELECTRIC' *Company Limited* LC 13

VORTEXION TAPE RECORDER



★ The total hum and noise at $7\frac{1}{2}$ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

The amplifier, speaker and case, with detachable lid, measures $8\frac{1}{4}$in. x $22\frac{1}{2}$in. x $15\frac{3}{4}$in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

We supply and recommend the Jason F.M. Feeder Unit. **PRICE £15 17 0,** including Purchase Tax.

FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.
It is recommended by a number of tape recorder manufacturers for this purpose.
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.
The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.
The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.
An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.
Used in many hundreds of large public address installations and recording studios throughout the world.

PRICE £36 15 0.

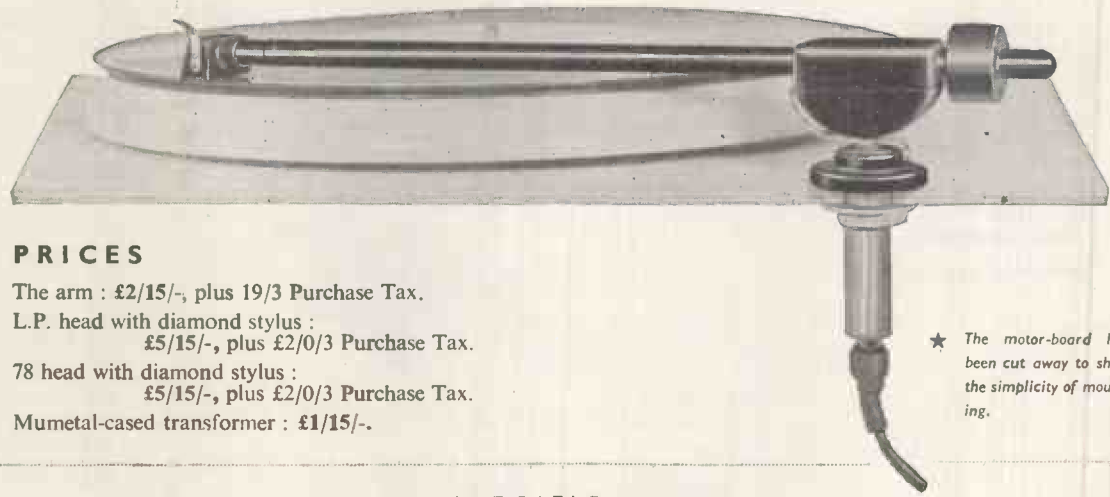
Manufactured by

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

THE LEAK DYNAMIC PICKUP

This pickup will very probably earn recognition as the best in the world. It is a definite advance on the pickup introduced five years ago, which is used in many recording studios for dubbing and playback.



★ *The motor-board has been cut away to show the simplicity of mounting.*

PRICES

The arm : £2/15/-, plus 19/3 Purchase Tax.

L.P. head with diamond stylus :
£5/15/-, plus £2/0/3 Purchase Tax.

78 head with diamond stylus :
£5/15/-, plus £2/0/3 Purchase Tax.

Mumetal-cased transformer : £1/15/-.

SPECIFICATION

★ THE ARM

This is of advanced design having very low inertia. Friction is kept to a minimum by using a single pivot bearing. The arm is counter-weighted and has provision for plug-in interchangeable heads. An arm-rest is provided.

★ GENERATING SYSTEM

Dynamic (moving-coil). Coil impedance approximately 6 ohms, 1,000 c/s. No magnetic material is embodied in the moving parts, and the pickup is free from the inherent distortion of moving iron (magnetic variable reluctance) types. These distortions are also inherent in those dynamic pickups in which the moving coil is wound on a magnetic core.

★ STYLUS

Material : Diamond, guaranteed unconditionally not to chip or break.
Stylus sizes : L.P. 0.001 in. radius + nothing —0.0001 in.
78, 0.0025 in. radius ± 0.0001 in.

★ PLAYING WEIGHTS

Between 2 and 3 grammes for L.P.
Between 5 and 6 grammes for 78.
Automatically adjusted by the weight of the head.

★ RECORD AND STYLUS WEAR

These are lower than on any pickup of which we have cognisance. Diamond has a playing life of approx. 100 times longer than sapphire, and because it will take a higher polish than any other material it therefore causes less record wear.

★ OUTPUT

The shielded step-up transformer delivers an output of 11 mV for each cm/sec. r.m.s. recorded velocity. This means that an amplifier with a sensitivity of 40 mV at 1,000 c/s will be easily loaded by the pickup from commercial records.

★ FREQUENCY RESPONSE

Total variation ± 1 db 20,000 c/s to 40 c/s with the LP head, including transformer (recorded velocity 1.2 cms/sec. r.m.s. above turnover).
Low frequency resonance :
20 c/s ± 5 c/s with our very lightweight arm.
High frequency resonance :
0.001 in. radius Vynil, 21,000 c/s ± 2,000 c/s.
0.0025 in. radius on shellac, above 27,000 c/s.
The frequency response does not change with temperature.

★ SIGNAL-TO-HUM-RATIO

It is not possible to specify this important ratio without stipulating the strength of the interfering fields. These fields will, of course, vary according to the installation. However, for the purpose of comparison measurements have been taken under working conditions, i.e. with various pickups mounted normally within inches of the electric turntable motor and within two feet of a power transformer in an amplifier. The results show that the Leak Dynamic Pickup has a lower hum content than any variable reluctance (moving-iron, magnetic) pickup and a very much lower hum content than a single turn moving coil (i.e. "ribbon") pickup. This confirms what would be expected from theoretical considerations.

★ DIMENSIONS

From the centre of the fixing stem to the front of the pickup head, 9¼ in. From the centre of the fixing stem to the rear of the arm, 2 in. The height of the pickup is adjustable and it can be used with any turntable.

★ MOUNTING

A template of original Leak design is supplied, enabling the pickup to be accurately located on the turntable mounting board. There is a single fixing hole and the stem contains a miniature socket which accepts the plug leading to the transformer (see illustration).

★ TRANSFORMER

The transformer has a step-up ratio of 1.80 and is heavily shielded in mu-metal. The primary lead is terminated in a plug and a shielded secondary lead is supplied.

★ *Write for illustrated leaflet 'W'.*

ELECTROSTATIC LOUDSPEAKERS

Reprints of the article by H. J. Leak, reviewing the latest advances in Electrostatic Loudspeakers, can be obtained from us on request, free of charge.

Sole distributors for H. J. LEAK & CO. LTD.

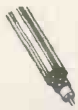
AUDIO TRANSDUCERS LTD., PICCADILLY HOUSE, 33-37 REGENT STREET, LONDON, S.W.1

Telephone: REGent 5659 *Telegrams: HIFI, PHONE, LONDON* *Cables: HIFI, LONDON*

BAND III ITEMS

AERIALS

BAND III AERIALS
These aerials have quick fitting elements, all alloy tube construction and polythene low-loss insulators.



DOWNLEADS

BAND III DOWN-LEAD.
Patented five cell construction ensures maximum air to polythene ratio around the conductor, high performance, 9d. per yard.

THIS MONTH'S SPECIAL

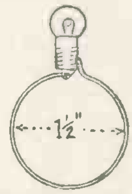
The first of a series of highly efficient low priced aerials to be made by Cleveland Electric.
This is an array for Band III technically known as a folded "v" it is highly efficient, and directional and suitable for indoor or outdoor use, even for fitting on the window frame or coping, or existing T.V. mast, it employs polythene low loss insulators and non-corrodable elements.
Heavy demand likely, so please order at once. Price 17/6, post and packing 1/6.

PRE-ASSEMBLED WITH ⅝in. DIA. RODS

DESCRIPTION	List Price
3-element array with swanneck mast with 'U' bolt clamp for fitting to exiting masts from ⅝in. to 2in. dia...	41/6
3-element array with cranked mast and wall mounting bracket	42/6
3-element array with cranked mast and chimney lashing equipment	56/-
5-element array with swanneck mast and 'U' bolt clamp for fitting to existing mast from ⅝in to 2in. dia...	52/6
5-element array with cranked mast and wall mounting bracket	53/6
5-element array with cranked mast and chimney lashing equipment	67/-
8-element array with swanneck mast and 'U' bolt clamp for fitting to ⅝in. to 2in. dia. mast	69/-
8-element array with cranked mast and chimney lashing equipment	83/6
8-element array with 1¼in. mast cap, 10ft. mast and heavy duty single chimney lashing equipment	134/-
10-element array with cranked mast and chimney equipment	94/6
10-element array with 1¼in. mast cap, 10ft. mast and heavy duty single chimney lashing equipment	145/-
10-element array with 2in. mast cap, 12ft. mast and heavy duty double chimney lashing equipment	178/6

WHAT IS IT?

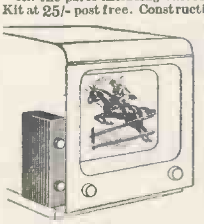
It is the indicator that you would make to check that the "Elpreq Band III Signal Generator" is working properly. When the loop is brought up to the output circuit the lamp lights brightly.



THE "ELPREQ" Band III SIGNAL GENERATOR is most useful. It:—

1. Will provide the signal for tuning to any Band III station.
2. Can be used as a grid-dip meter for checking the frequency of Band III T.V. aerials, Coils, etc.
3. Can be made to give a pattern on T.V. Receiver screen.
4. Can be accurately calibrated with included equipment.

All the parts including valves, tuning condenser and metal chassis are available as a Kit at 25/- post free. Constructional data free with Kit or available separately price 2/6.



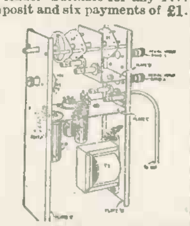
BE READY FOR THE NEW COMMERCIAL T.V.

Daily Test Transmissions are already taking place

Our convertor which fixes to the side or back of your T.V. will give you the new station or the old by the flick of a switch. You do nothing to your existing set; just plug in mains and aerial leads. Suitable for any T.V. Price £6/10/-, or 30/- deposit and six payments of £1.

BUILD YOUR OWN CONVERTER

The Converter has given very satisfactory results from the experimental Beulah Hill station. It uses 2 valves, is not at all difficult to make and can be lined up with the simple 25/- instrument described above. Price for all the components including constructional data is £3/10/- or £4/10/- with mains equipment. Price includes stove enamelled case, prepared metal chassis, and all parts to make up convertor as illustrated—data available separately price 2/6.



MADE FOR THE JOB

This ex-W.D. 10-valve superhet was designed to receive 200 megacycles transmissions so it will require virtually no conversion to receive the commercial T.V. programmes.

These contain 6 valves type SP61, and one each RL7, RL16 and EA50. Six IF transformers 12 Mc/s. band and hundreds of other useful components. Price 59/6, plus carriage and packing 7/6 These receivers are unused and perfect.

THE ELPREQ F.M. UNIT

In the ELPREQ F.M. Tuner four valves and two crystals are used. The last valve acts as a limiter so reducing the necessity of exact tuning and at the same time improving interference rejection. Crystals are used in the ratio detector to avoid heater-cathode hum so often encountered with valve ratio detectors. Stability is extremely good and tuning most simple. The tuner draws its power supplied from the set or amplifier, its valve heaters are not connected to earth.
With only a simple indoor aerial made by parting the ends of ordinary flexible cable this tuner works very well at Eastbourne (over 60 miles from London) and we await reports from even greater distances.
Cost of all parts including valves, prepared metal chassis, scale, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit suitable for mounting through the side or back of an existing reasonably sized radio, or into a separate cabinet, is £6/12/6, data is included free with the parts or is available separately price 2/-.

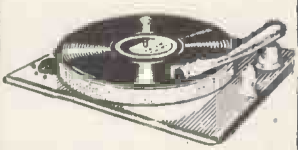
SALE! *SPECIAL PRICES THIS MONTH*

2/6 100ft. Post Free.

CONNECTING WIRE

P.V.C. covered in 100ft. coils—most colours—four coils, different colours, 9/-.

3-SPEED RECORD PLAYER



3-speed record player with pick-up using the famous Acos "Hi G" turnover crystal —motor also by very famous maker. All on unit board ready for installation. A wonderful bargain at £5/10/-, plus 5/- carriage.

17/6 Carr. 3/6.

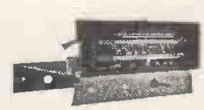
12" TELE-CABINET

Veneered and Polished—Perfect. New and unused.

CARBON RESISTORS

50 assorted ¼ and ½ watt resistors. Ranging between 10 ohms and 10 meg. ohms. (Our Selection). Price 5/- pkt. 50 at 1 watt, 7/6.

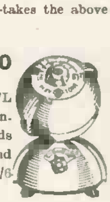
12/6 Post 1/-.



CONSTRUCTOR'S PARCEL

Five valve superhet chassis—size 15 × 5 × 2in. with three waveband glass scale, pulley, driving head, etc.
Also TABLE CABINET
Veneered and polished—takes the above chassis, 39/6. Post 2/6.

NOVELTY RADIO



Complete tunable M/L Radio with room for 3in. speaker in base. Needs only valves, speaker and batteries, 29/6, plus 2/6 postage, etc.

BEETHOVEN CHASSIS

Chassis size approx. 9½ × 7½ × 8½. First-class components. A.C. mains operation; Three wave (medium and two shorts). Complete with five valves, ready to work. Special cash-with-order price this month. £5/19/6, carriage and insurance 7/6.

10/- Carr. 3/6.

BAKELITE CABINET

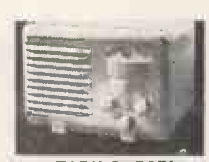
Two tone with built-in handle. Note.—All have slight imperfections but these are hardly noticeable and will not affect the soundness of the set.

2/6 Post 9d.

INSTRUMENT CASE

Veneered and polished—undrilled.

14/6 Post 2/6.



CONSTRUCTOR'S PARCEL

Bakelite cabinet, complete with dial, metal chassis and back, and plans of T.R.F.

1/- Post 1/- for 4.

UNBREAKABLE GLASS PANELS

Size 10½ × 9½in.—parcel of five panels 5/-. Post free.

CORNER CONSOLE

A massive cabinet but being corner fitted is not out of place even in a modern small living room. Overall dimensions of this cabinet are 47in. wide × 31in. (deep to corner) × 50in. high. Made to house 15in. Televisor, Radio Unit, Amplifier, Tape Deck, etc. Originally £18. Our Price—£10 plus 30/- carriage.

THIS MONTH'S SNIP

Prepared metal chassis for 5-valve superhet size approximately 12" × 8½" × 3" fitted with coil pack (L. M. & S.), two 465 KC I.F. transformers, wave change switch, and scale.
These are ex-equipment, fully reconditioned tested and guaranteed. Price is only 14/6 (less than the value of coil pack only), complete with circuit diagram, post and packing 1/6 extra.

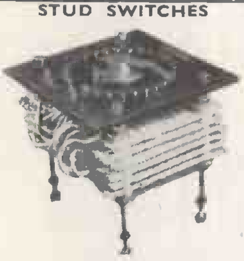
SELECTIONS FROM MISCELLANEOUS STOCKS

TRANSORMER PRIMARIES

These are transformers with wound, primaries tapped 200, 220 and 240 but with no secondaries. There is ample window space, however, for the hand winding of secondary to suit your own requirements. Number of turns per volt required, depends upon the overall size of the stack, for example, our 100 watt stack requires approximately 2½ turns per volt. The size required depends upon amps. taken out and the voltage, e.g. if 10 amps. at 10 volts is required then a 100-watt primary is needed. 50 Amps. at 5 volts requires 250 watt, etc., etc. Transformers are complete with clamps and feet.

Watts	Price	Post & Pkg.
80	7/6	1/6
100	10/-	2/-
120	12/6	2/6
250	12/6	2/6
500	25/-	4/6
1,000	40/-	6/6
2,000	60/-	8/6

STUD SWITCHES



Stud Switch for building up variable resistors as illustrated or similar devices, complete with handle, metal side pieces, and spacer bolts. Price 6/6, post and packing 1/-.

SPECIAL BARGAINS FOR CALLERS at all BRANCHES

SELECTIONS FROM OUR RANGE OF CABINETS

EMPRESS CONSOLE

This cabinet is undoubtedly a beautiful piece of furniture. It is elegantly veneered externally in figured walnut, internally in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut, it measures 16 × 14in. and has a clearance of 5in. from the lid. There is a compartment for the storage of recordings.
Overall dimensions of this essentially modern cabinet are 3ft. wide, 2ft. 8in. high, and 1ft. 4½in. deep.
Price £15/15/-, carriage etc., 12/6.

THE CONTEMPORARY

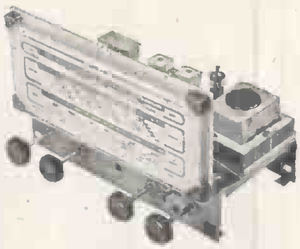
Also in the modern trend is this very stylish contemporary console. Veneered in oak with contrasting mouldings, and is ideal for use with modern furniture or with other contemporary fittings or furnishings. The radio and motor board is uncut and its size, 30 × 15½in., provides ample room for all equipment. Price £8/15/-, carriage etc., 12/6.

OFFERED AT APPROX. HALF COST TO MAKE

An impressive costly looking cabinet originally designed for T.V. but simple modification makes the cabinet suitable for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 22in. deep and 37½in. high. Limited quanity left at £8/15/- each, which is approximately half of their manufacturing cost. Also slightly damaged but repairable. Price from £6. Carriage 12/6.

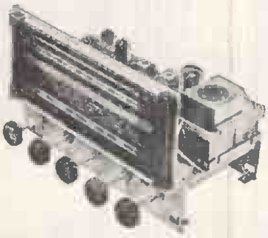
BEST SELECTION OF CHASSIS IN LONDON

THE CLEVELAND "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 sizes is 10½ × 4½in.
This reciver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results.
Price £11/10/- or £3 deposit—carriage, etc., 7/6 Similar model but with ferrite rod aerials £12/10/-. Hire purchase deposit £4.

THE LATEST DULCI



This is the Model F3PP. Developed especially to meet the increasing demand for high fidelity equipment. Particularly suitable for replacement in a radiogram. This is a 7-valve 3 wave band superhet with push-pull output, incorporating separate bass and treble controls thereby ensuring a maximum control of fidelity, volume and tone. Wave band coverage 16-50, 190-550, 900-2,000 metres. Valve line X79, 6BA6, ECC83, GZ30 and two 6AQ5. This chassis is suitable for use on A.C. mains from 100-110 v. and 200-250 v. Price 17 guineas or £4 deposit carriage and insurance 7/6.

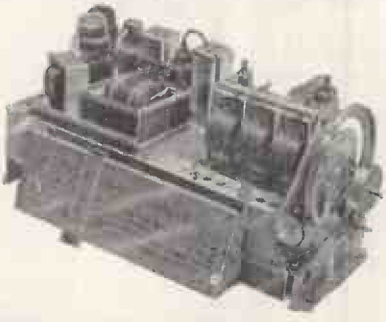
ANOTHER CLEVELAND CHASSIS—"THE TREMENDO"

The Cleveland Organtone is good, but this one is really superb. It has a 7-valve circuit with 6 watts output, fitted with independent bass and treble controls. It is really an efficient R.F. circuit coupled to a high-fidelity amplifier. The chassis size is the same as the Organtone, namely 12 × 7 × 7 with the 10½ × 4½ multi-coloured scale, and it is built to the same exacting specification as the Organtone. Price £15/10/-, carriage and packing 7/6. H.P. terms if required. Ditto but with ferrite rod aerial coil. £16/10/-.

THE ARMSTRONG F.C. 48

Among high class radio chassis, the name Armstrong is probably the most famous, and their new model FC48 certainly lives up to tradition. It is virtually a 10-valve circuit, for among its eight valves two double triodes are employed. Special features of this chassis are (a) 8 watts output in a push-pull circuit with ample negative feed-back to ensure the highest fidelity: (b) provision for using F.M., e.g., power brought out to sockets and indicator on dial: (c) independent bass and treble controls with visual indication of setting: (d) four wave bands covering 16-51, 50-120, 190-550, and 1,000-2,000 metres. The size of this chassis is 12½ × 9 × 9½in. Price £23/18/-, plus 7/6 carriage and insurance.

OFFERED FOR PRICE OF ITS COIL PACK ONLY



This set, a product of one of our famous manufacturers, has H.F. stage, tuning indicator, and all modern refinements, covers 5 wavebands including short waves to 11 metres. Offered less valves, power-pack, scale and drive, otherwise complete and unused, price £5. Or 20/- deposit, balance over 12 months, carriage 7/6 (uses octal range valves).

ELECTRONIC PRECISION EQUIPMENT LTD.

249 Kilburn High Road, Kilburn Phone: MAI 4921 Half-day Thursday	42-46, Windmill Hill, Ruislip Middlesex Phone: RUISLIP 5780 Half-day Wednesday	152-153, Fleet St., E.C. Phone: CENTRAL 2833 Half-day Saturday	29, Stroud Green Road, Finsbury Park, N.4 Phone: ARCHWAY 1049 Half-day Thursday

Post orders should be marked "Dept. 2" and addressed to E.P.E. LTD., 123, TERMINUS ROAD, EASTBOURNE.

BK CUSTOM BUILT REPRODUCERS

H.C.12

CORNER HORN ASSEMBLY

★

Designed and executed for those who appreciate near perfection in Sound Reproduction

This and other fine loudspeaker systems are demonstrated daily at our Regent Street Showrooms on audio amplifiers by LEAK, GOODSELL, ACOUSTICAL, ROGERS, and ARMSTRONG.

H.P. TERMS AVAILABLE

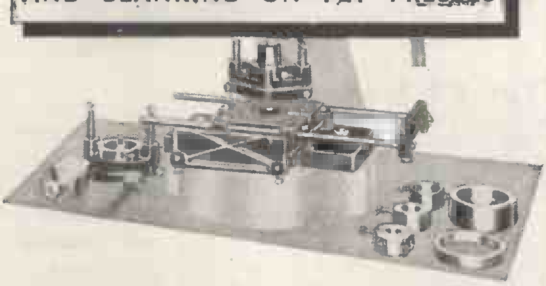
★ *Send for illustrated brochure.*

B. K. PARTNERS LTD.

229 REGENT ST., LONDON, W.1. (*Entrance Hanover St.*) *'Phone: REG 7363*

HUNTON will cut your press tool costs for PROTOTYPE and PRE-PRODUCTION RUNS!

THE UNIVERSAL BOLSTER OUTFIT USING STANDARDISED PUNCHES AND DIES FOR SHEET METAL PIERCING AND BLANKING ON FLY PRESSES



VISIT US ON STAND No. 3
Grand Hall Gallery, Olympia
Engineering, Marine and Welding Exhibition
SEPT. 1st — SEPT. 15th

If in London and Home Counties, ask for a practical demonstration in your own works. Alternatively, write for illustrated price list to:

HUNTON LIMITED, PHŒNIX WORKS, 114-116, EUSTON ROAD, LONDON, N.W.1.

Tel: EUSton 1477 (3 lines). Grams: Untonexh, London.

L·R·S

Estd. 1925

EASY TERMS

LEAK QUALITY EQUIPMENT *for the Connoisseur*

If you want the Finest Quality Reproduction together with Workmanship of the Highest Order your choice must be **LEAK.**

AS USED BY BROADCASTING CORPORATIONS THROUGHOUT THE WORLD.

LEAK "TL/10" AND "POINT ONE" PRE-AMPLIFIER. **Cash Price £28/7/-**, or sent for **£4/10/-** Deposit and 18 monthly payments of 30/-, carr. and crate free.

LEAK TL/10 AND VARISLOPE MK. II PRE-AMPLIFIER. **Cash Price £34/13/-** or sent for **£6** Deposit and 18 monthly payments of 35/-, carr. and crate free.

LEAK DYNAMIC PICK-UP
Complete with two detachable diamond heads and transformer. **Cash Price £20/19/9** or sent for **£3** Deposit and 10 monthly payments of 40/-. Post and packing paid.

Delivery of all the above is from stock. We can also supply Wharfedale, Goodmans and Tannoy loudspeakers, etc., Connoisseur Variable 3-speed Motors and all other Quality Equipment on EASY TERMS.

Please let us have your requirements.

14 DAYS FREE TRIAL

with the SUPERB NEW

REMINGTON '60' ELECTRIC SHAVER

will convince you

that it really does shave quicker and smoother than any other method. The extra long shaving heads are slightly arched to fit easily into those hard-to-shave spots.

SEND DEPOSIT OF ONLY 5/- FOR IMMEDIATE DELIVERY
(*Returned if not satisfied*)

Balance after 14 DAYS FREE TRIAL 15/-, and 8 monthly payments of 24/-. Cash Price £9.17.11. AC/DC 200-250v. Brand new. Sent post paid in silk lined presentation case.

● **WE WILL ALLOW YOU 40/- FOR YOUR OLD ELECTRIC SHAVER** if you decide to keep the **REMINGTON** after trial.

SEND FOR FREE BROCHURE

The L. R. SUPPLY Co. Ltd.
BALCOMBE : SUSSEX Phone 254

TAPE PRE-AMPLIFIER

. . for those who want the best . .

Used with the WEARITE 2B DECK, our Tape Pre-amplifier 4/WRB/2b is capable of giving recorded quality to the highest professional standards; yet at moderate cost.

- ★ **Completely separate recording and replay chains with direct/replay monitor comparison switching.**
- ★ **Correct pre- and post-equalization to C.C.I.R. standards.**
- ★ **Peak-programme signal metering.**
- ★ **Positive metering of bias and erase voltages.**
- ★ **Designed mainly for WEARITE 2B Tape Deck—uses all the facilities provided on this deck.**

Price 55 gns.

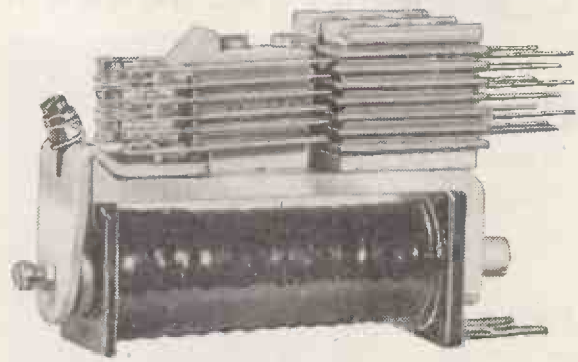
For full details, write or telephone:

ARIEL SOUND LTD.,

57, LANCASTER MEWS, LONDON, W.2.

Telephone: PADDINGTON 5092

STEVENAGE RELAYS LTD



- Manufacturers of Type 3,000 relays with contacts and windings to customers' requirements.
- Impregnation, tropicalisation and high voltage insulation available.
- No used or second-hand materials employed.

For particulars apply:

48 DOVER STREET, LONDON, W.1

Grosvenor 1716

Transformers

Transformers

Transformers

QUALITY-RELIABILITY

For the Mullard Amplifier.
For the Osram 912 Amplifier.
For the Williamson Amplifier.
C. R. Tube Isolation Transformers.
Instrument Transformers,
and all popular types.

FROM

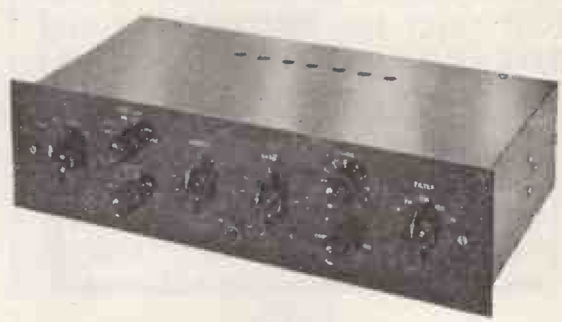
Ellison Transformers

LIMITED

62, BRIDGE ST. NORTHAMPTON

AND ALL LEADING COMPONENT DEALERS

GOODSELL



Type PFA Pre-amplifiers

The latest PFA unit is built especially for use with our range of Williamson Amplifiers. Separate bass and treble control in equaliser section. Low noise—high gain, 5 mv. input, 6 valves.

Price **£20.**

Write for details of Williamson and Mullard 20-watt amplifiers and F.M. units

★ *Demonstrations of all these units at B.K. Partners Ltd., 229, Regent St., London, W.1. and Classic Electric Co. Ltd., Croydon.*

GOODSELL LTD.

40 Gardner Street · Brighton 1 . Sussex

Tel. : Brighton 26735

"High Fidelity Reproduction"

RADIO TUNING UNITS A.M. & F.M. DESIGNS

AMPLIFIERS ASSEMBLED or KITS OF PARTS

"STERN'S" HIGH QUALITY 8-10 WATT AMPLIFIER

Having a front panel which is very attractively finished in deep gold, and on which the controls are clearly identified. The ideal amplifier for general home use and for small halls, etc.

Price of COMPLETE KIT including Valves and Drilled Chassis, etc. (Plus 2/6 carr. and ins.) **£7/10/-**

We will supply it Completely Built for (Plus 5/- Carr. & Ins.) **£9/10/-**

Designed for high quality reproduction up to an output level of 10 watts, having 6V6s in Push-Pull and incorporating negative feedback. It is suitable for use with all types of Pick-ups and most types of microphones and the output transformer provides for use of 3 and 15 ohm speakers.

BRIEF FEATURES

- Valve line-up 6Z5, 6SN7, 5Z4, with 6V6s in push-pull.
- The undistorted output level of up to 10 watts is produced from an input of .25 volts.
- First class reproduction of Radio (where a Tuning Unit is used) and Record Playing.
- Separate Bass Boost and Treble Controls provide an excellent range of frequency control.
- Very satisfactory results are obtained with an average type of high Impedance Moving Coil or Crystal Microphone, a clear speech level of approx. 5 watts output being obtained.
- Power supplies (HT and LT) are available for a Tuning Unit.
- For operation on A.C. Mains 200-250 volts 50 cycles.

THE ASSEMBLY MANUAL is available for 1/- and includes detailed layouts and component Price List.

"STERN'S" 12 WATT "HIGH FIDELITY" Push-Pull AMPLIFIER

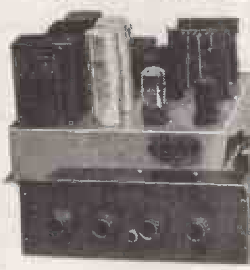
A very high quality Unit attractively finished in deep gold with each control clearly identified on the front panel. Comprising a Main Amplifier Chassis and a Remote Control Pre-Amplifier-Tone Control Unit. The remote control unit measures only 9 × 4 × 2½in. and contains four controls, being; Bass-Treble-Volume and a Radio, Gram, Microphone Switch control. It incorporates its own feed-back circuit on the Bass Channel. Loop negative feed-back is employed on the Main Amplifier which has a valve line-up of 6J5-6N7-5U4 with two PX25s in push-pull and 6J5 and 6SN7 are used in the remote control unit.

THE COMPLETE KIT IS AVAILABLE FOR (Carr. & Ins. 6/- extra.) **£14/0/0**

THE COMPLETE UNIT ASSEMBLED AND READY FOR USE **£17/0/0**
H.P. Terms £4/5/- Deposit, 12 Months at £1/3/11. (Carr. & Ins. 7/6 extra.)

The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV and 6.3 volts at 2 amps. and 30 mA. H.T. is provided for tuning unit, etc. This Amplifier compares well with the Williamson and similar designs at a fraction of their cost. The complete set of assembly instructions is available for 2/-.

A COMPLETELY ASSEMBLED "HIGH FIDELITY" PUSH PULL AMPLIFIER.



Supplied Complete with THE STERN'S DUAL CHANNEL TONE CONTROL PRE-AMPLIFIER UNIT FOR ONLY £13/13/-
(plus 7/6 Carr. & Ins.)

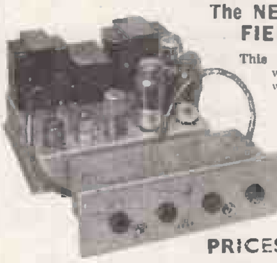
H.P. TERMS DEPOSIT £3/8/- and 12 monthly payments of 19/2.

We are able to offer this equipment at such an attractive price only because of a bulk purchase of PARMEKO TRANSFORMERS, CHOKES, etc.

It is designed for really good reproduction, employing two 6F6s in push-pull for approximately 10 watts output. A total of 7 valves are employed, the main Amplifier having 6J5—6SN7—two 6F6s and 5 Volt Rectifier and the separate Control Unit, which is identical to that supplied with the 12 Watt "Hi Fi" Amplifier described above, has types 6J5 and 6SN7. Loop Feedback is employed over the whole of the main Amplifier and the PARMEKO OUTPUT TRANSFORMER ensures really good reproduction. Power take-off socket is provided for an external Radio Tuning Unit, the POWER SUPPLY AVAILABLE being 200 to 250 Volts at 45 mA. and 6.3 Volts at 1½ amps.

WHEN ORDERING PLEASE STATE WHETHER FOR 3 OR 15 ohm SPEAKER.

The NEW "LEAK" TL/10 AMPLIFIER and "Point One" PRE-AMPLIFIER



This Amplifier has a maximum output of 10 watts and maintains in every respect the world renowned LEAK reputation for precision engineering; fine appearance and fastidious wiring. The Pre-Amplifier will operate from any make or type of pick-up. A continuously variable input attenuator at the rear of the Pre-amp. permits the instantaneous use of crystal, moving iron and moving coil pick-ups. H.T. and L.T. supplies are available for a Radio Tuning Unit. An input attenuator is fitted. S.A.E. for descriptive leaflet.

PRICES:

(a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER, £28/7/-, or £7/2/- Deposit and 12 months at £2.

(b) The TL/10 MAIN AMPLIFIER ONLY: £17/17/-, or £4/7/- Deposit and 12 months at £1/5/4.

(c) The "POINT ONE" PRE-AMPLIFIER ONLY: £10/10/-, or £2/12/6 Deposit and 12 months at 15/-.

THE DENCO F.M. FEEDER UNIT

INCORPORATING AN R.F. STAGE

A 5 VALVE SUPERHET DESIGN having a frequency coverage of 88 to 100 mc/s. This F.M. Receiver is designed to operate with any type of Amplifier and most Radio Receivers. It incorporates R.F.—F/Changer and two I.F. Stages followed by a Ratio Discriminator, the valve line-up being 6AM6—12AH8—two 6BA6s and 6AQ5. Overall size of assembled Chassis 7in. × 5½in. × 4¾in. high excluding power supply, or 7in. × 8½in. × 4¾in. high with power supply.

The CONSTRUCTOR'S MANUAL, containing Circuit Diagram and Component Layout, etc., is available for 1/6, and WE CAN SUPPLY ALL SPECIFIED COMPONENTS including Valves and Drilled Chassis for Assembly as illustrated, or for £7/2/6 with Dial **£6/13/6** (plus 2/6 carriage and ins.)

WE WILL ALSO SUPPLY IT . . .

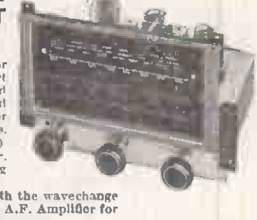
(a) Assembled and Ready for use, excluding Dial Assembly, £8/17/6.

(b) Assembled and Ready for use including Dial Assembly (as illustrated), £9/10/-.

(c) Assembled and ready for use, with Dial Assembly and "Magic Eye" indicator mounted in centre of Dial, £10/10/-.

(d) We can also supply (a), (b), and (c) with and including an HT LT Power Supply for an additional £2/17/6. The Supply Unit is also available as a separate Unit size 6¼in. × 3in. × 5in. high. Provides 250 volts at 50 mA. and 6.3 volts at 2 amps.

"STERN'S" MODEL CP3G 3 WAVEBAND SUPERHET TUNING UNIT



A highly sensitive tuning unit providing for excellent reception of stations on the short wavebands (16-50 metres) medium waveband (200-550 metres) and the long waveband (800-2,000 metres). We can supply this tuner to correctly operate with each of the Amplifiers.

- Valve line-up; 6K8G (Frequency Changer) 6SK7g (I.F. Amplifier), 6Q7g (Detector, A.V.C. and 1st A.F. Amplifier), and 5Z4g (rectifier).
- A gramophone position is incorporated with the wavechange switch and the 6Q7g valve becomes the 1st A.F. Amplifier for the gramophone pick-up.
- This tuner is normally supplied with four controls—Tuning, Volume, Tone and the Wavelength Switch (Tone and Volume operate as both Radio and Gram.)—but if your Amplifier already has the Tone and Volume Controls we can omit both. When ordering please state what is required.
- Overall chassis dimensions are 12in. × 8½in. × 8in. including the full vision dial. Size 8¾in. × 4½in.
- For A.C. Mains only, power supply required—H.T. 250 volts 30 mA., L.T. 6.3 volts 1½ amp.

Price, completely assembled and including built-in power supply £10/10/-. H.P. Terms. Deposit £2/12/6. 12 months at 15/-.

Price completely assembled excluding Power Supply £9. Carriage and Insurance 7/6 extra. (Dial Escutcheon is 4/6 extra.)

SPECIAL PRICE REDUCTIONS

SELECT ANY TUNING UNIT and an assembled AMPLIFIER (or a TUNING UNIT, AMPLIFIER and RECORD PLAYER) and we will quote you a REDUCED PRICE for the combined order. H.P. TERMS ALSO QUOTED. . . . As an example we offer:

(a) STERN'S 8-10 WATT AMPLIFIER and the Model CP3G (or DENCO F.M. TUNER) all assembled for £17/-/- (plus 10/- carriage & insurance). H.P. TERMS. Deposit £4/5/-. 12 months of £1/3/8.

(b) The above Units with the B.S.R. MONARCH 3-SPEED CHANGER for . . . . £26/10/-. H.P. TERMS. Deposit £6/12/-. 12 months of £1/16/11.

EQUIPMENT OF THIS NATURE ENSURES "FIDELITY" REPRODUCTION ON BOTH RADIO AND GRAM.

109 & 115 FLEET ST. LONDON, E.C.4. Phone: CENTRAL 5812-3-4

!! Home Constructors !!

YOU CAN ASSEMBLE The Stern's "Fidelity" TAPE RECORDER FOR ONLY £40

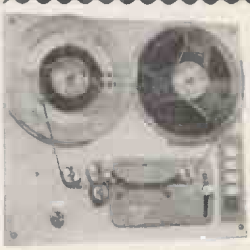
H.P. Terms are shown below.

!! IT ONLY NEEDS CONNECTING UP !!

We are completely satisfied that this Tape Recorder, although supplied at a genuinely low price, provides absolute Fidelity Recordings and, in addition to being completely dependable, has a performance at least equal to recorders marketed at a far higher price. The actual assembly of the Tape Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Quality Amplifier are supplied tested and ready for use, and all that is required to complete the Recorder is to connect the two together (a connection chart is supplied for this purpose) and secure them by the screws provided into the Attache Case. The items illustrated and described below form the complete equipment.

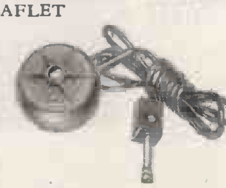
- WILL TAKE ALL STANDARD TAPES UP TO 1,200ft.
- WILL PLAY THE NEW PRE-RECORDED TAPES
- WILL PROVIDE 2 HOURS' PLAYING AT 3¾in. or 1 hour at 7½in. per second.
- INCORPORATES AN ELLIPTICAL P.M. SPEAKER 7×4in., with EXTENDED FREQUENCY RANGE

SEND S.A.E. FOR DESCRIPTIVE LEAFLET



THE NEW TRUVOX MODEL TR7U TAPE DECK

THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3¾in. and 7½in. per sec. Positive Azimuth Adjustment. Overall size only 14¾ × 12¾in.

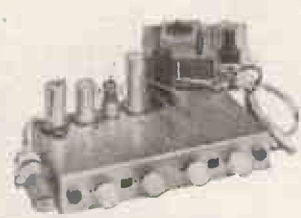


ACOS CRYSTAL MICROPHONE MODEL MIC.33.1

1,200 ft. REEL OF SCOTCH BOY MAGNETIC RECORDING TAPE.

MODEL T.R.I./F. QUALITY AMPLIFIER

This amplifier has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Level Indicator (Operative on Record). In addition it can be used as a general purpose Amplifier for high quality reproduction of gramophone records direct from a Gram Unit.



PORTABLE ATTACHE CASE

This, as may be judged from the illustration opposite, is a neat, compact and attractively finished case, being covered with maroon rexine and having an ivory coloured speaker escutcheon. It contains concealed pockets to accommodate the Microphone, Mains Lead and a spare 1,200ft. reel of tape.

GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)

PRICE SUMMARY

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e., THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40/-/-. H.P. Terms: Deposit £10 and 12 monthly payments of £2/15/0 or in two parts as follows:—

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE	£33 10 0	£8 10 0	£2 6 4
	See note below re packing charge		
(b) ATTACHE CASE AS ILLUSTRATED ACOS CRYSTAL MICROPHONE	£6 10 0	—	—

NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.

EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK	£23 2 0	£5 17 0	£1 12 0
(b) AMPLIFIER MODEL TRIF WITH SPEAKER	£14 14 0	£4 16 6	18 4
(c) PORTABLE ATTACHE CASE	£5 0 0	—	—
(d) ACOS CRYSTAL MIKE "33"	£2 10 0	—	—
(e) REEL OF TAPE 1,200ft.	£1 15 0	—	—

Please include £1 when ordering (a) or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

PRICE REDUCTION OF THE ASSEMBLED RECORDER

WE HAVE DISCONTINUED SUPPLYING WHOLESALERS. THE SAVING EFFECTED ENABLES US TO REDUCE THE PRICE AND OFFER IT COMPLETE AND READY FOR IMMEDIATE USE FOR **£43/-/-.** (Plus £1/10/- carriage and insurance. £1 is refunded when packing case is returned to us.)

H.P. terms. Deposit £11 and 12 monthly payments of £2/18/8.

STERN RADIO LTD.

MAKE YOUR OWN PORTABLE RECORD PLAYER ! ! !

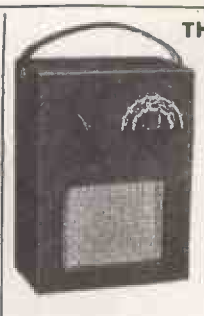
WE OFFER THE PORTABLE CASE ILLUSTRATED

CONTAINING A 3-VALVE AMPLIFIER AND A P.M. SPEAKER FOR ONLY £7/17/6

(plus 10/- carriage and insurance—7/6 refunded on return of Packing Case).
The Portable Case was originally used by Collaro Ltd. for their Microgram Record Player. It is robustly constructed and finished in good quality grey rexine. It will accommodate the COLLARO R.C.54 3-SPEED AUTOCHANGER and any make of 3-speed Single Record Player, all of which we can supply.
The Amplifier will operate with any high impedance Pick up and comprises a 3 VALVE A.C. MAINS design employing a 6K6 Output Valve for approx. 3 watts output. Tone and Volume Controls, combined with On-Off Switch are provided together with a coloured indicator.
Case and Amplifier are available separately.

(a) Portable case (plus 10/- carriage and insurance, 7/6 refunded) £3 7 6
(b) 3-VALVE AMPLIFIER, with P.M. SPEAKER £4 10 0
(Plus 3/- carriage and insurance.)

THE "MINI TWO-THREE"



An "Alldry" Battery Portable of midget size, 6¾in. × 4½in. × 3¾in. designed to cover medium waveband 190-559 metres, with use of short trailer aerial.
The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.
Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up 1T4—1T4—DL94.
The 2-valve set can be completely built for £4/3/6 (less case) and the 3-valve for £5/3/- (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layouts and diagrams.

!! STERN'S AMAZING BARGAIN OFFER !!

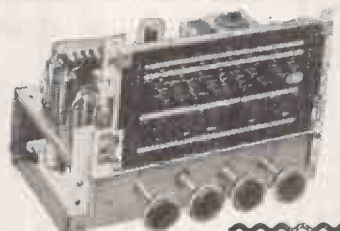
WE HAVE BOUGHT THE ENTIRE STOCK OF THE FAMOUS MODEL B3PP RADIO or RADIOGRAM CHASSIS

A 6 VALVE 3 WAVEBAND SUPERHET with PUSH-PULL OUTPUT

Thousands of these successful and very popular Receiver Chassis have been sold for **£15/15/-** each.

WE CAN NOW OFFER THEM FOR £11/19/6

(plus 7/6 carriage and insurance). H.P. Terms. DEPOSIT £3 and 12 Monthly payments of 17/5.



These Receivers Chassis have undoubtedly proved to be about the most popular and successful yet offered. They are designed to the most modern specification with great attention having been given to the quality of reproduction which gives really excellent clarity of speech and music on both Radio and Gram.

THEY ARE THE IDEAL REPLACEMENT CHASSIS FOR THAT "OLD RADIOGRAM" TC.

ALL CHASSIS ARE BRAND NEW and GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS).

GENERAL DETAILS

- For use on A.C. Mains 100/110 Volts and 200/250 volts.
- Employs the latest Valves 6BE6, 6BA6, 6AT6, two 6BW6's in push-pull and 6X4 (or similar) Rectifier.
- It has a Mains socket on the chassis for connection to Gram unit.
- Incorporates extension speaker and Pick-up sockets.
- Overall size of Chassis is 11in. × 7¾in., 8½in. high. Dial size 8½in. × 4½in. (A Bronze coloured Dial Escutcheon is available for 4/6.
- Waveband coverage is Shortwave 16 to 50 metres, Medium 187 to 550 and Long-wave 900 to 2,000 metres.
- Has four controls; (1) Volume Control with on-off switch. (2) Tone Control (operative on Gram and Radio). (3) Wavechange Switch with Gram position. (4) Tuning Control (Flywheel type drive).
- Negative Feedback is employed over the entire audio stages.
- Excellent reproduction up to approximately 6 Watts output.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 69 volts at 10 mA and 1.4 volts at 250 mA.
This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver, requiring H.T. and L.T. voltage as above, or approx. to 69 volts. The Kit is quite easily and quickly assembled and is housed in a light-aluminium case size 4¾in. × 1¾in. × 3¼in. Price of complete Kit with easy-to-follow assembly instructions, 42/6.
In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts at 10 mA. and 1.4 volts at 250 mA. Size of assembled unit 7in. × 2¼in. × 1¾in. Price 47/6.

A BULK PURCHASE ENABLES THIS

SPECIAL PRICE REDUCTION

OF THE FAMOUS

SHAFTESBURY PORTABLE AMPLIFIER

Suitable for home use and small Halls. Has matched inputs for both Record Players and Microphone. Also provides for the "mixing" and "fading" of both Gram. and speech as request.

COMPRISING

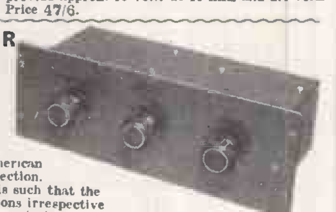
(a) A 4-Valve High Gain Amplifier for use on A.C. or D.C. mains. 200-250 volts with 5 watts output. Incorporating independent Volume Controls for Mike and Gram., either of which can be faded at will, a variable Tone Control and independent input sockets for Mike and Gram.
(b) A Transverse Carbon microphone which obtains its polarizing current from the amplifier—no batteries are necessary.
(c) A 8in. Goodmans P.M. Speaker with the "Ticonal" magnet for first-class reproduction.

THE COMPLETE EQUIPMENT is all contained in the

PORTABLE CARRYING CASE £18/0/0

Having been reduced from £30/9/-. HIRE PURCHASE TERMS DEPOSIT £4/10/- and 12 monthly payments of £1/5/4 ● Light in weight ● Easy to CARRY ● GENUINELY PORTABLE. An illustrated leaflet containing free data is available on receipt of S.A.E.

A DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

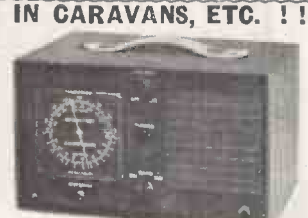


Attractively finished in "Old Gold" and providing full control of BASS and TREBLE in conjunction with a main volume control.
It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-ups and all natures of recordings, i.e., English, American and long-playing without recourse to pick-up correction.
The extreme flexibility of the bass and treble control is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12-watt amplifier advt. The unit measures only 9in. × 4in. × 2½in., including self-contained power supply and can be accommodated either on or away from the main amplifier, i.e. on the front panel of a cabinet or any other position. Price including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data are available separately for 1/-. Completely assembled and ready for use, £5/5/-.

! ! THE IDEAL SET FOR USE IN CARAVANS, ETC. ! !

A 5-VALVE 2-WAVEBAND SUPERHET RECEIVER OPERATED FROM A 6-VOLT BATTERY FOR ONLY £6/17/6

(plus 5/- Carriage and Insurance).



These Receivers, which we have recently acquired by bulk purchase, are ex-British Ministry of Supply, and are new and unused. They are a two-waveband Superhet with R.F. Stage, covering Short Wave 18 to 50 metres and Medium Wave 200 to 550 metres, fully calibrated on a clockface dial. A 5in. loudspeaker is built in and the whole Chassis is contained in a metal cabinet with lid and carrying handle which measures 12½in. × 7½in. × 7½in. overall. Valve line up is 7A7, 7Q7, 7A7, 7B6 and 7C5. They possess excellent sensitivity and will give very good results on a very short aerial. They are made for 6 Volt D.C. supply (current consumption is 4/5 amps.) but we can supply a dropping resistance at 7/6, to also enable their use from a 12-volt battery.

WILLIAMSON AMPLIFIERS BY GOODSELL

These Amplifiers hardly need enlarging upon, being sufficient to say that they have now become the accepted standard for quality reproduction by which all others are judged. Two Models are available:

MODEL G.W.12. Uses slightly lower H.T. voltage to produce 10-12 watts output but otherwise is built completely to specification.
Price **£27/10/-** (Plus 7/6 Carriage and Insurance.) H.P. Terms Deposit £6/17/6 and 12 months at £1/18/8

THE MODEL P.F.A. TONE CONTROL UNIT

This Control Unit has established a reputation for its excellent quality of reproduction and ability to give adequate gain for any type of pick-up.
Price **£20/-/-** (Plus 7/6 Carriage and Insurance.) H.P. Terms. Deposit £5 and 12 months at £1/8/2.

SEND S.A.E. FOR ILLUSTRATED LEAFLETS

109 and 115 FLEET ST.

LONDON, E.C.4. *Phone* : CENTRAL 5812-3-4

SELENIUM RECTIFIERS

L.T. Types		H.T. Type H.W.	
2/6 v. ½ a.h.w....	1/9	120 v. 40 mA....	3/11
6/12 v. ½ a.h.w.	2/9	250 v. 50 mA....	5/9
		250 v. 80 mA....	7/9
F.W. Bridge Types		250 v. 150 mA.	9/9
6/12 v. 1 a.	5/9	RM4 250 v. 250 mA.	11/9
6/12 v. 2 a.	8/9	300 v. 275 mA.	12/11

CO-AXIAL CABLE. 75 ohms ¼in., 7d. yard. Twin screened feeder, 10d. yard.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001µF), .002 mfd. (2,000 pfd.). All at 5d. each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.15 a., 6/9 doz.; 6.5 v. 0.3 a., 6/9 doz.; 4 v. 0.3 a., 6/- doz.

ELECTROLYTICS (current production). NOT ex Govt.

Tubular Types		Can Types	
8µF 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	24µF 350 v.......	2/11
16µF 450 v.......	2/9	32µF 350 v.......	2/11
16µF 500 v.......	3/9	32 mfd. 450 v....	4/9
32µF 350 v.......	3/9	64 mfd. 450 v....	4/9
32 mfd. 500 v....	5/9	100 mfd. 450 v.	4/9
8-16µF 500 v....	4/11	8-8µF 450 v....	3/6
25µF 25 v.......	1/3	8-8 mfd. 500 v.	4/9
50µF 12 v.......	1/3	8-16µF 450 v....	2/11
50µF 50 v.......	2/3	16-16µF 450 v.	4/11
100 mfd. 12 v....	1/9	16-32µF 350 v.	4/9
100 mfd. 25 v....	2/3	32-32µF 350 v.	4/9
Can Types		32-32µF 450 v.	5/11
8 mfd. 350 v....	1/3		
8 mfd. 450 v....	2/3		
16 mfd. 500 v....	3/9		

Many others in stock.

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.	26/9
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.	27/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a....	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a....	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc.	49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	69/6

TOP SHROUDED DROP THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a....	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a....	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a....	22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5. v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a....	29/9

E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 .... 37/6

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.......	5/9	0-4-6.3 v. 2 a....	7/9
6.3 v. 3 a.	8/11	0-2-4-5-6.3 v. 4 a.	16/9
		6.3 v. 6 a.........	17/6
12 v. 1 a.........	7/9	12 v. 3 a. or 24 v. 1.5 a.	17/6
6.3 v. 2 a.........	7/6		

CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a., 18/9. 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA.	7/11
130 v. 50 mA., 6.3 v. 3 a.	14/9
120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v., 250 mA.	9/11

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc....	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000 to 3Ω	4/9
Battery Pentode, 10,000 ohms to 3 ohms...	4/9
Multi-ratio 40 mA. 30:1, 45:1, 60:1, 90:1, Class B Push-Pull	5/6
Push-Pull 8 Watts 6V6 to 3 ohms	8/9
Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω, sectionally wound	16/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watt, 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

SMOOTHING CHOKES

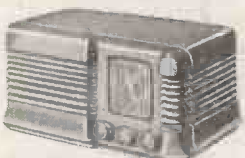
250 mA.,3 H., 100 ohms	11/9
150 mA., 7-10 H. 250 ohms	11/9
100 mA., 10 H., 150 ohms potted	9/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms	5/6
60 mA., 10 H., 400 ohms	4/11

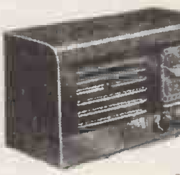
VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

WIRE WOUND POTS: 20 ohms, 500 ohms, 5K, 20K, 100K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K, Preset type, 1/9 each.

VIBRATORS. Wearite 12 v. 4 pin. Non synchronous, 6/9. Oak 2 v. 7 pin, synchronous 7/9.

THE SKY FOUR T.R.F. RECEIVER





A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 2/3. 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.

8.8 v. 4 a.	9/9
48 v. 1 a.	9/9
300-0-300 v. 80 mA. 5 v. 3 a.	8/11
278-0-278 v. 100 mA.	8/9
Carriage on following types 5/- extra.	
0-11-22 v. 30 a.	72/6
16-18-20 v. 35 a.	79/6
7.7 v. C.T. 7 amps., 4 times	25/9
460 v. 200 mA., 6.3 v. 5 a.	27/9
300-0-300 v. 150 mA., 610-0-610 v. 150 mA., 1,200 v. 250 mA.	29/6
400 v. C.T. 150 mA. 4 v. 5 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a.	22/9
325-0-325 v. 150 mA., 6.3 v. 4-6 a., 5 v. 2-3 a.	29/9

EX GOVT. E.H.T. SMOOTHING CONDENSERS

.25 mfd., 4,000 v. Blocks	4/9
.5 mfd., 2,500 v. Blocks	3/9
.5 mfd., 3,500 v. Cans	3/3
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)	9/6
1.5 mfd., 4,000 v. Blocks	5/9

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 800 v....	1/9	6-6 mfd. 450 v.	5/9
4 mfd. 500 v....	2/9	8 mfd. 500 v....	5/9
4 mfd. 1,000 v.	4/3	8-8 mfd. 500 v.	5/11
4 mfd. 1,500 v.	4/9	15 mfd. 500 v....	7/9
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX. GOV. UNITS, type RF26 in original sealed cartons 39/6. Transmitter Receivers type TR9D complete with all valves 45/-, carr. 6/6.

M.E. SPEAKERS. All 2-3 ohms, 8in. R.A. field' 600 ohms, 11/3. 10in. R.A. field. 1,500 ohms, 23/9. 10in. R.A. field, 1,000 ohms, 23/9.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 m.a. 6.3 v. 3 a. 5 v. 3 a. 37/9.

GOODMANS 3½in. P.M. SPEAKER (ex. equip.), with battery pentode trans., 12/9.

HEAVY DUTY BATTERY CHARGER
For normal 200/250 v. A.C. mains input. To charge 12 v. battery. Variable charge rate of up to 10 amps. Fitted Meter and Fuses. Guaranteed 12 months. Carr. 10/-. £6/19/6.

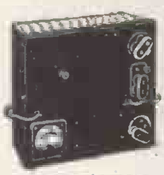
OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT with louvred crackle finished case. Mains input 200-250 v. Output 120 v. 40 mA., and 2 v. ½ a. Price with circuit, 29/6. Or in working order, 37/6.

P.M. SPEAKERS. All 2-3 ohms. 6½in. Plessey with 5,000 ohm output transformer, 16/11. 8in. Goodmans, 19/9. 10in. R.A., 26/9. 10in. Rola with Trans., 29/6.

R.S.C. BATTERY CHARGER KITS. For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., 25/9. To charge 6 v. or 12 v. battery at 2 a., 31/6. To charge 6 v. or 12 v. battery at 4 a., 49/9. ABOVE KITS CONSIST OF GREEN CRACKLE LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT. Any type assembled and tested for 6/9 extra.

R.S.C. 6 v. or 12 v. BATTERY CHARGER For normal A.C. mains input 200-230-250 v., 50 c/s. Selector panel for 6 v. or 12 v. charging. Variable charge rate of up to 4 AMPS. Fused, and with ammeter. Well ventilated metal case with attractive crackle finish. Guaranteed for 12 months, 69/6. Carr. 2/6.



EX GOVT. AUTO TRANSFORMERS

15-10-5-0-195-215-235 v. 500 watts	27/9
Double wound 10-0-200-240 v. to 10-0-275-295-315 v. 1,000 watts	69/6
Double wound 0-110-240 v. to 0-130-140-150-160-170 v. 1,500 watts	69/6

Carriage on any of above 5/- extra.

EX GOVT. SMOOTHING CHOKES

250 mA., 10 H., 50 ohms	14/9
250 mA., 10 H. 100 ohms	14/9
250 mA., 3 H., 50 ohms	8/9
150 mA., 10 H., 50 ohms	10/11
100 mA., 10 H., 100 ohms, Tropicalised	6/9
100 mA., 5 H., 100 ohms, Tropicalised	3/11
50 mA., 50 H., 1,000 ohms, Potted	8/11
90/100 mA., 10 H., 100 ohms, Potted	8/9
50 mA., 5-10 H.	2/9
L.T. type 1 amp.	2/9

CHASSIS

18 s.w.g. undrilled aluminium amplifier type (4-sided).

14in. × 10in. × 3in.	7/11
16in. × 10in. × 3in.	8/3

18 s.w.g. aluminium receiver type.

6in. × 3¾in. × 1½in.	1/11
7¾in. × 4½in. × 2in.	2/9
10in. × 5½in. × 2in.	3/3
11in. × 6in. × 2½in.	3/11

16 s.w.g. aluminium receiver type.

12in. × 8in. × 2½in.	5/3
16in. × 8in. × 2½in.	7/6
20in. × 8in. × 2½in.	8/11

16 s.w.g. aluminium amplifier type, 4-sided.

12in. × 8in. × 2½in.	7/11
16in. × 8in. × 2½in.	10/11
20in. × 8in. × 2½in.	13/6
14in. × 10in. × 3in.	13/6

R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A4

A NEW DESIGN FOR 1955
HIGH GAIN "PUSH PULL OUTPUT". BUILT-IN PRE-AMP. TONE CONTROL STAGES. INCLUDES 7 valves, sectionally wound output transformer, block paper reservoir condenser, and reliable small components. AN INPUT OF ONLY 20 millivolts IS REQUIRED FOR FULL OUTPUT. THIS MEANS THAT ANY TYPE OF MICROPHONE OR PICK-UP IS SUITABLE. Two separate inputs controlled by separate volume controls allow simultaneous use of "Mike" and Gram., or Tape and Radio, etc., etc. Individual controls for Bass and Treble "lift" and "cut". Six negative feedback loops giving total of 24 D.B. Frequency response ± 3 D.B. 30-20,000 c/s. Hum level 66 D.B. down. Certified total harmonic distortion of only 0.35% measured at 10 watts. Comparable with the very best designs. SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC ORGAN OR GUITAR. For STANDARD OR LONG PLAYING RECORDS. Size 12 × 10 × 9in. For mains A.C. 200-250 v. 50 c/s. Power consumption 175 watts. Outputs for 3 and 15 ohm speakers. The kit is complete in every detail. Chassis is fully punched. Easy to follow point-to-point wiring diagrams are supplied. EXTRA HIGH SENSITIVITY, HIGHEST QUALITY for **9 GNS.** Or assembled ready for use 50/- extra.

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments of £1. Plus carr. 10/-.
Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/6 extra.

A PUSH PULL 3-4 WATT HIGH GAIN ASSEMBLED AMPLIFIER FOR £3/19/6.

For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 2-3 ohm speaker. Supplied ready for use, £3/19/6. Full descriptive leaflet 6d.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. BRAND NEW, CARTONED. Only £3/19/6 (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequencyresponse. 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. 1a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-..

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensicive 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. 25 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. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carr. Output for 3-ohm speaker.

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS.

With crystal pick-up and separate sapphire point stylii for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. Supplied in sealed cartons with template and operating instructions. Only £9/19/6, plus 5/- carr., or 2 gns. deposit and 11 monthly payments 17/6.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS

High impedance type. Limited number, brand new, boxed and perfect at fraction of normal price. Only 35/-.

DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH MAGNETIC PICK-UP.

Pick-up is high impedance type. Unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.). Limited number. Brand new, cartoned, £5/19/6. Carr. 7/6.

ACOS HIGH FIDELITY CRYSTAL MICROPHONES. Type 22-2. Complete with table stand. Normal price 4 gns. Limited stocks, brand new, boxed, £2/19/6.

R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only £7/15/-. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet, can be supplied at 35/- each.

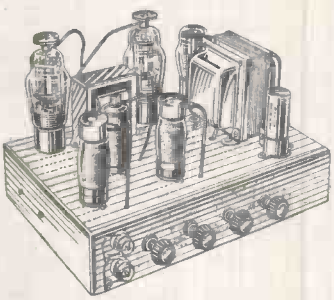
ALL DRY RECEIVER BATTERY SUPERSEDER KIT

All parts for an "All Dry" Battery Eliminator, Complete with case. Completely replaces 1.4 v. and 90 v. batteries where normal mains supply of 200-250 v. 50 c/s. is available.
Price with circuit, 38/9. Or ready for use, 45/6. Size of unit 5¼ × 4¼ × 2¼in. Suitable for receivers with L.T. loads of 125 mA. to 250 mA. thereby covering latest low consumption types.

BATTERY SET CONVERTER KIT. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v, 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only 48/9. Supplied ready for use for 8/9 extra.

R.S.C. A3 10 WATT "PUSH-PULL" HIGH FIDELITY AMPLIFER

With Self-Contained Pre-amplifier and Tone Control



Large safety factors in every component A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, 6 valves, and with easy-to-follow point-to-point wiring diagrams. Everything supplied to last nut.
Two independent inputs are provided with two associated independent volume controls so that programmes can be mixed together if desired, such as microphone announcements superimposed on a musical programme, or two independently controlled microphones, or even just gramophone/radio, fading over from one to the other. Variable base lift and cut with variable treble lift and cut tone controls are fitted, giving full long playing record equalisation for uncorrected pick-ups. They are also provided so that the user can alter the tonal value to suit his personal taste and surroundings. Terminals are provided for 3 ohm and 15 ohm loudspeakers.
H.T. and L.T. available for the supply of a Radio Feeder Unit.
Six Negative Feedback Loops.
130 millivolts input only required for full output.
Frequency response 50-20,000 cycles.
Negligible hum and distortion.
For A.C. mains input 200/230/250 v. 50 c/s.

COMPLETE Kit of Parts **7 GNS.** (carriage 7/6).
Supplied, assembled and tested for 45/- extra.
Cover as for A4 amplifier 17/6 extra if required.
H.P. TERMS on assembled units. Deposit 23/6 and 9 monthly payments 21/-.

FOUR-STAGE RADIO FEEDER UNIT.

Design of a HIGH FIDELITY L. and M. wave T.R.F Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-400 v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped response characteristic. Loaded H.F. coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-6-7½in. Illustration, full set of easy-to-follow wiring diagrams and instructions and individually priced parts list 2/6. This unit can be built for only £3/15/- including Dial and Drive Knobs and every item required.

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, £3/17/6.

MICROPHONES. Crystal, hand or Desk type, high fidelity Acos, 50/-. Stand type with base and adjustable stem, £6/19/6. Both suitable for use with our amplifiers.

GOLDRING MAGNETIC PICK-UPS. Due to a fortunate purchase we can offer these popular high-impedance pick-ups. Brand new, boxed, at only, 23/9.

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/- extra under 10/-, 1/- extra under £2, 2/6 extra under £3. Full Price List 6d. Trade List 5d.
Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m.**

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 ROAD, LONDON, N.W.1.**

EUSton 5533/4/5

HIRE PURCHASE
We are pleased to announce advantageous hire purchase facilities on any single item over £5. Ask for details, mentioning what you are interested in. We regret we cannot extend this facility to kits.

R1155A RECEIVERS guaranteed serviceable in original packing cases. £7/19/6. Fully assembled Power Pack and output stage, to plug straight into R1155 for A.C. 200/250 volts at 79/6. We have a few brand new R1155A at £11/19/6, also in original packing cases—Deduct 10/- if purchasing either receiver together with power pack. Plus 10/- packing and carriage.

R1124 RECEIVER UNIT. Coverage 30-40 Mc/s. Including 6 valves—3 type 9D2, 1 each, 8D2, 15D2 and 4D1—Six valve screening cans, 24 ceramic trimmers, 6 ceramic valve holders, resistors, condensers I.F.T.'s coils, etc. In very good condition. a bargain at 16/6 each only, plus 3/6 packing and postage.

RECEIVER TYPE 25/73. (The receiver section of TR1196). Supplied complete with full data for conversion to 3-wave-superhet receiver. Unit is complete with 6 valves 2-EF39, 2-EF36, FK32 and EBC33, also standard I.F.T.'s 465 Kc/s. Price 27/6 plus 2/6 P. & P.

TR1196 TRANSMITTER PORTION. We can also supply the transmitter portion of the above receiver incorporating valves, EL32, EF50, CV501. Type 600 relay transformer, coils, switches, etc. Limited quantity at 12/6 only, plus 2/6 P. & P.

No. 17 Mk. II TRANSMITTER/RECEIVER. Built into a strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. 44-61 m/cs. (5-7 metres). Uses standard 120 v. H.T. and 2 v. L.T. batteries. Illustrated instruction book supplied with each unit. 50/- each plus 7/6 post and packing.

INDICATOR UNIT TYPE 302—A bargain! Incorporates, VCR97, Mu-metal shield, 4 valves, EF50, 3 type SP61, 3 Type EB34, EA50, .1 mfd. 2.5 Kv., 10 pots, etc., etc. 50/- only, plus 7/6 P. & P.

U.S.A. PACKARD-BELL PRE-AMPLIFIER. Incorporating valves, 6SL7GT, 28D7GT, relay-plugs, sockets, condensers, etc. Brand new, with instruction booklet 12/6 only.

MAINS TRANSFORMER BARGAINS! Limited quantities only. Manufacturers' Surplus 350-0-350, 80 mA., 6.3 v. 3 a., 5 v. 2 A, Half shrouded, drop-through, 14/6 only, plus 1/6 P. & P. 110/210/240 v. Input. 350-0-350, 120 mA., 6.3 v. 6 A., 6.3 v. 1.5 A., 5 v. 3 A., tropicalised drop-through type, 21/- only, plus 2/6 P. & P. 110/210/240 v. Input, 250-0-250 120 mA., 6.3 v. 4 A., 5 v. 2 A. Upright mounting, 21/- plus 2/- P. & P. 230 v. Input, 300-0-300 80 mA., 6.3 v. 3 A., 4 v. 2 A. Tropicalised drop-through type, 9/6 only, plus 1/6 P. & P. Input 110/230 v. Auto load 230 v. 750 mA. 350-0-350 130 mA. Tapped filament winding 6 v. 3 A., 15 v. .3 A., 21.5 v. .6 A., also 5 v. 2 A. Tropicalised drop-through type. 21/- plus 2/6 P. & P. 270-0-270, 100 m/a. 6.3 v. 3 a., 5 v. 2 a., 200/250 v. Input universal mounting 16/6, plus 1/6 P. & P.

L.T. TRANSFORMER — ADMIRALTY Heavy duty type, 180 230 v. input, 4.2 v. plus 4.2 v. at 10 amp. 25/- only, plus 1/6 P. & P. Also manufacturers' surplus. Input 180/200/220/250 v. Output 6 v. 2 a. and 6 v. 6a., 15/- only, plus 1/6 p.p.

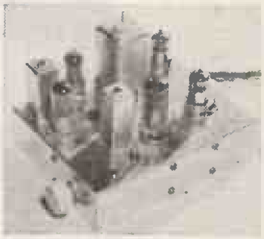
TELESCOPIC AERIAL MAST. Ex-R.A.F. dinghy transmitter mast. Total length when extended, 17ft. Collapses into two sections each approx. 24in. Complete with dies and lashings, lightweight duralumin construction, diameter at thickest point, 1¼in. approx. tapering to ⅜in. New condition. 32/6. Plus 2/- post and packing.

EX-W.D. CATHODE RAY TUBES. Guaranteed full picture. VCR97 at 40/-, VCR517C at 35/-. Also VCR139A—Ideal for oscilloscope 2¾in. screen at 35/-. We also have VCR97 with slight cut-off very suitable for oscilloscope, testing purposes, etc., at 15/- only. All these tubes are brand new, in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

TRANSISTORS. Mullard Type OC71 available from stock, 40/- post free.

MINE DETECTOR UNITS. Complete with 3-VP23 Valves, 1 pair CHR, High resistance headphones, condensers, resistors, etc., in web haversack, 19/6 only, plus 3/6 packing and carriage. New Condition.

F.M.!! (Frequency Modulation)



We are pleased to announce our complete Kit for the "Denco" F.M. Feeder Unit.
This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where triode/pentode output are available. Within an average of 30 miles from a V.H.F. transmitter one I.F. stage should be adequate, but our complete Kit supplied includes all components and valves for an extra I.F. stage if necessary, or if the unit is used at greater distances. Full Constructional details, theoretical circuit and point-to-point wiring diagram can be supplied for 1/6 post free, or the complete Kit right down to the last nut and bolt at only £6/7/6, plus 2/6 packing and postage. This unit can be supplied if desired, ready assembled, aligned and tested, at £8/10/-, plus 2/6 packing and postage.
If required we shall be pleased to align this unit for constructors not possessing the necessary equipment for a charge of 7/6. N.B.—Valve line-up is 6AM6, 12AH8, 2-6BA6 and 6AL5.
Chassis measures only 6⅝ × 5¼ × 1½in.
Demonstrations at 18, Tottenham Court Road!!

The Jason F.M. Tuner Kit!

This kit has been based on the booklet by Data Publications, price 2/- post free. With each booklet is enclosed our individually priced parts list. The construction and alignment of this tuner are no more difficult than a normal medium wave tuner. It is highly sensitive and free from drift. Incorporates 4 valves type 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in megacycles, and attractive bronze stove enamelled front plate already mounted (as illustrated) front plate size 8in. × 5in., chassis size 7in. × 4½in. × 1½in.
N.B. The standard model is at present operating satisfactorily up to 80 miles from Wrotham. Our price for the complete standard kit is £6/15/- only! Plus 2/6 p. & p. Fringe area model including extra valve, coil, etc. (results could be expected up to 150 miles from Wrotham!), is £7/15/-, plus 2/6 p. & p. The Standard Model Tuner can be supplied ready built, aligned, tested and manufactured by the Jason Motor and Electronic Company at a price of £15/17/-, purchase tax paid.

N.B. THESE TUNERS ARE BEING DEMONSTRATED AT 18 TOTTENHAM COURT ROAD.

F.M. AERIALS. Indoor two-element type by Lumex. Brand new 11/6 each only, plus 2/-. P. & P.

F.M. POWER PACK KIT.—We can now supply complete kit for power pack suitable for either of the above F.M. tuners or any other similar type. Price for the complete kit is 42/- only, or 52/6 for ready assembled unit. This pack is extremely small incorporating valve rectifier type 6X4 and built on chassis size only 6in. × 4in. × 1¼in. Optional extra for power pack, Bulgin Octal Plug at 2/3.

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.P.	50/-
100 microamp	D.C. 2½in.	M.O.	F.R.	45/-
500 microamp	D.C. 2in.	M.C.	R.P.	13/6
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. 2½in.	M.C.	F.R.	22/6
1 mA.	D.C. 2½in.	M.C.	Desk Type	27/6
5 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
10 mA.	D.C. 2½in.	M.C.	R.P.	8/-
10 mA.	D.C. 2½in.	M.C.	F.R.	10/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
200 mA.	D.C. 2½in.	M.C.	R.P.	10/-
1 amp.	R.F. 2½in.	Thermo	R.P.	10/-
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	M.C.	Thermo F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.R.	6/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
20 volt	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
150 volt	D.C. 2in.	M.C.	F.R.	15/-
300 volt	A.C. 2½in.	M.C.	F.R.	35/-

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 8/6. also 5 mA. by Westinghouse at 8/6.

CO-AXIAL CABLE. Standard 80 ohms. brown, stranded centre, conductor, 8d. per yard only! Not Govt. Surplus. Min. 12 yds. Also the latest air-spaced type for Band III, 9d. per yd.

22 SET POWER UNITS No. 4MK1 ZA10478—Complete with 4 metal rectifiers each 250 v. 60 mA. 2-12 v. 4 pin Mallory Vibrators, transformers, condensers, resistors, signal 1 amp. indicator, etc., etc., in good condition. Complete in metal box size 10½in. × 6in. × 8in. Weight 19lb., 27/6, plus 5/- P. & P.

L.T. RECTIFIERS TYPE R.K. A newly manufactured range guaranteed 12 months.

6 or 12 v. 1 a. F.W. bridge type	7/6
6 or 12 v. 1.5 a. F.W. bridge type	9/6
6 or 12 v. 2 a. F.W. bridge type	11/3
6 or 12 v. 2.5 a.	12/6
6 or 12 v. 4 a. F.W. bridge type	15/-

CHARGER TRANSFORMERS, Input 230 v.

6/12 v. 1 a.	9/9
2/6/12 v. 2 a.	14/6
2/6/12 v. 4 a.	17/6

ACOS TYPE 7 Crystal Microphone Inserts. Brand new, 7/6 each, plus 9d. P. & P.

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.

VIBRATOR PACK. Brand new, by Mallory, 12 volt input, 150 v. 40 mA. output, Complete with synchronous vibrator, 27/6.

DECCA LIGHTWEIGHT PICKUPS. Complete with either standard or L.P. Crystal Cartridge insets. Complete with Rest and Tracking instructions, 32/6 plus 1/6 P. & P. Also their very latest type, as above, but with turn-over head 47/6 only! Plus 1/6 P. & P.

6-VOLT VIBRATOR PACK. Ex-W.D. 6-volt input, output 140 v. 30 mA. Fully smoothed and rectified, incorporating Wearite 6 volt 4 pin vibrator type N8B6. Unit size only 6½in. × 5in. × 2½in. Price 15/- plus 1/6 P. & P. New condition.

SPECIAL OFFER—TRANSMITTING VALVES. These are brand new originally boxed, and guaranteed O.K. Type 813, 80/- ea. Type 866A, 17/- per pair, both post free. Also type 29C1 at 20/-, 12E1 at 25/- ea. 807 (U.S.A.), 10/- per pair.

VALVES. We have a very comprehensive stock of surplus valves at competitive prices. A stamp will bring Valve Price List.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in. Type 24.—20-30 Mc/s. 15/-, Switched Tuning. Type 25.—40-50 Mc/s. 19/6. Switched Tuning. Type 27.—65-86 Mc/s. 45/-. Variable Tuning. Type 26.—50-65 Mc/s. Variable Tuning 35/-. We have a limited supply of RF27 new condition and complete, but tuning dial damaged. Price only 30/- each. ALL these units Post Free!

LOUDSPEAKER SPECIAL!! 12in. 3 ohm Plessy P.M. 37/6 plus 2/6 P. & P.

I.F. TRANSFORMERS SPECIAL OFFER. All iron-cored 465 Kc/s. Plessey—Iron-cored 2½in. × 1½in. × 1in., 7/6 pr. Philips size 2¾in. × 1⅛in. diameter (cylindrical), 7/6 pair. By Invicta—Cylindrical 2¾in. × 1⅜in. diameter, 8/6 pr. Also our own special ultra midget size 1¾in. × 13/16in. × 13/16in. Only 9/9 per pair. By Wearite, Type 501 and 502 12/6 per pair. M800 12/6 pair.

AMERICAN CONTROL UNIT C58/APT1. Box measures only 5in. × 3½in. × 2in. Incorporating 2in. round 0-1 mA. meter 200 ohm pot, 2 toggle switches, indicator lamp, etc. Price 22/6, post free.

HEADPHONES. Brand new, ex-Govt., by S. G. Brown. Type CLR. Low resistance, 7/6 per pair. Type CHR high resistance, 12/6 per pair.

PORTABLE CABINETS. Manufacturers' surplus. Well made brown rexine covered. Will take any standard single player with bottom clearance of 3in. Total size closed 15in. × 13½in. × 5½in., fitted with snap catches and carrying handle. 22/6 only, plus 2/6 P. and P.

No. 38 TRANSMITTER/RECEIVER WALKIE-TALKIE. Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only, complete with valves at 30/-, in very good condition.

AMERICAN INDICATOR UNIT TYPE BC929A. Brand new incorporating 3in. tube 3BP1, with mu-metal shield, 2-6SN7GT 2-6H6GT, 6X5G, 2X2, 6G6G, 9 potentiometers 24 v. aerial switch motor, transformer, and a host of small components. The whole unit which measures only 8½in. × 8½in. × 13¾in. is brand new, enclosed in black crackle box, and can be supplied at 65/-, plus 5/- P. & P.

Please add postage under £1. C.O.D. or Cash with order. C.O.D. charge extra—open 9 a.m.-6 p.m. Monday to Friday. Sorry, but we close at 1.0 p.m. on Saturday.

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

VALUE IN MAGNIFICENT TV CABINETS

THE DE LUXE

Complete with mask, glass, castors, shelf, bearers C.R.T. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "View master," "Practical Television," "Tele-King," "Magnaview," "Wireless World," etc. Supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost.

An allowance of 4/6 will be made if the mask is not required.

Inside Dim.; Depth 16½in.; width 17⅞in.; Height 28in. Overall height 32in.; Width 18½in.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL!

Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

LASKY'S PRICE £8/10/-. Carriage 12/6 extra.

H.P. Terms. Deposit £2/17/- plus carriage. Balance plus charges spread over 12 months.

THE ROTHESAY

The last word in outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. The C.R.T. aperture frame is detachable, supplied to suit any size tube to order.

NOTE THESE GENEROUS SIZES.

Outside dim.; 34½in. high, 21⅞in. wide, 21½in. deep. Inside dim.; 18⅞in. wide. 19½in. deep. Size of top; 22½ × 21⅞in. Thickness ⅜in.

LASKY'S PRICE £9/19/6 Carriage 15/- extra.

H.P. Terms. Deposit £3/10/- plus carriage charge. Balance plus charges spread over 12 months.

THE ROTHESAY CABINET WITH FULL-LENGTH DOORS veneered both sides, polished to match the cabinet, and mounted with full-length piano hinges. Price £14 9/6.

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.

Line E.H.T. Trans., Ferrox-cube, core 9-16kV	25/-
Scanning Coils, low imp. line and frame	25/-
Frame Output Transformer	10/6
Scanning Coils low imp. line and frame	17/6
Frame or line blocking osc. Trans.	4/6
Focus Magnets Ferrox-dure	25/-
P.M. Focus Magnets, Iron Cored	19/6
Duomag Focalisers	29/6
300 m/a. Smoothing chokes	15/-
Electromagnetic focus coil with combined scan coils	25/-

STANDARD 35 mm.

Line Output Trans. No. E.H.T.	12/6
Line Output Trans. 6-9Vk. E.H.T. and 6.3 v. winding. Ferrox-cube	19/6
Scanning Coils. Low imp. line and frame	12/6
Ditto by Igranic	14/6
Frame or line blocking oscillator transformer	4/6
Frame output transformer	7/6
Focus Magnets: without Vernier	12/6
With Vernier	17/6
Focus Coils, Electro-magnetic	12/6
200 m/a. Smoothing chokes	10/6

LOUDSPEAKERS

12in. Plessey, 3 ohms	32/6
10in. heavy duty, alum. speech coil, 3 ohms	26/6
P.M. Speakers: 6½in., 17/6, 8in., 19/6, 10in.	19/-

ALUMINIUM CHASSIS

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

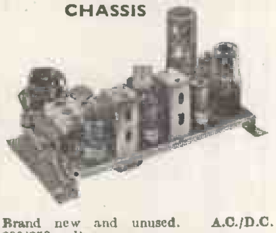
6 × 4 4/-	12 × 8 7/-	16 × 10 8/3
8 × 6 5/-	14 × 9 7/6	12 × 3 4/9
10 × 7 6/-	16 × 9 8/-	12 × 6 6/6

Post 1/- per chassis extra.

BUILD THE "TELE-KING" 5 CHANNEL, 16in. or 17in. SUPERHET TV.

Full constructional data, wiring diagrams, circuit and detailed price list. 6/- post free. Every component supplied separately.

COMPLETE 5-VALVE RADIO CHASSIS



Brand new and unused. A.C./D.C. 200/250 volts. I.F. 465 kc/s—A.V.C.—4 watts output—3 station pre-set—frame aerial—fully aligned—chassis 10 × 5½in.—max. height 5½in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls—volume and station switch. Valves used: 10C1, 10F9, or UF41, 10LD11, 10P14, U404 or UY41.

LASKY'S PRICE 69/6 less valves. Post 3/6 extra. With valves £5/19/6.

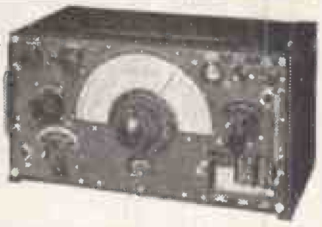
PLESSEY LINE E.H.T. TRANSFORMERS. Type CP.72036/2. 7 kV incorporating double wound width control. List 63/-.

LASKY'S PRICE 25/- Post 1/6.

R1155 RECEIVERS

Now available on H.P. terms

Ask for details



5 Frequency ranges: 18.5-7.5 Mc/s.; 7.5-3.0 Mc/s; 1,500-600 kc/s; 500-200 kc/s; 200-75 kc/s. Supplied in maker's original wood transit case.

LASKY'S PRICE

BRAND NEW	£11 19 6
Secondhand. Grade 1	£9 19 6
Secondhand. Grade 2	£7 19 6

Carriage 17/6 extra, including 10/- returnable on packing case.

ASSEMBLED POWER PACK-OUTPUT STAGE FOR R.1155 RECEIVER

For use on 200-250 v. A.C. mains. Complete with 2 valves. In metal case size; 12 × 7 × 5½in. LASKY'S PRICE 79/6. Carr. 5/-.

Power Pack for above. Fitted with 6½in. p.m. speaker. LASKY'S PRICE, £5/5/-. Carr. 5/-.

SPECIAL PURCHASE TABLE RADIOGRAM CABINETS

Solidly made of ⅜in. laminated wood, finished beautiful Walnut veneer. Panel (3in. × 16in.) for dial and controls, baffle for 8in. speaker, gold finish metal grille, fully hinged lid. Overall size: 18in. deep, 18in. wide, 13in. high. Slightly soiled.

LASKY'S PRICE £3/19/6 Carriage 7/6.

Cabinet complete with Collaro 3-speed Autochange and dual-purpose crystal pick-up. Brand new. £14/19/6. Carriage 12/6.

3-WATT MIDGET A.C./D.C. AMPLIFIER PUSHPULL, VERY HIGH GAINS

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

★ THE MULLARD 5/10 AMPLIFIER KIT

All components, chassis and valves in stock. Available separately. THE BOOK, 2/6, post free.

★ THE OSRAM 912 AMPLIFIER KIT

All components in stock. Chassis, Partridge, W/B, and Ellison trans., chokes, etc. Available separately. THE BOOK, 3/6, post free.

PRINTED CIRCUITS (by T.C.C.) for the MULLARD 5/10 and OSRAM 912 Amplifiers now available. Complete models of these famous amplifiers built on printed circuits can be seen and heard at our Tottenham Court Road premises, and are available from stock. Write for List.

LASKY'S 4-WATT A.C. AMPLIFIER KIT

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

MAINS TRANSFORMERS.

All 200-250 v. 50 c.p.s. primary finest quality, fully guaranteed.

MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.

MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. 22/6.

MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.

MBA/10. 500-0-500 v. 150 mA. 6.3 v. 4 a., 5 v. 3 a. 32/6.

AT/3. Auto trans. 0-10-120. 200-230-240 v. 100 watts. 17/6.

OUTPUT TRANSFORMERS

Midget Pentode	3/6
Miniature Personal, 3S4, etc.	3/6
Standard Pentode	3/11
Push-pull, 6V6	9/6
Multi Ratio, P.P.	12/6
Heavy Duty P.P.	14/11

LASKY'S RADIO

LASKY'S, (HARROW ROAD) LTD.,

NOTE—Open all day Saturday, early closing Thursday.

42 TOTTENHAM COURT ROAD, LONDON, W.1. MUSeum 2605. Between Tottenham Ct. Rd. & Goodge St. Stns.

370 HARROW ROAD, PADDINGTON, LONDON, W.9. CUNningham 1979/7214. Opposite Paddington Hospital

ALL MAIL ORDERS TO HARROW ROAD PLEASE

INDICATOR UNIT. TYPE BC-929-A. Complete with 3BPI C.R. tube (with screen and base), 2-6SN7, 6G6, 2-6H6, 6 × 5 and 2 × 2 valves, resistors condensers, potentiometers, etc. Ideal for constructing oscilloscopes, etc. Brand new in original cartons, with black crackle case 14½ in. × 9 in. × 9 in. Price 47/6, plus 5/- carriage and packing.
TRANS./REC. UNIT, TYPE 7/APN-1, with 3-12SJ7, 4-12SH7, 2-12H6, 2-955 and 2-9004 valves (but less OD3 volt. stab.), 27v. D.C. Dynamotor, Resistors (incl. 3-1 megohm 1%), Condensers, Pots. etc. Covers approx. 445 mc/s. Price 27/6, plus 5/- carriage and packing.
PACKARD-BELL PRE-AMPLIFIERS. Complete with 6SL7 and 28D7 valves, midget relay, resistors, condensers, pot, 8-way midget plug and socket. Brand new in original cartons, with circuit. Price 12/6 only.
MASTER CONTACTOR, TYPE Z, with a superb clockwork movement. Gives two impulses per second; 7 hours running. Brand new in sound-proof case. Ideal for constructing photographic timers, etc. Price 9/6, plus 1/6 post and packing.
SANGAMO MOTOR UNITS. These are brand new pre-paid meter movement with dozens of gears, and a Sangamo-Weston 200-250 v. A.C. 50 cycles motor (silent running). Has numerous applications (clockmaking, etc.). Price 10/6 each, plus 1/6 postage.
BLOCK CONDENSERS (AMERICAN). Oil filled. 1 mfd. 3600 v. D.C. wkg., 5/- each, plus 1/6 post; 2 mfd. 1000 v. D.C. wkg., 3/6 each, plus 1/3 post; 7 mfd. 800 v. D.C. wkg. 6/6 each, plus 1/6 post, also 4 mfd. 1000 v. D.C. wkg. (English), 3/9 each, plus 1/3 post.
SPECIAL OFFER. POTENTIOMETERS. 2000 Ω linear with D.P. switch, at 12/6 per doz. 100 kΩ carbon with S.P. or D.P. switch. Fair length spindle, 1/6 each; 12/- doz. 20 kΩ wire wound ¾ spindle, at 1/6 each; 15/- doz. 2 kΩ wire wound, ⅜ in. spindle, at 1/6 each; 15/- doz.
MAINS TRANSFORMERS (SLIGHTLY SUB-STANDARD). Input, 200-250 v. Output 250-0-250 v. 60 mA., 6.3 v. 1.5 a., 6.3 v. 1.5 a. (tapped 5 v.). Price 7/6 each, plus 1/6 post.
FILAMENT TRANSFORMERS. Input 210-240 v. A.C. Secondary 6.3 v. 6 a., 6.3 v. 4 a., 2 v. 2 a., 30 v. 60 mA., at 14/6 each, plus 1/6 post. Also Transformers with Secondary Windings, 6.3 v. 6 a., 4 v. 4 a., 2 v. 2 a. and 30 v. 60 mA., at 14/6 each, plus 1/6 post. These transformers are new.
SPEAKER OUTPUT TRANSFORMERS FOR BATTERY RECEIVERS, at 3/- post paid.
POTENTIOMETERS (U.S.A.). 1 meg.Ω double bank with 7/16 in. spindle, 2/6 each; 24/- doz. 2 meg.Ω double bank pre-set type, 2/- each; 20/- doz., plus 1/6 post.
PRE-SET POTENTIOMETERS. TV types, viz. 50 kΩ and 100 kΩ, at 1/6 each; 15/- doz.
YAXLEY SWITCHES. 8-way, single pole. Midget type with 1¼ in. spindle. Three-pole 3-way single bank midget type with ¼ in. spindle, at 1/6 each; 15/- doz.
PUSH-BUTTON SWITCHES. D.P.S.T., 3.5 amp., 250 v. Hold-on safety switch for rack-mounted equipment, etc. Price, 3/6.
VEEDER-ROOT REV. COUNTERS. 0-9999 with drive coupler. Brand new and boxed. Price 7/6 each.
TELCOTHENE TWIN-FEEDER. 2-1/.036. Type K20C., 3/6 per doz. yards.
CO-AXIAL CABLE. Standard 80 Ω impedance. 7d. per yard, min. 12 yds., plus 1/- post. Brand new current stock.
RELAYS. 3000 Type. 6500 Ω. 1 break, 1 change-over. Brand new and boxed. Price 8/6 each, plus 9d. post.
NEONS. MIDGET. TYPE CV988. 150 v. striking. Brand new and boxed, at 1/6 each; 15/- doz.
HAND GENERATOR POWER SUPPLY UNIT No. 7 (ZA17571), with hand generator and cut-out but less accumulator. Can be used as a wind generator or as ordinary hand-operated charger for 6 volt batteries. Will give sufficient current to a "flat" battery to start a car. Complete in case (17in. × 10in. × 7½in.) with full working instructions. Brand new in original cartons, 19/6, plus 3/6 carriage.
VALVE HOLDERS. Ceramic int. octal, at 1/3 each; 12/- doz. Ceramic 807, at 1/3 each; 12/- doz. Rubber-mounted B9A (anti-microphonic) Noval, at 7/6 doz. Ceramic B9G (EF50), at 8/6 doz. B9A Ceramic with screen cans, 1/3 each. Ceramic B7G with screen cans, 1/3 each.
1355 RECEIVER. The well-known receiver for TV conversion. Brand new and complete with all valves. Price, 22/6, plus 5/- carriage.
"GRIMES" LANDING LAMP. Complete with bulb, and motor for deflection of beam. Brand new and boxed, 17/6, plus 3/6 post and packing.
FOR THE 2-METRE FANS. 2-METRE TX TANK TUNERS. Consisting of butterfly tuning condenser, silver-plated tank coil, H.T. choke and mounting base. Brand new and boxed, 1/6 each.
VALVES. EF50, at 5/- each; 54/- doz. EF50 Red Sylvania, 6/- each; 66/- doz. SP61 (VR65), EA50 Diodes, at 2/- each; 20/- doz. VS70, at 3/6 each.
GERMANIUM CRYSTAL DIODES. Wire-ended, 1/6 each; 15/- doz.
LOW RESISTANCE EARPIECES (8.2Ω). at 4/- per pair, WITH HEADBAND, plus 1/- post.
MIDGET CARBON MIKE INSERTS. Size 1¼ in. dia. Brand new and boxed at 1/3 each, post free.
TANNOY POWER MICROPHONE INSET. For Tele L.S. No. 1, 2 and 3 (YA2815). Brand new in sealed tins. Price, 2/6 each, plus 6d. post.
CONDENSERS. B.I. TYPE. .02 mfd. 5 kV. wkg., at 2/- each. .03 mfd. 2.5 kV. wkg., at 2/- each. .05 mfd. 2.5 kV. wkg., at 2/- each. .25 mfd. 1.5 kV. wkg., at 1/3 each. .1 mfd. 1.2 kV. wkg., at 1/- each. .05 mfd. 800 v. wkg., at 6d. each.
AMERICAN SPRAGUE METAL TUBULAR WIRE-ENDED .1 mfd. 350 v. wkg. CONDENSERS, at 5/6 doz.
ELECTROLYTIC CONDENSERS. Brand new current stock. 20 mfd. 500 v. wkg., 2/6 each; 5 for 10/-. 100 mfd. 450 v. wkg., 2/6 each; 5 for 10/-. Please add 1/3 postage.
I.F. TRANSFORMERS. 465 kc/s. Size 1⅜ in. × 1⅜ in. × 2½ in., at 3/9 per pair.
VITREOUS RESISTORS (10W/10102) 12,000 Ω 80 watt, at 2/6 each; 20,000 Ω 80 watt, at 2/6 each; 25/- doz.
R.F. MONITOR TYPE 114, with 2 EF50 valves and EA50 Diode, mounted on neat chassis, 4in. × 4½in. Price 12/6, plus 1/6 post.
.15 AMP. DROPPER RESISTANCES. 745 Ω-280 Ω, 3in. long, 520 Ω-143 Ω, 3in. long, and 900 Ω-280 Ω, 3in. long, all at 1/- each, plus 3d. post.
CERAMIC 100PF TRIMMERS (Postage Stamp Type), at 3/- doz.
OCTAL PLUGS (with covers). Fits into int. octal holder to make a useful 8-way plug and socket, 9d. each; 8/6 doz.
12-PIN PLUG AND SOCKET (Paxoline), at 9d. pair; 8/6 doz. pairs.
MOVING COIL HEADPHONES, at 10/6 per pair, plus 1/6 post.

PLEASE WRITE NAME AND ADDRESS IN BLOCK LETTERS

C. MARKS & Co. (Newport, Mon.) Ltd.

90 COMMERCIAL ST., NEWPORT, MON.

Telephone: Newport 64711

Also at 25 Wyndham Arcade, Cardiff

All mail orders and enquiries to Newport branch please.

WALMORE ELECTRONICS LIMITED

PHOENIX HOUSE, 19/23 OXFORD STREET, LONDON, W.1.

Telephone: GERrard 0522 *Cables: Valvexpor*

EXPORTERS OF RADIO, TELEVISION AND INDUSTRIAL TUBES, HAVE PLEASURE IN INTRODUCING THEIR BRAND

RADIO
WALRAD
TUBE

AND INVITE ENQUIRIES FROM BUYING AND CONFIRMING HOUSES EXCLUSIVELY FOR EXPORT

We wish to advise our many friends in the trade that we are unable to supply the home market and that all previous lists and quotations must be considered cancelled

---

OPENING FOR A

young electronic brain

If yours is a knowledgeable mind in the ways of modern ELECTRICAL AND ELECTRONIC PRODUCTION METHODS and if you seek to apply that knowledge more fruitfully in an organisation whose resources and activities are as broad as its horizons—then let us hear from you.

Men of the right calibre will find this opportunity unusually rewarding both in salary and opportunity. And as a matter of additional interest to prospective personnel, many of the people engaged in this specialised work at Plessey are given the chance to travel extensively in the world's large industrial centres in search of new and better production methods.

Write in the first instance, to the

PERSONNEL MANAGER

THE PLESSEY COMPANY LIMITED

ILFORD · ESSEX

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-.
300-0-300, 100 mA, 6 v. 3 amp., 5 v. 2 amp., **22/6.**

Semi-Shrouded, drop-through 380-0-380 v., 120 mA., 6.3 v. 4 amp., 5 v., 2.5 amp., **22/6.**

Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6.**

Chassis mounting or drop-thro'. Pri. 110 250 v. Sec. 350-0-350, 250 mA., 6.3 v. 7 amp., 6.3 v. 0.5 amp., 5 v. C.T., 0.5 amp. 4 v. 4 amp. P. & P. 3/6, **32/6.**

Chassis mounted and fully shrouded, 80 mA., 6 v. 3 amp., 5 v. 2 amp., **14/6.**

250-0-250 80 mA., 6 v. 4 amp., **14/-.**

Drop thro' 270-0-270, 80 mA. 6 v. 3 amp., 4 v. 1.5 amp., **13/6.**

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., **11/6.**

250 v. 350 mA., 6.3 v. 4 a., twice 2 v 2 a., **19/6.**

Auto-trans. Output 200/250 H.T. 500 v 250 mA., 6 v. 4 a., twice, 2 v. 2 a., **19/6.**

250-0-250, 60 mA., 6.3 v. 1.5 a., 0-5-6.3 v. 1.5 a., **10/6.**

Auto Trans. Input 200/250. H.T. 350 v. 350 mA. Separate L.T. 6.3 v. 7 a., 6.3 v. 1½ amp., 5 v. 3 amp., **25/-.** P. & P. 3/-.

Primary, 230 v., fully shrouded, screened primary, 13 v. 1 amp., **7/6.**

Pri. 200 v. Sec. 500-0-500 and 500-0-500 250 mA., both windings. 4 v. 3 amp. 4 v. 3 amp., **39/6.** P. & P. 5/-.

Mains Transformer, fully impregnated. Input 210, 220, 230, 240. Sec. 350-0-350 100 mA., with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp. and 5 v. 2 amp., **30/-.** P. & P. 5/-.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., **13/6.**

500-0-500 125 mA. 4 v. C.T. 4 a., 4 v. C.T. 4 a., 4 v. C.T. 2.5 a., **27/6.**

500-0-500 250 mA. 4 v. C.T. 4 a., 4 v. C.T. 5 a., 4 v. C.T. 4 a., **39/6.**

6½in. M.E. Speaker, 1,000 ohm field. **15/-.**

R. & A. T.V. energised 6½in. speaker with O.P. trans, field coil, 175 ohms **9/6.** P. & P. 2/6.

R. & A. 6½in. M.E. speaker, with O.P. trans. field 440 ohms, **10/6.** P. & P. 2/6.

Volume Controls. Long spindles less switch, 50K, 500K, 1 meg., **2/6** each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ½, ¼, 1 and 2 meg., **4/-** each. 10K and 50K, **3/6** each. ½ and 1 meg., long spindle double pole switch, miniature, **5/-** P. & P. 3d. each.

Trimmers, 5-40 pf., 5d 10-110, 10-250, 10-450 pf., **10d.**

Twin-Gang .0005 Tuning Condenser, **5/-** With trimmers, **7/6.**

Twin Gang, .0005, with feet, size 3¼ × 3 × 1½in., **6/6.**

3-gang .0005, with feet, size 4¾ × 3 × 1½in., **7/6.**

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1¾ × 1¾in., **1/-** each, 2 iron-core Ali-can 2¾ × ¾in., **1/6** each.

Used Metal Rectifier, 250 v. 150 mA., **6/6.** Metal Rectifier, 230 v. 45 mA., **6/-.**

Metal Rectifier, RM2, 125 v. 100 mA., **3/6.**

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., **4/9;** 42-1 with extra feed-back windings, **4/3.** Miniature 42-1, **3/3.** Multi-ratio 3,500, 7,000 and 14,000, **5/6.** 10-watt push-pull, 6V6 matching, **7/-.** 90-1 3 ohm speech coil, **6/6.**

PUSH-BACK CONNECTING WIRE. Doz. yds., **1/6.** Post paid.

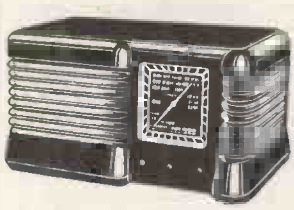
STANDARD WAVE-CHANGE

SWITCHES. 4-pole 3-way, **1/9;** 5-pole, 3-way, **1/9;** 3-pole, 3-way **1/9;** 9-pole 3-way, **3/6;** Miniature type, long spindle 3-pole 4-way, 4-pole 3-way and 4-pole 2-way, **2/6** each. 2-pole 11-way, twin-wafer **5/-;** 1-pole 12-way single wafer **5/-.** P. & P. 3d.

PERMEABILITY TUNED T.V. UNIT Input 300 ohm balanced line, coverage 54 Mc/s—89 Mc/s and 174 Mc/s—217 Mc/s. Vision I.F.:—45 Mc/s., sound 40.5 Mc/s. Uses 6AK5 RF valve, 6AK5 as mixer, and 6C4 Oscillator, Provision for auto-gain control, Dimensions 9in. wide. 6½in. deep, 4in. high, 9in. blank-scale. Width including scale-overlap 14in. Four stages permeability tuned. Complete with 3 valves. Post and Pkg. 3/-. **£2/19/6.**

T.V. CONVERTER for the new commercial stations, complete with 2 valves. Frequency can be set to any channel within the 186-196 Mc/s band. I.F. will work into any existing T.V receiver between 42-68 Mc/s. Input arranged for 80 ohm feeder. EF 80 as RF amplifier, ECC81 as local oscillator and mixer. The gain of the first stage, R.F. amplifier 10DB. Required power supply of 200 D.C. at 25 mA., 6.3 v. A.C. at 0.6 amp. Input filter ensuring freedom from unwanted signals. Simple adjustments only, no instruments required for trimming. Will work into any T.R.F. or superhet. Size 4½ × 2½ × 2in. P. & P. 2/6. **£2/19/6.**

R.F. E.H.T. OSCILLATOR COIL. 6-9 KV with EY51 rectifier winding, and circuit diagram, **15/-** As above but complete with 6V6, EY51 and associated resistors and condensers. Circuit diagram **37/6.** As above but complete with line O.P. transformer, scan coils and frame O.P. transformer **£2/19/6.** P. & P. 3/.



PLASTIC CABINET, as illustrated, 11½in. × 6½in. × 5½in., in Walnut and Cream, also in polished Walnut complete with T.R.F. chassis, 2 waveband scale, station names, new wave-band, back-plate, drum, pointer, spring, drive spindle, 3 knobs and back. **22/6.** P. & P. 3/6. AS ABOVE, with superhet chassis, **23/6.** P. & P. 3/6. Either of the above items complete with 5" P.M. speaker and O.P. transformer, **17/6** extra.
Used metal rectifier, 230 v. 50 mA., **3/6;** gang with trimmers, **6/6;** M. and L.T.R.F. coils, **5/-;** 3 obsolete ex-Govt. valves, 3 v/h and circuit, **4/6;** heater, trans., **6/-;** volume control with switch, **3/6;** wave-change switch, **2/-;** 32 × 32 mfd., **4/-;** bias condenser, **1/-;** resistor kit, **2/-;** condenser kit, **4/-.**

Used A.C. mains 200/250 volts, 4 valve plus metal rectifier, medium wave superhet in polished walnut cabinet, size 14 × 9½ × 7½", complete with valves 6K8, 6K7, 6Q7 and 6F6. 6½ P.M. speaker. Fully guaranteed. P. & P. 7/6. **£3/15/-.**

P.M. SPEAKERS. 6½" closed field **18/6.** 8" closed field **20/6.** 10" closed field **25/-.** 3½" **16/6** P. & P. on each 2/-.

EXTENSION SPEAKER in polished walnut, complete with 8in. P.M. P. & P. 3/-. **24/6.**

SINGLE SPEED PLAYER. A.C. mains 200/250 v., complete with needle armature pick-up in a really wonderful polished walnut cabinet, will take up to a 12 inch record. Pull-out draw on steel runners. Original list price £8/17/6, our price **£4/9/6,** post and packing 10/-.

> Three speed automatic changer by a very famous manufacturer, current model. Will take 7in., 10in. or 12in. records mixed. Turnover crystal head.
> **VERY LIMITED QUANTITY.**
> A.C. Mains 200/250. **£7/19/6.** P. & P. 4/6.

CUB one-sixth h.p. A.C. 220/230 v. by Brook Motors. Reversible for continuous running, **£4/9/6.** Post and pkg. 7/6.

Radiogram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 195/255 v. 19-49, 200-550 and 1,000-2,000 metres, I.F. 470 Kc. size of chassis 13 × 6½ × 2½in., size of scale 7½ × 3½in. Valve line-up 10C1, 10F9, 10LD11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M., **£8/17/6.** P. & P. 5/-.

> **SPECIAL OFFER** 8in. P.M. speakers, removed from chassis, fully guaranteed. All by famous manufacturers. P. & P. 1/6. **12/6.**

CONSTRUCTOR'S PARCEL, medium and long wave A.C. mains 230/250 2-valve plus metal rectifier, comprising chassis 10½ × 4½ × 1½in., 2 wave-band scale, tuning condenser, wave-change switch, volume control, heater trans., metal rectifier, 2 valves and v/holders, smoothing and bias condensers, resistors and small condensers, and medium and long wave coil, litz wound **22/6.** P. & P. 2/6 extra. Circuit and point-to-point, **1/3.**

CONSTRUCTOR'S PARCEL, comprising chassis 12½ × 8 × 2½in., cad. plated, 18 gauge, v/h., I.F. and trans. cut-outs, back-plate, 2 supporting brackets, 3 wave-band scale, new wavelength stations names. Size of scale 11½ × 4½in., drive, sp., drum, 2 pulleys, pointer, 2 bulb holders, 5 pax. I.O. v/h., 4 knobs and pair of 465 I.F.s, twin gang, 16 × 16 mfd. 350 wkg., mains trans. 250-0-250 60 mA. 6.3 v., 2 amp., 5 v. 2 amp. and 6½in. M.E. speaker with O.P. trans. **39/6.** P. & P. 3/6.

CR100 Coil packs in first-class condition less oscillator section, complete with 4-gang tuning condenser, **19/6.** P. & P. 3/6.

CR100 465 Kc. I.F.s, types 3, 4 and 5 and F.B.O., new condition, **7/6** each. 465 Kc. Xtal for CR100, **12/6.**

4-gang tuning condenser for CR100, **9/6.**

POLISHING ATTACHMENT for electric drills. Quarter inch spindle, chromium plated 5in. brush, 3 polishing cloths and one sheepskin mop mounted on a 3in. rubber cup., Post and pkg. 1/6. **12/6.** Spare sheepskin mops, **2/6** each.

POTATO AND VEGETABLE PEELER. By famous manufacturer. To suit models A200 and A700. Capacity 4½lbs. complete with water pump. All aluminium construction, white stove-enamelled finish. Originally intended for adaption on an electric food-mixer, can be easily converted for hand operation, **39/6.** P. & P. 3/-.

USED A.C. MAINS 5 VALVE, 3 WAVE-BAND SUPERHET CHASSIS

Size 11½ × 8½ × 3in., complete with 3 wave-band scale, size 10½ × 5½in., pair of 465 Kc/s IFs, tuning condenser, mains transformer, volume control with switch, tone control. 3 waveband coil pack (this is a completely detachable coil pack on separate small chassis), various small condensers and resistors and biasing condensers. **19/6.** Post & Pkg. 3/6.

40-WATT FLUORESCENT KIT, A.C. mains 230/240. Comprising choke, power-factor condenser, 2 tube holders, starter and starter-holder. P. & P. 3/-. **17/6.**

20 watt A.C. or D.C. 200/250 v. **FLUORESCENT KIT** comprising trough in white stoved enamel finish, two tube holders, starter and holder and barreter. Post and packing 1/6, **12/6.**

Mains Droppers. 0.3 amps., 460 ohms. tapped 280 and 410, **1/6;** 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, **1/6;** 0.3 amps. 950 ohms, tapped 700 and 825, **2/6;** 0.2 amp., 1,000 ohms, vitreous, tapped **2/6;** vitreous, 0.3 amp., 700 tapped 680, 640, 600, **3/6.** P. & P. on each 3d.

T.V. Width Controls, **3/6.**

PERSONAL SHOPPERS ONLY. 9in. Enlarger, **17/6;** 12in. **27/6.**

Germanium Crystal Diode, **1/6,** post paid Used 9in. Tube with ion burn, **17/6,** post paid.

Line O.P. Transformer in aluminium can mounted in rubber, **12/6.**

Speaker Matching Unit on aluminium chassis, 3-15 ohms reversible, **12/6.** Line and E.H.T. Transformer, 14 Kv., using ferrocart core, complete with line and width control, and corona shields U37 rectifier winding, **35/-.** Line and E.H.T. Transformer, 9 Kv., using ferrocart core, complete with built-in line and width control. Mounted on small all-chassis. Overall size 4½ × 1½in. EV51 rec. winding, **27/6.**

Scan coils, low line low impedance frame, complete with frame transformer. to match above, **27/6.** P. & P. 2/-.

Line and E.H.T. Transformer, 9 Kv. ferrocart core, EY51, heater winding, complete with scan coils and frame output transformer, and line and width control, **£2/5/-.** P. & P. 3/-.

As above, but complete with line and frame blocking transformers, 5 Henry 250 mA. choke, 100 mfd. and 150 mfd. 250 wkg. 380 mA. A.C. ripple. **£2/19/6.** P. & P. 3/-.

Valve Holders, moulded octal Mazda and loctal, **7d.** each. Paxolin, octal Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded and B9A with screening can **1/6** each.

32 mfd. 350 wkg.	2/-
16 × 24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
16 × 8 mfd., 500 wkg.	4/6
16 × 16 mfd., 500 wkg.	5/9
16 × 16 mfd., 450 wkg.	3/9
32 × 32 mfd., 350 wkg.	4/-
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100 mfd., 450 v. wkg., 280 mA., A.C. ripple	3/11
150 mfd., 350 v. wkg., 280 mA. A.C. ripple	4/6
200 mfd., 275 wkg.	7/6
16 + 16 mfd., 350 wkg.	3/3
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60 + 100 mfd., 280 wkg.	7/6
50 mfd., 12 wkg.	11d.
50 mfd., 50 wkg.	1/9

Miniature wire ends moulded, 100 pf., 500 pf., and .001, each, **7d.**

Combined 12in. mask and escutcheon, in lightly tinted Perspex. New aspect edged in brown. Fits on front of cabinet, **12/6.** As above for 15 in. tube, **17/6.**

Frame Oscillator Blocking Trans., **4/6.** Line Osc. Blocking Trans., **4/6.**

CHOKES:
2-20 Hen. 150 mA., **15/-.** P. & P. 3/-.
6 Hen., 275 mA., **15/-.** P. & P. 3/-.
100 Hen., 40 mA., **15/-.** P. & P. 3/-.
2 henry 150 mA., **3/6;** 250 mA. 10 henry, **10/6;** 5 henry 250 mA., 60 ohms., **8/6.**

Wide Angle P.M. Focus Units. Vernier adj. state tube, **15/-.**

Energised Focus Coil, low resistance mounting bracket, **17/6.**

Ion Traps for Mullard or English Electric tubes, **5/-,** post paid.

Standard 465 Kc. iron-cored I.F.s, 4 × 1½ × 1½in., per pr., **7/6.** Wearite standard, iron-cored, 465 Kc. I.F.s, 3½ × 1½ × 1½in., per pr., **9/6.**

Iron-Cored 465 Kc. Whistle Filter, **2/6.**

465 KC. MIDGET I.F.s. Q.120 size 1½in. long, 1in. wide, ¾in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, **12/6.**

> **SIGNAL GENERATOR**
> Coverage 120 Kc/s-84 Mc/s,
> **£4-19-6**
> P. & P. 4/-.

R. AND T.V. COMPONENTS (ACTON) LTD.
23 HIGH STREET, ACTON, W.3

Telephone: ACOrn 5901 *(Opposite Granada Cinema)*
GOODS NOT DESPATCHED WHERE CUSTOMS DECLARATION IS APPLICABLE
Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/6 up to 10/-, 2/- up to £1, and 2/6 up to £2. All enquiries S.A.E., lists 5d. each.

> **PATTERN GENERATOR**
> Coverage 40 Mc/s-70 Mc/s,
> **£3-19-6**
> P. & P. 4/-.

GEE RADIO LTD.

VALVES—SPECIAL BARGAINS IN GOVT. SURPLUS

5/- each any type: VU.120A, VR91 Sylvania, VR.53, VR.56, VT.52, 12SH7, 12SJ7, 2X2, 9004, 6K7G, 6J5G, 1299(3D6), 3A4, OZ4

7/6 each any type: 12A6, 6SL7gt, 6SN7gt, 6N7gt, VR.136, VR.55, S.130, 6V6gt, VR.150/30, 807, 860, 12SR7, 6X5gt, CV.73

3/6 any type: 6H6m, 12H6m, VU.111, VR.91, VT.501, VR.65A, ARP.12

5/- any type: 956, IG6gt, VS.70, 958, 12J5gt, 860, 1616

6L6m	12/6
5T4m	10/6
1T4	7/6
12SK7	6/6
1619	10/-
VU.508(U19)	8/6
954	2/6
E.1148	2/6
6B4G	10/-
35T	30/-
829B	50/-
8012	12/6
8011	12/6
1C5gt	7/6

VALVE ORDERS OVER £5, less 5% discount, post free.

R.C.A. SPEECH AMPLIFIER MI-11220A. 200 250 v. A.C. input. Containing 2-6L6 valves in push-pull output, 7 valves in all. Gram and mike inputs fitted. This model is undoubtedly one of the finest medium powered amplifiers ever produced. Complete with all valves, £18/10/-. Carr. 10/-.

50 WATT AMPLIFIER, EX-GOVT. With 4-KT66's in paralleled push-pull. Standard 200-250 v. mains input, A.C. Output impedance 600 ohms line. For high imp. gram. and mike input. Bass boost control fitted. This excellent quality amplifier is housed in a strong metal case and is ready for use. Terrific performance. Bargain value £25, carr. paid.

HALLICRAFTER SPEECH AMPLIFIER BC.614A. Part of BC610 equipment. As new, £25, carriage paid.

VITAVOX PRESSURE UNITS COMPLETE WITH 42in. EXPONENTIAL HORN, £7/12/6, carriage 10/-. Pressure Unit can be supplied separately at £4/9/6, carriage 5/-.

ROTARY CONVERTERS. 24 v. D.C. input, 230 v. A.C. output at 50 cycles, 100 watt. Brand new, £4/17/6, carriage 7/6.

VARIABLE VOLTAGE REGULATOR TRANSFORMERS. Input 230 v. A.C. at 21 amps. Output 57.5 in 16 equal steps to 230 v. at 21 amps. Ex-Govt. In perfect condition. £12, carriage 10/-.

LATEST MODEL MONARCH B.S.R. 3-SPEED CHANGER, £9/7/6, carriage paid.

RA-88 RECTIFIER UNIT (PART OF SCR.720 EQUIPMENT). Containing the following valve line-up: 3-6L6m, 3-5T4m, 2-6SL7gt's, 2-VR.150/30's, etc., etc. Bargain value at £4/19/6, carriage 5/-.

CRYSTAL CALIBRATOR BY MARCONI INSTRUMENTS. Brand new and unused, complete with spare set of 5 valves and operating manual. Freq. range 170-240 Mc/s. Accuracy: 1 part in 10,000. Our price £7/9/6, carr. 10/-.

AMERICAN H.F. SIGNAL GENERATORS. Type 122A. Input 110 v. A.C. Freq. range: 8-150 Mc/s and 50-230 Mc/s. New and unused £25, carriage 10/-.

ELECTRIC LIGHT SLOT METERS. 200-250 v. A.C. at 5-10 amps. 1/- in slot and 6d. or 7d. per unit. By Measurement Ltd. All bakelite case In very good condition, 50/-, p. p. 2/6.

R.1155 COMMUNICATION RECEIVERS. Individually tested and despatched in good working order. Cases slightly soiled, £8/19/6. Brand new, £10/19/6, carriage 7/6.

RECEIVER TYPE 109. In good condition. Freq. range 1.8-3.9 Mc/s and 3.9-8.5 Mc/s continuous. Designed to operate on 6 v. battery. Limited quantity only, £4/7/6, carriage 10/-.

PHOTO-ELECTRIC MULTIPLIER CELLS. Type 931A. £2/10/- p.p. 1/-. Also 931A complete on chassis with multiplier network and 2-832 valveholders, etc., £3/10/-, p.p. 2/-.

TIME SWITCHES (NEWBRIDGE). 250 v. A.C. Synchronous 5 amp. Used but in good working order, 39/6, p.p. 2/6.

CONDENSERS. 2 mfd. 7.5 kv. working at 15 kv. Test (Dubilier). Brand new, £2/10/- each, carr. 5/-.

EVERSHED AND VIGNOLES (EX-G.P.O.) HIGH RANGE CONSTANT PRESSURE MEGGERS. 5 meg. 1,000 meg. infinity. In good working condition. Housed in wooden case, £7/10/-, carr. 10/-. Ditto, 250 v. Low range bridge megger. 5000 ohms-20 megs. infinity. Finish as above, same price and carr.

813 CERAMIC VALVE HOLDERS, 9/6 each, p.p. 6d. Also 4 pin large 'Jumbo' ceramic valve holders, 6/6 each, p.p. 6d.

TRANSMITTER-RECEIVER T.R. 1143A or 1430. Either type available. Complete Unit (less crystals and power supply). In very good condition. This trans-receiver, which until recently was extensively used by the R.A.F., has a very wide freq. range and is offered at the ridiculously low price of £9/19/6, carr. 10/-.

CATHODE RAY TUBES. Types 3BP1, 3in., new and unused with base and screen, 42/6, p.p. 2/-. Type VCR138 (ECR35), 3½in. with screen and base in new and unused condition, 42/6, p.p. 2/-. Type VCR97, 6in., ex-equip., in good order, 20/-, p.p. 3/6. VCR131, 1in. C.R.T., new and in perfect condition. Miniscope replacement tube, etc., 35/-, p.p. 1/-. Type CV1526, 2¾in., 4 v. filament, 3,000 v. anode, complete with base and Mu metal screen, 20/-, p.p. 2/6.

MASTER CONTACTOR MK. II. REF. 10A/10994. 24 v. new and unused, 10/-, p.p. 2/.

B.C. 929A C.R.T. INDICATOR UNIT (EX-U.S.A.). Containing 1-3BP1 3in. C.R.T., 2-6SN7s, 2-6H6s, 1-6G6, 1-6X5, 1-2X2, 7 valves in all. Ideal for 'Scope conversion. New in original sealed cartons. Bargain value, 65/-, carr. 5/-.

DRY BATTERIES (EX-GOVT.). 72 v. H.T. 1. 5 v. L.T. Ideal for battery portables, size: 6¼in. x 5in. x 2in. In very good condition tested before despatch. Price 5/-, carr. paid.

TELESCOPIC DINGHY AERIALS. Min. length 14in., max. length 7ft. 4/6 each, p.p. 9d.

SELENIUM METAL RECTIFIERS BUILT TO SPECIFICATION. ALL TYPES AVAILABLE FULLY GUARANTEED. VERY GOOD DELIVERY. COMPETITIVE PRICES. MAY WE QUOTE YOU? K3/ AND K8 SERIES STILL AVAILABLE FROM STOCK.

MANY OTHER LINES IN STOCK. YOUR ENQUIRIES INVITED. TRADE SUPPLIED.

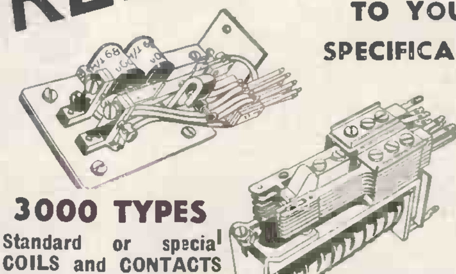
15 LITTLE NEWPORT ST., LONDON, W.C.2.

ADJOINING LEICESTER SQUARE TUBE STATION

GERrard 6794/1453

RELAYS

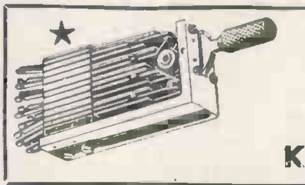
P.O. TYPES TO YOUR SPECIFICATION



3000 TYPES

Standard or special COILS and CONTACTS up to 80,000Ω and up to 8 c/o's. 600 and HIGH-SPEED TYPES also Supplied.

PROMPT DELIVERY



LARGE STOCKS OF KEYSWITCHES

THE KEYSWITCH CO.

ALL POST OFFICE EQUIPMENT

Enquiries to Sales Manager

126 KENSAL ROAD, LONDON, W.10

Telephone: LAD. 0666, 4640

Anybody here ~~seen~~ HEARD Kelly?

THE NEW R.L.S.I. H.F. RIBBON LOUDSPEAKER

The latest development in reproducers: a "tweeter" with superb response over a wide frequency range. **LIST PRICE 12 GNS.**

Response	3,000–20,000 c/s	Horn loaded	1,000 c/s cut off
Power Capacity	10 watts	* Equivalent moving-coil units	3.00 gms / 5 x 10⁵ dynes/gm
Impedance	15 ohms		
Flux	10,000 Gauss		
Dynamic Mass*	0.008 grammes	Dimensions	8½" x 5½" x 4½"
Force/mass ratio*	4x10⁷ dynes gm.	Weight	8 lbs.

Exclusive world-wide distribution by

THERMIONIC PRODUCTS LIMITED

HYTHE, SOUTHAMPTON, HANTS. *Tel.: Hythe 3265*

CABINETS!!

Many and varied types (Table and Console) and Console Tape Recorder Types.

The "Empress"

DE LUXE CONSOLE CABINET

Beautifully styled, elegantly veneered in medium full grain walnut, highly polished finish. Interior finished in light polished sycamore. Ample storage space. Designed to our own specification, it will accommodate the largest tape desk on the market. It has many applications, good quality amplifier, etc. O.A. dimensions 3ft. x 1ft. 6¼in. x 2ft. 10in. high with lid closed.

Send for our cabinet list which gives details of this and many other types.

Send for our current monthly bulletin of Replacement Radio/Radiogram chassis, Tape Recording equipment, etc.

Trade Only Supplied

V.E.S. WHOLESALE SERVICES Ltd

Dept (W.W.), 11, Gunnersbury Lane, Acton, W.3. *Tel.: ACOrn 5027*

ALPHA OFFER A SELECTION OF GOVERNMENT SURPLUS VALVES ALL TESTED BEFORE DESPATCH

Full list available 2½d. stamp. Complete catalogue 6d.

OZ4	6/-	6K7GT	6/6	25Z4G	9/-
1A5GT	6/6	6K7M	6/9	35L6GT	8/9
1A7	11/6	6K8G	8/-	35Z4GT	8/6
1C5GT	8/-	6K8GT	9/6	50L6GT	8/6
1L4	7/6	6L6G	9/-	AC6/PEN	5/6
1N5	10/-	6L7M	7/6	ATP4	6/6
1R5	7/6	6N7	7/6	E1148	2/-
1S5	7/6	6Q7G	9/-	EBC41	11/-
1T4	7/6	6R7G	8/-	ECH42	10/6
1U5	8/-	6SA7GT	8/-	ECL80	12/6
220VSG	6/9	6SG7	7/6	EF80	11/-
2A3	6/9	6SH7	6/-	EL41	11/6
2X2	5/-	6SJ7GT	8/-	EY51	13/6
3A4	8/-	6SK7	6/3	FW4/500	10/-
3Q4	9/-	6SL7	8/-	GZ32	12/6
3Q5	10/-	6SN7GT	9/-	H30	5/-
3D6	5/9	6SQ7	9/-	HL23DD	7/6
3S4	8/6	6SS7	8/-	KT2	5/-
3V4	9/-	6U4	14/-	KT33C	11/6
4D1	3/-	6U5G	8/6	KT66	10/6
42	8/-	6U7G	9/-	MS/PEN	5/-
5U4	8/6	6V6G	7/6	PCC84	11/6
5Y3GT	8/6	6V6GT	7/6	PCF80	11/-
5Z3	8/6	6X5GT	7/9	PCF82	11/-
5Z4G	8/6	7B7	8/6	PEN25	8/-
6A7	10/6	7C5	8/6	PEN45	8/6
6A8G	10/6	7C6	8/6	PEN220A	4/-
6AC7	6/6	7H7	8/-	PM12M	10/-
6AG5	7/6	7Q7	8/-	QP21	7/6
6AJ5	9/-	7R7	8/6	S130	8/6
6AK5	7/-	7S7	8/6	VR53(EF39)	6/6
6AL5	7/-	7Y4	8/6	VR54(EB34)	2/-
6AM5	5/6	80	8/6	VR55(EBC33)	7/6
6AM6	7/6	807	7/6	VR56(EF36)	6/-
6AQ5	8/6	8D2	2/9	VR57(EK32)	8/-
6AT6	8/-	9001	5/6	VR65(SP61)	3/9
6B4	5/-	9002	5/6	VR65A(SP41)	3/6
6B8G	4/-	9003	5/6	VR66(P61)	3/9
6BA6	8/6	9004	5/6	VR91(EF50)	6/-
6BE6	8/-	9006	6/-	VR91(EF50Syl)	8/-
6BR7	9/6	954	2/-	VR92(EA50)	2/-
6BW6	8/6	955	4/9	VR105/30(OC3)	5/6
6C4	8/-	956	3/6	VR116(V872)	4/-
6C5GT	7/6	12A6	6/9	VR119(DDL4)	4/-
6C6	6/6	12AT7	9/-	VR123(EF8)	6/6
6CD6G	13/6	12AU7	9/-	VR136(EF54)	7/-
6D3	7/6	12AX7	10/-	VR137(EC52)	6/3
6D6	7/3	12C8	8/-	VR150/30(OD3)	9/-
6F6G	7/6	12H6	5/-	VP23	8/-
6F6M	8/6	12J5	6/-	VT52(EL32)	8/-
6F8G	7/-	12K7	9/-	VT501(TT11)	6/-
6G6G	6/6	12K8GT	9/-	VU39(MU12/14)	8/6
6H6	3/6	12Q7GT	9/-	VU64(U12)	8/6
6J5G	5/-	12SJ7	8/6	VU111(V1907)	3/6
6J5GT	5/6	12SK7	6/6	VU120A	3/-
6J5M	6/6	12SQ7	8/6	X65	10/-
6J6	8/-	12SR7	7/6	X66	11/6
6J7G	6/6	25A6G	10/6	Y63	9/-
6K6GT	6/6	25L6GT	3/6	Barreter	
6K7G	6/-	25Y5G	9/-	Atlas 150A	4/6

Wire Wound Controls R.C.A.
Pre Set 25 ohms 2/6
Colvern CLR901 10K. ohms .. 2/-
Colvern CLR1232/268 500 ohms 2/6
Colvern 1,000 ohms, spindle ⅜in. 2/6

HEATER TRANSFORMERS

		Each
230 v. Input	2 volt .5 amp.	4/6
230 v. Input	2 volt 3.0 amp.	7/9
230 v. Input	4 volt 1.5 amp.	5/-
230 v. Input	4 volt 3.0 amp.	10/-
230 v. Input	5 volt 2.0 amp.	10/-
230 v. Input	6.3 volt .5 amp.	5/-
230 v. Input	6.3 volt 1.5 amp.	6/-
230 v. Input	6.3 volt 3.0 amp.	9/-
230 v. Input	12 volt .75 amp.	5/-

SENTERCEL RECTIFIERS

RM1, 3/9 ea.; RM2, 4/2 ea.; RM3 5/- ea.; RM4, 16/- ea.

METAL RECTIFIERS

12 v. ½ amp., 1/6 ea.; 12 v. 1 amp. 4/6 ea.; 2 v. 1 amp., 3/- ea.; 250 v. 45 mA., 6/3 ea.; 250 v. 75 mA., 7/6 ea.; 300 v. 60 mA., 7/6 ea.

CRYSTAL DIODES

Plastic case, wire ends, 2 for 2/1.

"Another Alpha Kit for you to build."

3 Valve (6K7, 6J7, 6V6GT) Plus Metal Rectifier, 2 Wave Band Midget radio AC Mains, complete in every detail, full instructions, circuit diagram and shopping list 1/6. Complete kit down to nuts, bolts and solder £5/10/-. Post 2/6

POCKET TEST METER

Ex-Govt. volt meter two ranges 0-15 v.: 0-250 v. D.C. Complete in case. 17/6 each.

IRON ELEMENTS

Standard adaptable type, 230 v. 450 w., 1/8 ea. Morphy Richards, replacement type, 3/9 ea. H.M.V. replacement type 3/- ea.

PLIERS, with side cutters, 4/3 pair.

PUBLICATIONS

	Each
Midget Radio Construction Manual	3/6
Radiofolder "F" An inexpensive tape recorder	2/6
Radiofolder "B" A practical Oscilloscope	2/6
Radio Calculations Manual	3/6
Practical Circuits Manual	3/6
Radio and Television Laboratory Manual	2/6

	Each
L.E.M. Silver Mica 1,000pF 10%	3½d.
L.E.N. Silver Mica 100 pF. 5%	3½d.
T.C.C. Silver Mica 50 pF. 10%	3½d.
L.E.M. Silver Mica 300 pF. 10%	3½d.
Hunts Silver Mica 374 pF. 1%	3½d.
L.E.M. Silver Mica 350 pF. 10%	3½d.
L.E.M. Silver Mica 25 pF. 20%	3½d.
T.C.C. Silver Mica 1,000 pF. 10%	3½d.

	Each
Tubular Condenser .5 mfd. 500 v.	6d.
Yaxley Switch 1 pole 8 way 1¼in. spindle	1/9
Arrow Toggle Slotted Dolly S.P.	1/9
Single Screened Cable ...... yard	6d.

	Each
Eric Mains Dropper 725 ohms 7½% tapped	1/6
Dubilier Moulded Mica AP9 .005	4½d.
HF Pile Wound Chokes	1/-
Vibrator Clips	5d.
Dubilier Nitrogol B45 12 mfd. 350 v.	5/6
International Octal Valve Holders Paxolin	4½d.
Vitreous Enamelled Resistors 20 w. 5,000 ohms	1/-

B.S.R. MONARCH AUTOMATIC RECORD CHANGER

These units will autochange on all three speeds, 7in., 10in. and 12in. They play MIXED 7in., 10in. and 12in. records. They have separate sapphire for L.P. and 70 r.p.m. which are moved into position by a simple switch. Minimum baseboard size required 14in. × 12½in., with height above 5¾in. and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price. These units are beautifully finished in cream enamel with cream bakelite arm. COMPLETE WITH FULL INSTRUCTIONS. £9/19/6.

AMERICAN INDICATOR UNIT TYPE BC929A

Brand new incorporating 3in. tube 3BP1, with mu-metal shield, 2—6SN7GT, 2—6H6GT, 6X5G, 2X2, 6G6G, 9 potentiometers, 24 v. aerial switch motor, transformer, and a host of small components. The whole unit which measures only 8½in. × 8½in. × 13¾in. is brand new, enclosed in black crackle box, and can be supplied at 65/- plus 5/- P. & P.

Standard 1¼in. Brown Knobs, per dozen	5/6
Zenith Dropper 910 ohms, each	2/6
Bakelite case. Double coil Buzzers, each	2/6
Erie Dropper, 1,340 ohms, 150 ohms, each	2/6
Box. 4 BA Nuts and Bolts, each	1/-
Intervalve Transformers Ex. Equip, each	2/-
Hand Microphone Bakelite switch in handle, each	7/6
High to low Impedance headphone units (insert in lead) each	3/6
Rubber grommets, assorted, per dozen	6d.
Bakelite Needle cups, each	1d.
Sleeving, various colours, 1 MM, length	1½d.
Mains Switch, 2 hole fixing, S.P., each	1/6
Yaxley Switch, 3 P., 3 B., 3 W., each	1/6
Yaxley Switch, 1 Pole, 9 Way, each	1/9
Waxed Carton, 8 MFD., 450 v., each	1/9
Westectors, WX12, W4, WX6, each	9d.
Collaro H1 F1 Pickup, each	32/6

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/- unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

MAIL ORDER ONLY

MAINS TRANSFORMERS

3-WAY MOUNTING TYPE

MT1
Primary: 200-220-240 v.
Secondaries: 275-0-275 v. 80 mA. 0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v. .... 17/6 ea.

MT2
Primary: 200-220-240 v.
Secondaries: 350-0-350 v. 80 mA. 0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v. .... 17/6 ea.

PENCIL RECTIFIERS

K3/25 5/8; K3/40, 7/6; K3/45, 8/2; K3/50, 8/8; K3/60, 9/8; K3/100, 14/8.

CONDENSERS

	Each		Each
8 × 8 mfd. 450 v.	4/-	32 × 32 mfd. 450 v.	6/11
8 × 16 mfd. 450 v.	4/-	32 × 32 × 8 mfd. 350 v.	5/6
8 × 24 mfd. 350 v.	3/-	32 × 32 mfd. 350 v. 25 mfd. 25 v.	5/-
8 × 32 mfd. 475 v.	3/9		
12 × 4 mfd. 450 v.	2/-	60 mfd. 450 v.	2/9
16 mfd. 450 v.	3/-	64 mfd. 350 v.	2/-
16 × 8 mfd. 350 v.	4/-	Dubilier (B.R. Range):	
16 × 16 mfd. 450 v.	3/3	BR 850. 8 mfd. 500 v.	2/9
16 × 16 × 8 mfd. 350 v.	3/6	BR. 1650. 16 mfd. 500 v.	3/3
20 × 20 mfd. 500 v.	4/9	BR.2050. 20 mfd. 500 v.	3/6
24 mfd. 450 v.	2/9	8 × 8 mfd. 500 v.	4/-
24 × 16 mfd. 350 v.	3/6	BR.501. 50 mfd. 12 v.	1/9
32 mfd. 450 v.	3/-	16 × 16 mfd. 500 v.	5/-
32 × 8 mfd. 350 v.	3/6	16 × 8 mfd. 500 v.	4/9
32 × 16 mfd. 350 v.	4/6		

OSMOR COIL PACKS

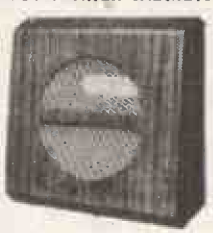
Type H.O., 48/- each. Type L.M., 40/- each. Type T.B., 50/- each. Type TRF, 40/- each.

SPRAGUE CONDENSERS

.05 mfd., 500 v.; 0.1 mfd., 1,000 v.; .1 mfd., 350 v.; .02 mfd., 750 v. All 9/- doz.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

LOUDSPEAKER CABINETS



This attractive walnut finished cabinet is available for 6½in. or 8in. speaker units. Metal speaker fret, complete with back and rubber feet.

6½in. type: Measures 8¾in. × 8½in. × 4½in. at base. Price 16/6 each.

8in. type: Measures 10¾in. × 10½in. × 5in. at base. Price 20/6 each.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

LOUDSPEAKER UNITS

Rola 5in. Speaker	17/6 ea.
Goodmans 5in. unit	18/6 ea.
Plessey 6½in. lightweight unit	16/6 ea.
Rola 6½in. standard type	17/6 ea.
Lectrona 6½in. with transformer	18/- ea.
Truvox 6½in. wafer type	20/- ea.
Plessey 8in. lightweight unit	17/6 ea.
R. & A. 10in.	25/6 ea.
Elliptical 4in. × 7in. unit	21/10 ea.
Mains energised 8in. unit, 1,000 Ω	21/- ea.
Mains energised 6in. unit, 600 Ω	17/6 ea.

CHASSIS

Aluminium Undrilled with Reinforced Corners. Available in the following sizes.

6in. × 4in. × 2½in.	4/6 ea.
8in. × 6in. × 2½in.	6/3 ea.
10in. × 7in. × 2½in.	7/3 ea.
12in. × 8in. × 2½in.	8/6 ea.
14in. × 8in. × 2½in.	9/6 ea.
16in. × 9in. × 2½in.	12/- ea.

All are four sided—ideal for radio receivers — amplifiers — powerpacks, etc.

PERSPEX IMPLOSION GUARDS

Incorporates escutcheon and filter. 12in. type, 11/6 ea.; 16in. type, 14/6 ea.

EX GOVERNMENT AND SURPLUS CONTROLS

This popular range is suitable for all Television constructors, etc. Keep your costs down when building the "Argus" or "Simplex" receivers. Available 500 Ω, 600 Ω, 1,500 Ω double type, 2 KΩ, 5 KΩ, 10 KΩ, 20 KΩ, 25 KΩ, 50 KΩ, 200 KΩ, 100 KΩ; ¼ meg. Ω, ½ meg. Ω, 1 meg. Ω, 2 meg. Ω, 50 KΩ double type. All 1/2 each.

ALPHA RADIO SUPPLY CO.

5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1. (Coventry Street end)

Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

BARGAIN OFFER OF BATTERIES

4½ v. Heavy Duty Bell Battery. Size 6½ x 4½ x 2¼in.	4/6
72 v. H.T. 1.5 v. L.T. Size 6 x 5 x 1¾in.	5/6
150 v. H.T. Size 2¾ x 5½ x 1⅜in.	5/6
67½ v. Size 2¾ x 1⅜ x 3¾in.	6/6

All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

ELECTROLYTIC CONDENSERS Per doz.

16 mfd. 375 v., 2/- each	21/-
16 x 24 mfd. 350 v. 2/6 each	27/-
20 x 20 mfd. 275 v. 2/3 each	24/-
24 mfd. 350 v. 1/6 each	15/-
24 mfd. 450 v. 2/3 each	24/-
Condenser Clips for above	3/6

BIAS CONDENSERS

50 mfd. 12 v. Single Hole Fixing 1/- each	10/6
100 mfd. 6 v. Tag End 10d. each	9/-
100 mfd. 25 v. Tag End 1/3 each	12/-

BLOCK PAPER CONDENSERS

4 mfd. 400 v. D.C. 3/6 each. Many other types in stock. Your enquiries invited.

LARGE ASSORTMENT OF TUBULAR CONDENSERS 6/-
MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005 5/-
200 Assorted Moulded Micas. Popular Values £2 10 0
200 Assorted Silver Micas. Popular Values £2 10 0
200 Assorted Carbon Resistors: ¼, ½ and 1 watt. Good selection £1 10 0

SPECIAL OFFER

0.1 mfd. 12,000 volts test Mansbridge Condensers. Height 6½in. Width 3¼in. Depth 2¼in. Fixing Centres 4in. Plus 1/- post ... 5/6

PAXOLIN SHEET

18 x 4½ x 1/16in., 1/- each; 10 x 10 x 1/16in., 1/6 each; 20 x 10 x 1/32in., 1/6 each; 20 x 10 x 1/16in., 3/- each.

RESISTORS

Carbon ¼ watt 2/6; ½ watt 3/-; 1 watt 4/-; 2 watt 6/- per doz.
WIRE WOUND AND VITREOUS. 5 watt 1/6; 10 watt 2/6; 15 watt 3/-; 20 watt 3/6 each.
HIGH STABILITY. ¼ watt 5% 6d.; ½ watt 5% 9d.; 1 watt 5% 1/3 each. A few values in 1% and 2% still available.
ALL ORDERS FOR RESISTORS C.O.D. PLEASE AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.
W.W. V/CONTROLS. ALL WELL-KNOWN MAKES. Pre-set 2/6 each Spindle types 3/- each. Values from 5 ohms to 50k.
V/CONTROLS WITH SWITCH 5k, 50k, ½ meg., 1 meg. ... 3/6 each
V/Controls Less Switch. Most values spindle and preset ...... 2/- each

METERS

0-300 mA. 2½in. Flush Mounting. Brand new. Guaranteed	8/6 each
0-500 mA. 2½in. Flush Mounting. Brand new. Guaranteed	10/6 each

TWIN GANG .0005 Less Trimmers	6/6 each
4-Way push button units 2/6 each	27/- doz.
Push Button Knobs	3/- doz.
TAG STRIPS. 3-way 2/-; 4-way 2/6; 5-way 3/-; 7-way 4/-; 28-way	12/- doz.
SLEEVING. 2 mm. 2/6; 3 mm. 3/6; 4 mm. 4/6; 5 mm.	5/6 per doz. yd.
POINTER KNOBS. Small black with white line, standard ¼in. spindle	7/6 doz.
WANDER PLUGS. Red and Black	2/- doz.
PHILIPS TRIMMER TOOLS. 1/- each	10/6 doz.
BELLING LEE FUSE HOLDERS. Type L.356 (Pnl. Mtg.)...	2/6 each
WEARITE COILS. PA4, PO4, PA5, PO5, 1/3 each	12/- doz.
VALVE HOLDERS. Moulded B9A 7/6; B7G 6/-; Int. Oct. 9/-; Eng. Oct.	4/6 doz.
VALVE HOLDER FITTED WITH LOWER CAN 1/6 per doz. extra.	
Screening Cans for B7G and B9A	6/- doz.
Paxolin V/H Int. Oct. B9A, B7G 5/- per doz.; Eng. Oct., 5-pin, 7-pin	3/- doz.
STANDARD SCREENING CANS 3-piece 1/- each; Spring Loaded	1/- each
BELLING LEE PLUGS AND SOCKETS, 5-pin 1/9; 7-pin 2/-; 10-pin	2/6 each
AIR SPACED TRIMMERS 5, 10, 15, 20, 25, 50 and 75 of pre-set and spindle types 1/6 each	15/- doz.
PYE PLUGS AND SOCKETS 1/6 per pair, "Tee" pieced	1/9 each
GROMMETS 1 grs. assorted grommets ⅛in. to 1in.	8/6 gross.
POST OFFICE LAMP JACKS No. 10 1/- each	9/- doz.
Lamp covers for same	3/- doz.

WESTINGHOUSE KH1 Half-wave Rectifier, rating 6 v. at 10 mA., 2/6 each ...... 27/6 doz.

OUTPUT TRANSFORMERS. Multi-ratio, 5/- each; Pentode or power	4/- each
DRUM DRIVES, 3¾in.	1/- each
WESTECTORS, WX6, WX12, W1, W12, W4, 1/- each	9/- doz.
ARCOLECTRIC (Whitney Lamp), Red, Green, Clear, 1/6 each	15/- doz.
SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder, 1/9 each	18/- doz.
NUTS 8 BA 3/-; 6BA 2/6; 4BA 3/-; 2BA	4/- per gross
SOLDER TAGS 2/6 per gross; Shakeproof Washers	2/- per gross
JONES PLUGS AND SOCKETS. 4-pin, 2/6; 6-pin, 3/-; 8-pin, 3/6; 10-pin, 4/-; 12-pin	6/- pair

CASH WITH ORDER OR C.O.D. ALL ORDERS DEPT. W.1
ALL ORDERS FOR LESS THAN £2 ADD POSTAGE

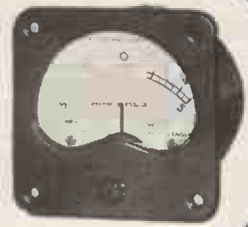
We invite your enquiries for items not listed

Trade Counter open 9 to 6 Monday to Friday
Callers Welcomed

WHOLESALE, MANUFACTURERS' AND EXPORT ENQUIRIES INVITED

WEIR

Instruments manufactured in Moving Coil and rectifier types to B.S. 89-1954.



SMALL PANEL INSTRUMENTS

2in., 2½in. and 3½in. enclosed in cases of black moulded insulating material and provided with scales printed in black on matt white enamelled metal dials.

Available as Ammeters, Voltmeters Milliammeters and Microammeters.

MANUFACTURED BY
WEIR ELECTRICAL INSTRUMENTS CO. LTD.
BRADFORD-ON-AVON - - WILTSHIRE
TELEPHONE 2378

INSULATING SLEEVINGS . . .

P.V.C. AND POLYTHENE SLEEVINGS INSULATED WIRES AND FLEXIBLES

An aircraft's performance . . . your car's reliability . . . tonight's Television and Radio's sound may depend upon efficient electrical insulation.

A.I.D. Approved

PLASTICABLE LIMITED
HAWLEY LANE, FARNBOROUGH, HANTS
Phone: Farnborough, Hants 85

STAR (SM) METAL

RIVerside 6673/4
for
PRESSED METAL COMPONENTS
— FINISHED TO SPECIFICATION —

• MANY STANDARD TOOLS AVAILABLE IN STOCK •
STAR METAL PLATE WORKS,
74-76 CHURCH ROAD, BARNES, S.W.13

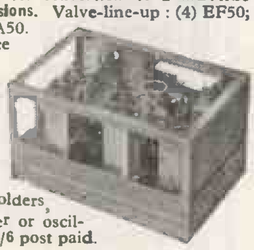
PROOPS BROS. LTD.

The Walk-around Shop

For those interested in
2 METRES or 70 CM

TRANSMITTER UNIT Ex-TR1143A.—Suitable for conversion to 2 metres. Circuit diagram and coil conversion details supplied free. Price, less valves, 5/- post paid.

RECEIVER UNIT Ex-1143A. Suitable for conversion to 2 METRES or F.M. Wrotham transmissions. Valve-line-up : (4) EF50; (1) EL32; (2) EF39; (1) EBC33; (1) EA50. Supplied with circuit diagrams. Price 9/- post paid (*less valves*).



AMPLIFIER UNIT Ex-TR1143A.—A 3-stage transformer coupled amplifier. Push-pull VT52's output to modulate push-pull VT501's. Circuit diagram free. Price, less valves, 4/6 post paid.

70 C.M. UNIT. Brand New, consisting of pair of tuned lines. 2 acorn valve holders, coarse and fine tuning. Suitable for mixer or oscillator unit. Size 5in. × 3½in. × ⅜in., 6/6 post paid.

CHOKES AND COILS
of American Manufacture

HEATER CIRCUIT RF CHOKES for Pre-amplifiers, Converters, etc.

Type L.1. 510 micro-henries. Type L.3. 8 micro-henries.
Type L.2. 25 micro-henries. Type L.4. 6 micro-henries.
All at 1/6 each post paid.

SLUG TUNED RF COILS

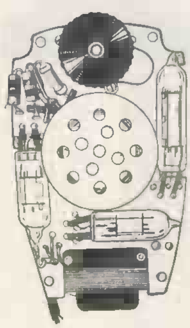
Type L.5. 0-5 micro-henries. Type L.8. 2.2-4 milli-henries.
Type L.6. 120-210 micro-henries. Type L.9. 8.6-28 milli-henries.
Type L.7. 200-580 micro-henries. Type L.10. 14-42 milli-henries.
All at 2/6 each post paid.

AUDIO TREBLE LIFT CHOKES. Type L.11. 43-110 milli-henries.

H.T. SMOOTHING CHOKES

4 henries 40mA (Potted), 5/6 post paid.
8 henries 100mA (Potted), 8/6 post paid.

Miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

Technical Details. A Germanium Diode Detector circuit followed by the existing 3 valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

THE COMPLETE KIT OF PARTS includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature ear phone and moulded ear insert attached: ferrite rod, germanium diode, components, circuit diagram and full instructions. Price **£2 6s. 0d.** post paid (or without crystal microphone £2 2s.). *Batteries extra:* 1.5v. L.T. (Type D18), 8d.; 30v. H.T. (Type B119), 4/3.

NOTE: As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

SEE and HEAR this Miniature POCKET RADIO demonstrated.

DROPPERS. Chassis type heat dissipating droppers for midget receivers. 5000Ω 10W. 3/6 post paid.

MAIN DROPPERS. 7500Ω 50W. 2/6 post paid.

NEON TUBES. Miniature bayonet type. 80V striking (1 megohm in series for mains). 1/6 post paid.

ABSORPTION WAVE METER. Easily converted to 2 metres or 70 cm. In Copper-plated metal case 3⅛in. × 4½in. × 5½in. with dial calibrated 0-100 and 80V Neon Tube. Coverage approx. 190-210 Mc/s. New. 6/6 each post paid.

25 WAY 2 BANK SWITCH. Contained in metal case 9in. × 6in. × 2½in. with two 12 way terminal blocks. Useful for multi-test meters, model control, etc. Type 5D/460, 7/6 pp.

BENDIX COMMUNICATIONS
RECEIVER TYPE RA-10DB

A superb 8-valve 4 band receiver covering 150-400 kc/s., 400-1100 kc/s., 2-5 Mc/s., and 5-10 Mc/s. Valve line up 6SK7 R/F, 6K8 F/C, Two 6SK7 IF Amplifiers, 6R7 Second Det. AVC and AF Amplifier, 6C5 BFO, 6K6 OP, 6H6 Sig. limiter diode.

SENSITIVITY. 4 mV. signal, gives 50 mW. audio at 4-1 signal/noise ratio. **SELECTIVITY.** At 5 Mc/s. is 39 kc/s. at 1,000 times down. At 150 kc/s, bandwidth is only 22 kc/s. **IMAGE RATIO.** Minimum image ratio is better than 1500-1 on 5-10 Mc/s Band and 10,000-1 on 150-400 kc/s.

As a BOAT, TRUCK, CARAVAN or CAR RECEIVER it is UNEQUALLED in value; converted to a.c. operation for fixed station, it equals receivers selling for over five times the price we ask.

PRICE
£5 . 10 . 0
Pkg. & Carr. 10/-.

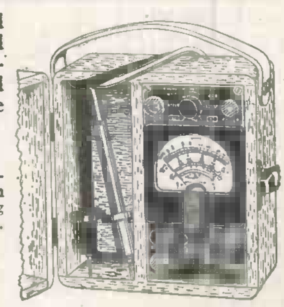
MULTIRANGE
A.C./D.C. TESTMETER
of well known American manufacture

This testmeter has a basic movement of 400 microamps and is calibrated for use on the following ranges:—

A.C. and D.C. Volts 0 to 5,000V in 6 switched ranges.
D.C. Current ranges 0-1mA, 1-10mA, 10-100mA and 100mA-1A.
Use as an OHMETER (Resistance Measurements) .1Ω to 1 Megohm.
Decibels from −10db to +15db. For line load impedances from 5 to 1,000Ω (directly calibrated for 500Ω line).

This instrument is contained in a well finished polished wood case with leather carrying handle. Leads and test probes are housed in the case which measures 6½in. × 6½in. × 4½in.

All meters fully tested before despatch. Supplied complete with moulded test probes, full operating instructions and circuit diagram.



PRICE
£4 . 19 . 0
Packing and Postage 3/-.

NOTE: Orders and Enquiries to Dept. 'W' please.

Shop hours : 9 a.m. to 6 p.m. Thursday : 9 a.m. to 1 p.m. **OPEN ALL DAY SATURDAY**

PROOPS BROS. LTD. The Walk-around Shop

52 TOTTENHAM COURT ROAD · LONDON · W.1. *Telephone : LANgham 0141*

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 13½in. × 5½in. × 2½in. Attractive Glass Dial 10in. × 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. feed-back. A.C. mains 200/250 v. Double wound transf. isolates chassis from mains. Aligned and calibrated ready for use.

BRAND NEW & GUARANTEED £9.15.0 Carr. and ins. 4/6.

3-ohm speakers suitable for this chassis available 8″ 17/6 10″ 25/-

This chassis is a genuine bargain and delivery is reasonably good.

BEST EVER VALUE IN RECORD PLAYERS

Latest P.S.R. Model. 3 speed Autochanger Mixer Unit. Famous Magidisc 7in., 10in. and 12in. record selector. Modern cream styling. Dual Xtal cartridge stylus for high fidelity reproduction. As used by leading Radiogram Manufacturers. Complete with full instructions and template.

OUR BARGAIN PRICE **9½gns.** post free.

JASON F.M. TUNER UNIT 87-105 mc/s

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 B.V.A. miniature valves, and all necessary quality components etc. for only £6/10s. post free. Superior dial calibrated mc/s., edge lit by 2 pilot lamps, 12/6 extra. 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.

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. 4/500v.	2/-	8+16/450 v.	5/-
8/450 v.	2/3	8+16/500 v.	5/6
8/500 v.	2/9	16+16/450 v.	5/6
8+8/500 v.	4/6	16+16/500 v.	6/-
8+16/450 v.	5/-	32/350 v.	4/-
16/450 v.	3/6	32+32/450 v.	6/6
16+16/450 v.	5/6	60+250 v.	6/6
32/350 v.	4/-	60+100/350 v.	11/6
32/500 v.	5/-	100+200/275 v.	12/6
32+32/350 v.	5/6	1500/6 v.	4/6
32+32/500 v.	7/6	1000+1000/6 v.	6/6

80 ohm CABLE CO-AXIAL

SPECIAL.—Semi-air spaced polythene, standard ¼in. diam. Stranded core. Losses cut 50% **9d. yd.**
12 yds. 8/9.

COAX PLUGS	1/2
SOCKETS	1/-
COUPLERS	1/3
OUTLET BOXES	4/6

BALANCED TWIN FEEDER per yd. (80 ohms) 6d.
TWIN SCREENED FEEDER per yd. (80 ohms) 1/-.
50 OHM COAX CABLE 8d. per yd. ¼in. dia.

CONDENSERS.—Mica, S. Mica, Ceramics. All pref. values. 3 pf. to 680 pf. 6d. ea., 5/- doz. Tubulars, 450 v., Hunts and T.C.C. .0005, .001, .005, .01, .02 and .1 350 v., 9d. .05, .1 500 v. Hunts Moldseal, 1/-. .25 Hunts, 1/6. .5 Hunts, 1/9.
SILVER MICA CONDENSERS.—10%. 5 pf. to 500 pf., 1/-. 600 pf. to 3,000 pf., 1/3.

DITTO 1% (ex stock). 1.5 pf. to 500 pf., 1/9. 515 pf. to 5,000 pf., 2/-.
SPEAKER FRET.—Expanded Bronze anodised metal 8in. × 8in., 2/3; 12in. × 8in., 3/-; 12in. × 12in., 4/3; 12in. × 16in., 6/-; 24in. × 12in., 8/6.
TYGAN FRET (Murphy pattern).—12in. × 12in., 2/-; 12in. × 18in., 3/-; 12in. × 24in., 4/-; etc., etc.

BAND 3 CONVERTOR 186/196 Mc/s

("W. World," May 1954).

Kit of parts complete to build this most successful unit comprising drilled chassis, valves, wound coils, and all necessary components, slightly modified version using 8D3 instead of EF80 valves, £2/5/-, post free.

Provision has been allowed on chassis for small power pack and Aerial switching.

Power Pack Components including Mains Transformer 30/- extra.

TRIMMERS, Ceramic, 4 pf.—70 pf., 9d. 100 pf. 150 pf., 1/3; 250 pf., 1/6; 600 pf., 1/9. PHILIPS Beehive Type—2 to 8 pf. or 3 to 30 pf. 1/3 each.

ALUMINIUM CHASSIS

18 g. Plain undrilled. Folded 4 sides, riveted corners, lattice fixing holes. Depth 2½in., 7in. × 4in., 4/6; 9in. × 6in., 5/9; 11in. × 7in., 6/9; 13in. × 9in., 8/6; 14in. × 11in., 10/6, etc.

S.T.C. RECTIFIERS

K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/45 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6; K3/160 14 kV., 18/-; RM1 125 v. 60 mA., 4/-; RM2 125 v. 100 mA., 4/9; RM3 125 v. 120 mA., 5/9; RM4 250 v. 275 mA., 16/-; HT59 250 v. 200 mA., 26/6.

MAINS TRANSFORMERS. Soundmaster, 35/-; Mullard Amp. F/shrouded, 35/-; Osram 912 F/shrouded 35/-.

RESISTORS

Carbon type. Pref. values 10 ohms-10 megohms. 20% Tol. ¼ 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—10000 ohms, 5 w., 1/3; 10 w., 1/6; 15 w., 2/-. 15000 ohms—33000 ohms, 5 w., 1/9; 10 w., 2/3. 47000 ohms—50000 ohms, 5 w., 2/3; 10 w., 2/3.

LINE CORD.—.3 amp., 60 ohms per foot, .2 amp., 100 ohms per foot, 2 way 6d. ft.; 3 way 7d. ft.

WIRE WOUND POTS

Standard 3-watt type—long spindles. 100 ohms, to 50000 ohms, 5/6; 100000 ohms 6/6.

PRE-SET W/W POTS

T.V. knurled slotted knob type. 25 ohms to 30000 ohms, 3/-; 50000 ohms, 4/-; 50000 ohms to 2 Megohms (carbon) 3/-.

CONTROL KNOBS

¼in. spindle fitting. 1¼in. diam. Walnut or Ivory. Gold engraved Focus, Contrast, Brilliance, On-off, Volume, Tone, Tuning, Treble, Bass, Wavechange, Radio-Gram, Record-Play etc. 1/6 each. Ditto, unengraved, 10d. Superior Unmarked Knobs with Gold Ring. Walnut or Ivory, 1¼in., 1/- ea.; 1in., 9d. ea. Pointer Knobs, Black with White Line, 9d.

VOLUME CONTROLS

lin. semi Midget Type, Long spindles. All values 10000 ohms to 2 Megohms. Less sw., 3/-; S.P. sw., 4/-; D.P. sw., 4/9. All individually boxed. Guar. 12 months.

T.R.S. RADIO COMPONENT SPECIALISTS

70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Phone: THO 2188 Hours 9am—6pm. 1pm. Wed. Open all day Saturday.
BY THORNTON HEATH STATION. BUSES 130A, 133, 159, 166, 190.
Terms: C.W.O. or C.O.D. Post & Packing up to ½lb., 6d., 1lb., 1/-, 3lb., 1/6, 5lb., 2/-, 10lb., 2/6. Send for our Bargain Lists, 3d.

Phœnix

EYELETTING and light PUNCHING MACHINES

Autophœnix No. 6

A new and improved treadle operated machine for the automatic insertion and closing of eyelets in either flat or formed work in metals, plastics, fabrics, etc. The deep throat, high vertical gap and projecting base make this machine adaptable for eyeletting radio chassis, cylindrical shells, spinnings, mouldings, etc.

VISIT US ON STAND No. 3
Grand Hall Gallery, Olympia
Engineering, Marine & Welding Exhibition
SEPT. 1st — SEPT. 15th

HUNTON LIMITED
Phœnix Works, 114-116, Euston Road, London, N.W.1
Tel.: EUSton 1477 (3 lines). Grams: Untonexh, London.

THE WORLD'S GREATEST BOOKSHOP

FOYLES

★ ★ FOR BOOKS ★ ★

NEW AND SECOND-HAND *Technical Books*

Foyles have Departments for Gramophone Records, Stationery, Handicraft Tools and Materials, Music, Magazine Subscriptions, Lending Library.

119-125 CHARING CROSS ROAD LONDON, W.C.2
Gerrard 5660 (16 lines) ★ *Open 9-6 (Thurs. 9-7)*
Nearest Station: Tottenham Court Road

POLYTHENE

INSULATORS, END CAPS, PLUGS, ETC.
for
T.V. AERIALS

Standard Articles or Special Mouldings

AMPLEX APPLIANCES (KENT) LTD.
19 DARTMOUTH ROAD, HAYES, BROMLEY, KENT
(RAVensbourne 5531)
All export enquiries to
ANTEX LTD., 3 TOWER HILL, LONDON, E.C.3

C.R.T. ISOLATION TRANSFORMERS

Designed to cover practically every demand for Transformers for Cathode Ray Tubes having Heater/Cathode short circuit or 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	With Tag
4 volt	10/6 each	Panel and
6.3 volt	10/6 each	Solder Tags
10.8 volt	10/6 each	
13.3 volt	10/6 each	

Type B. Mains Input 220/240 volts. Multi Output 0-2-4-6.3-7.3-10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for most Cathode Ray Tubes. The MOST versatile Low Capacity C.R. Transformer with Universal Output. With Tag Panel and Solder Tags. 21/- each.
Type C. A most useful low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 230/240 volts. Output 2-2½-2¾-2⅞-3 volts at 2 amps. With Tag Panel and Solder Tags 17/6 each. All Isolation Transformers are individually boxed, Labelled and clearly marked with relevant data.

Volume Controls

Midget type. Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg-ohms.

No Sw.	S.P.Sw.	D.P.Sw.
3/-	4/-	4/9

COAXIAL PLUGS	1/-
SOCKETS	1/-
DOUBLE SOCKETS	1/-
OUTLET BOXES	3/6

80 ohm CA COAXIAL

STANDARD ¼in. diam. Coaxial GRADE "A" **7d.** yd.

SPECIAL
Semi-air spaced Polythene insulated. ¼in. diameter.
Stranded core. Losses cut 50% **9d.** yd.

BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/- yd. 80 ohms.
50 OHM COAXIAL CABLE 8d. per yd. ¼in. dia.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf. 1/3; 250 pf., 1/6; 600 pf., 750 pf., 1/9.
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/-. Preferred values 100 ohms to 10 meg.

WIRE-WOUND RESISTORS
5 watt, 10 watt, 15 watt — 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/-.

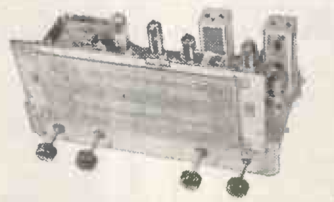
Standard Size Pots, 2¼in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K., 6/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS.—Heavy Duty 50 mA., 4/6. Ditto, tapped primary, 4/9. Multiratio, push pull, 6/6. Tapped small pentode 3/9. Miniature 3S4, etc., 3/9.

L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H. 120/150 mA., 12/6. 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, 21/-. MIDGET TRANS. 250-0-250 v. 50 mA. 6.3 v. 2 a., 12/6. HEATER TRANS. Tapped prim., 200/250 v. 6.3 v. 1½ amp., 7/6, tapped sec. 2, 4, 6.3 v., 1½ amp., 8/6. 6.3 v. 3 amp., 10/6.

CRYSTAL MIKE INSERT.—Famous make, precision engineered. Size only 1⅛ × $\frac{3}{16}$ in. Bargain Price 6/6. No transformer required.

EXTENSION LOUDSPEAKER SWITCHED SOCKET. on-off and parallel switching, complete with plug, 2/-.
COPPER PLATED AERIAL RODS. ½ × 12in. push fitting. 2/6 doz., p. & p. 9d.
MAINS LEAD. 3 yds. Twin Twisted Maroon Flex. 1/-. 2 yds. Non-kink Appliance Leads. Bargain 1/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 14/11. TYANA TRIPLE THREE. complete with detachable bench stand. 19/6. 200/220 v. or 230/250 v.
NEW SOLON MIDGET IRON. 25 w., 22/-. IDEAL FOR RADIO CONSTRUCTORS. 200/220 v. or 230/250 v.
MIKE TRANSF. Ratio 50 : 1. 3/9 ea., new and boxed.
V'HOLDERS. Pax. Int. Oct., 4d.; EF50, EA50, 6d.; B12A CRT, 1/3. Moulded: Int. Oct. 6d.; B7G, 9d.; with screening can 1/6; B8A, B8G, B9A, 1/-; VCR97, 2/6. Ceramic: EF50, B7G, 1/-. Paxolin ENG. and AMER. 5-, 7- and 9-pin, etc., 1/-. EF50 Clips 1½d.
Nuts, Bolts and Washers, 12 of ea., 1/- packets, 2, 4 or 6 B.A.
TAG STRIPS. 2- or 3-way, 2d.; 4- or 5-way, 3d.; 6-way, 4d.; 9- or 10-way, 6d., etc. 28-way, 1/6.
TOGGLE SWITCHES EX-GVT. "On-off." 9d. Ersin M'core solder 60/40, 16 g. or 18 g., 5/6; ¼lb., 4d. yd. T.C. wire, 18 to 22 s.w.g., 2/-; ¼lb. P.V.C. connecting wire, 8 colours, single or stranded, 2d. yd. 2 K. 5 w. w/w Pots, 2/6. 25 K., Colvern w/w Pot, 1in. spindle, 2/6.
SCREENED GRID CAPS. I.O. or Eng. 6d. ea.
BULGIN HIGH VOLTAGE VALVE CAPS. I. Oct., 1/-.
FUSES. 1¼in. all values 60 mA. to 10 a., 6d.
ALADDIN FORMERS and cores, ¼in., 8d.; ⅜in., 10d.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
INT. OCTAL CABLE PLUG (8-pin), with cover, 1/3.
200-250 Volt SELECTOR SOCKET (2 × 1in.) with Plug, 1/-. PILOT LAMPS. 6.3 v. .3 a., 8d.
MAINS DROPPERS. 3 × 1¼in. 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.



ALL WAVE RADIOGRAM CHASSIS

THREE WAVEBANDS	FIVE VALVES
S.W. 16 m.—50 m.	LATEST MULLARD
M.W. 200 m.—550 m.	ECH42, EF41, EBC41
L.W. 800 m.—2,000 m.	EL41, EZ40.

12 month Guarantee, with 10in. P.M. Speaker, A.C. 200/250 v. Switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½ × 5½ × 2¼in. Glass Dial 10 × 4½in., horizontal or vertical available. 2 Pilot Lamps, Four Knobs. Walnut or Ivory, aligned and calibrated. Chassis isolated from mains. PRICE £10/15/-. Without 10in. Speaker, £9/15/-. Carr. & Ins. 4/6.

RECOMMENDED FOR ABOVE CHASSIS

PRICE Carriage Paid **£9 . 19 . 6**

Brand new Plessey 3-speed Autochanger Mixer Unit for 7, 10 and 12in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire stylus. Plays 4,000 records. Sprung mounting. Baseboard required 15½ × 12½in. Height 5½in. Depth 2in. Super Quality.

FAMOUS MAKE. 3-speed Single Record unit with Acos 37 Turnover Head, each Sapphire Stylus plays 2,000 records. Starting Switch Automatically places Pick-up on records. 7in., 10in. or 12in. Auto Stop. Baseplate 12 × 8½in. Height 2½in. Depth 1½in. Price £7/15/6, post free.

£5/15/-. CONVERT YOUR RADIO. Playing desk 15 × 22 × 7in. Walnut finish, drawer front with 78 r.p.m. motor, turntable and pick-up. Press lever start places High impedance magnetic pick-up on records 10in. or 12in. Auto Stop. Brand new in original makers' boxes. £5/15/-, carr. free.

B.S.R. MONARCH 3-SPEED MIXER CHANGER. ACOS GP.37 XTAL HEADS. Baseboard, 14 × 12in. Height 5½in. Brand new in Makers' Boxes, £9/19/6, post free.

7/6 VALVE SALE 7/6

New Imported and Ex-Government. All guaranteed by us. 1R5, 1S5, 1T4, 1S4, 3S4, 3V4, 6AM6, 6F12, 6BE6, 6BW6, 6K7M, 6K8, 6SA7, 6SL7, 6V6, 6X4, 6X5, 787, 8D3, 12AX7, 807, EC91, EF39, EF91, EF92, EL32, HVR2A, PEN25, U22, UF41. AT 8/6: 5U4, 5Z4, 6AK5, 6AT6, 6C9, 6L6, 6Q7, 6SN7, 80, ECH42, Sylvania EF50, MU14. AT 10/6: ECL80, EF80, EL41.

RECORDING TAPE

1,200 ft. on standard fitting 7" Plastic reels. Brand new boxed 17/6

COMMERCIAL T.V. CONVERTOR, BAND III. With self-contained power pack, just plug in, full instructions supplied. An Aerialite Rainbow product, £9/10/-.

T/V PRE-AMP. Channel 1. Easily modified for other Channels or Converter use. Midget Chassis, 4¾ × 2½ × 1½. Complete with EF42 or 6F13 valve, coaxial lead, Belling plug and Octal plug. Ready for use. Brand new Mfrs. Surplus. Listed £3/15/-. Special Clearance Price 21/-. Buy Yours Now.

PYE Aerial Plug and Socket, 1/6 pr.
5in. RADIO SCREWDRIVERS. Sheffield made blade, 2½ × ⅛in. Ins. handle 5,000 v. 4½d. each.
CONDENSERS. New Stock .001 mfd. 7 kV. T.C.C., 5/6. Ditto, 12.5 kV., 9/6; 2 pf. to 500 pf. Mica, 6d.; .001 .002 500 v. .01 Sprague 1,000 v., .02 500 v., .1 mfd. 350 v. Tub., 9d.; Hunts Moldseal 500 v. .005, 9d.; .05 mfd. and .1 mfd., 1/-. .25 mfd., 1/6. .1 mfd., 600 v., 1/3. .5 mfd. 500 v., 1/9.
CERAMIC CONDENSERS, 500 v. .3 pf. to .01 mfd., 1/-.
SILVER MICA CONDENSERS. 10%, 500 v. 5 pf. to 500 pf., 1/-. 600 pf. to 3,000 pf., 1/3.
DITTO 1%, 500 v. 1.5 pf. to 500 pf., 1/9. 515 pf. to 5,000 pf., 2/-.

ELECTROLYTICS ALL TYPES NEW STOCK

Tubular Wire Ends		Can Types, Clips, 3d.	
1/275 v.	2/-	16/450 v.	3/6
2/450 v.	2/3	16/500 v.	4/-
4/500 v.	2/-	32/350 v.	4/-
8/450 v.	2/3	60/350 v.	5/6
8/500 v.	2/9	250/250 v.	5/6
10/500 v.	2/6	8+16/450 v.	5/-
16/500 v.	4/-	16+16/450 v.	5/6
32/500 v.	5/6	16+16/500 v.	6/6
25/25 v.	1/9	32+32/350 v.	4/6
50/25 v.	1/9	32+32/275 v.	4/6
50/50 v.	2/-	32+32/450 v.	6/6
8+8/500 v.	4/6	60+100/350 v.	11/6
8+16/500 v.	5/6	64+120/275 v.	7/6
16+16/500 v.	6/-	100+200/275 v.	10/6
32+32/500 v.	7/6		

SPECIALS. Can Types. 500 mfd. 12 v., 3/-; 1,000 mfd. +1,000 mfd., 6 v., 6/6; 1,500 mfd. 6 v., 4/6; 1 mfd. 1.5 kV. T.C.C., 3/6. Type 512 screw base, 8 mfd. 500 v., 3/-; 16 mfd. 500 v., 4/-.
SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/45 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6; K3/160 14 kV., 18/-. MAINS TYPE. RM1, 125 v., 60 mA., 4/-; RM2, 100 mA., 4/9; RM3, 120 mA., 5/9; RM4 250 v. 275 mA., 16/-.
T.V. AERIALS. Aerialite, all channels in stock. Indoor loft type Inv. T., 13/6. Band III Aerdaptors 7/6 pair.

WAVECHANGE SWITCHES
5 p. 4-way 2 wafer.............................. 6/6
2 p. 2-way, 3 p. 2-way........................ 2/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way......... 3/6
3 p. 4-way, 1 p. 12-way....................... 3/6

KNOBS, GOLD ENGRAVED.—Walnut or Ivory, 1½in. diam., 1/6 each. "Focus," "Contrast," "Brilliant," "Brilliance—On-Off," "On-Off," "Volume," "Vol.-On-Off," "Tone," "Tuning," "Treble," "Bass," "Wavechange," "Radio-Gram," "S., M., L., Gram.," "Record-Play," "Brightness." Ditto not engraved, 1/- each.

COILS. Wearite. "P" type, 2/6 each. Osmor Midget "Q" type adj. dust core, 3/6 each. All ranges in stock.
OSMOR COIL PACKS, H.O., 48/-, etc.
J.B. DIAL ASSEMBLIES, SL8, 26/6, etc.
PIFCO A.C.-D.C. MULTI-RANGE TESTMETER, 29/6.
REACTION COND.—.0001, .0003, .0005 mfd., 3/6 ea.

ALUMINIUM CHASSIS.—18 s.w.g. Plain, undrilled, folded 4 sides and riveted corners lattice fixing holes, Strong and soundly constructed with 2½in. sides. 7in. × 4in., 4/6; 11in. × 7in., 6/9; 13in. × 9in., 8/6; 14in. × 11in., 10/6; and 18 × 16in. × 3in., 16/6.

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/-.
ACID HYDROMETER.—New Ex-Govt. Unbreakable. Packed in metal case, 7in. × 1½in. dia., 4/6.
H.F. MIDGET CHOKES.—14 M.H., 2/6 each.
BRIMISTORS.—CZ1 for 3 a. heater chains, 3/6. CZ2 for .15 a., or .2 a., 2/6. CZ3, 1/6.
COPPER ENAMEL WIRE.—¼ lb. 16 to 20 s.w.g., 2/-; 22 to 28 s.w.g., 2/6; 30 to 40 s.w.g., 3/6.
SWITCH CLEANER Fluid, squirt spout, 3/9 tin.
TWIN GANG TUNING CONDENSERS.—.0005 mfd. midget with trimmers, 8/6; 375 pf. midget less trimmers, 6/6; .0005 Standard size with trimmers and feet, 9/-; less trimmers, 8/-; ditto, soiled, 2/6.
SLEEVING.—Various colours, 1, 2 mm., 2d.; 3, 4 mm., 3d. yd.; 6 mm., 5d. yd.
LOUDSPEAKERS P.M. 3 OHM. 5in. 16/6. 6½in., 17/6. Goodmans Eliptical 7 × 4, 18/6. 8in., 19/6. 10in., 25/-. 6½in. Goodmans with trans., 21/-. Famous make 10in., 10 watt heavy duty speakers, 3 ohm, Aluminium voice coil, 39/6. 8in. Mains energised, 2.5 K. or 2 K. ohm field, with tapped output trans., 24/6; less trans., 21/-.
CRYSTAL DIODE.—G.E.C., 3/6. Circuit Book, 1/-.
H.R. PHONES.—(Hi-grade Amer.), 15/6 pr.
S. G. BROWN'S. 4,000 ohms, 15/6 pr.

VCR97 TESTED FULL PICTURE £2

I. F. TRANSFORMERS
WEARITE TYPE 500. 465 Kc/s., adjustable 450-470 Kc/s., size 3½in. × 1½in. × 1½in., 10/6 pair. MIDGET I.F.s, size 1in. × 1in. × 2in., 8/9 pair.

We have no connection with any other firm. Please address all correspondence correctly as below.

RADIO COMPONENT SPECIALISTS

307 WHITEHORSE RD., W. CROYDON
OPEN ALL DAY—(Wed. 1 p.m.)
P. & P., 6d. £1 orders post free. C.O.D. Service 1/6. Lists S.A.E.

'Phone THO 1665 (after 6 p.m. 4198). Buses 133 or 68 pass door. 48-hour postal service.

direct TV REPLACEMENTS

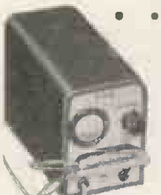
We carry the largest varied stock of line output transformers in Great Britain.

Rectifiers for T.V.

Whether you require a small M.3 rectifier or a larger H.T. rectifier (R.M.5, for example), we are almost certain to have them in stock.

Frame and Line Oscillator Transformers

Hundreds in stock, to suit majority of sets.



R.A.E. Type C.1.A. Line Output Tester

This is the most compact Line Output tester on the market, giving a clear indication of shorting turns, displayed on a cathode ray tube. £11/10/- inc. pkg. and post. Send S.A.E. for full details.

Band III Converters

Our company is supplying Band III converters in large numbers, many dealers placing orders for a hundred or more units. Do not wait until it is too late.

We are prepared to supply single converters from stock, or on contract orders for a quantity every week.

Contact us stating Make and Model number *and we will quote by return.*

Every Service Engineer and Dealer should have a copy of our "Rewind and Replacement Handbook." This cancels all previous Manuals. Price 1/-, post free.

Terms of Business C.W.O. or C.O.D.

direct TV REPLACEMENTS

134/136 LEWISHAM WAY · NEW CROSS · S.E.14 *TIDeway 3696-2330*

A Magnetic Tape Recorder you should know about

The Celsonic High Fidelity Magnetic Tape Recorder repeats all it hears, with exactitude. It eliminates "tone," "resonance," "boomph" and other inherent noises. It gives the naked truth from 50 to 14,000 cps. Time after time it is placed first for absolute fidelity. It will record 4,920ft. of tape at one session and give a two hours and ten minutes uninterrupted playback at 7½in. per second.

Other outstanding advantages are the superimposing device for recording words over music and the synchronising unit for converting silent films to "Talkies." The native music for the Twentieth Century Fox production "Untamed" was recorded by the Celsonic Tape Recorder.

For further proof that the Celsonic is no ordinary tape recorder write to Excel Sound Services Ltd., (Dept. W.D.Z.) Celsonic Works, Garfield Avenue, Bradford 8. Telephone: Bradford 45027.

Hire Purchase now available.

CELSONIC

Specialists in the manufacture of amplifiers and sound equipment to individual specifications.

We welcome your enquiries.

PLEASE PRINT YOUR NAME AND ADDRESS.

PARKER'S SHEET METAL FOLDING MACHINE

Heavy Vice Model. Capacity 18 gauge M.S.x2ft. wide. Loose Attachments for Radio Chassis Making Weight 22 lb. Price 50/-. Attachments 1/6 per ft. Carriage 4/-, with attachments 5/6.

Also Parker's Square Type Drill Vice. Machined table 7in. x 6in. x ½in. Jaws of Bright Steel. Admits stock of 4in. Complete with stand. Heavily constructed. Wt. 13½lb. Price 37/6. Carriage 2/6

Machines guaranteed. Send for details.

A. B. PARKER WHEATCROFT WORKS, WELLINGTON STREET, BATLEY, YORKSHIRE. *Tel.: Batley 426*

TRANSFORMERS COILS CHOKES

LARGE OR SMALL QUANTITIES
TRADE ENQUIRIES WELCOMED

SPECIALISTS IN

FINE WIRE WINDINGS

MINIATURE TRANSFORMERS, PICK-UP, CLOCK AND INSTRUMENT COILS, ETC.
VACUUM IMPREGNATION TO APPROVED STANDARDS

ELECTRO-WINDS LTD.

CONTRACTORS TO G.P.O., M.O.S., L.E.B., ETC.

123-5-7 PARCHMORE ROAD, THORNTON HEATH, SURREY

LIVINGSTONE 2261 EST. 1933

INTRODUCING THE NEW ACRU PYROBIT HEAVY DUTY SOLDERING IRON 450 w.

This Iron is extremely robustly built—and practically indestructible. The extremely large area of the element ensures life which surpasses all previous products. IT EVEN SOLDERS ALUMINIUM . . . with our special aluminium solder. Ideal for chassis or similar work. Delivery from stock—made in two voltages 110 v. and 230/250 v.

ASK FOR LEAFLET **The Acru Electric Tool Mfg. Co. Ltd., Chapel Street, Levenshulme, Manchester, 19.**

SPECTONE

MULLARD 5-10 AMPLIFIER

This remarkable development will meet the most exacting high fidelity requirements at an extremely low price.
Meticulous inspection at each stage ensures that the Spectone Mullard 5-10 Amplifier fully meets Mullards specification.

TWO INPUTS One for radio tuner, microphone, etc., and one for pickup. The pickup input has two switch positions for equalisation—L.P. and Standard. Plug-in equalisers are available to suit various pickups.

CONTROLS Besides the input and equalisation selection switch, volume, treble and bass controls are provided. The treble control is continuously variable from +10db to −10db and the bass +11db to −5db.

MAXIMUM OUTPUT
15 watts

POWER OUTLET for pre-amplifier
300 volts at 12 milli-amps. 6.3 volts at 2 amps.

HUM & NOISE
−73db referred to 10 watts.

OUTPUT IMPEDANCE
15 ohms

FREQUENCY RESPONSE
± 0.5db 10 c/s to 20,000 c/s.

TOTAL HARMONIC DISTORTION at 10 watts.
Less than 0.4% at 40 c/s.
Less than 0.2% at 400 c/s.
Less than 0.3% at 2,000 c/s.

OPERATING VOLTAGE
200/250 volts A.C. 110/115 volt model available to special order.

OUTPUT RESISTANCE
at 1,000 c/s is 0.9 ohm.

DAMPING FACTOR
approximately 17.

Send for Leaflet

PRICE
£18 - 18 - 0
Pick-up Equaliser Plug 12/6

Manufacturers of the
SPECTONE

Magnetic Tape Reproducers for playing Tape Records to the C.C.I.R. characteristic with the highest fidelity. The modern method of hearing good music faithfully reproduced.

Leaflets on request.

SPECTO LTD. Vale Rd Windsor

FREQUENCY METERS

$2\frac{1}{2}$-8" up to 10,000 cycles

DIFFERENTIAL A.C. CURRENT METERS

COMPARING THE MAGNITUDE OF TWO CURRENTS.

A full range of switchboard and portable instruments, including four types of Millirange Meters.

THE ELECTRICAL INSTRUMENT CO. (HILLINGTON), LTD.

Boswell Square Industrial Estate, Hillington, Glasgow, S.W.2. Halfway 1166 and 2194

LEEVERS RICH

Junior LeeRaser

Price £6. 5s. 0d.

Neat, compact, and erasing 5 in. tape spools with full efficiency of the well-known Standard and Senior LeeRasers.

200/250v. A.C. mains

LEEVERS-RICH EQUIPMENT Ltd.

78, Hampstead Rd., London, N.W.1. EUSton 1481

MAGNETIC RELAYS

The P.O. 3000 TYPE

remains the most popular and widely used relay of all.

THOROUGHLY RELIABLE AND BUILT TO SPECIFICATION

Tropical or jungle finish if required

Prototypes at short notice and reasonable deliveries on quantities.

Stocks also held of A/C relays, high-speed, sealed and open.

★ LARGE STOCKS OF KEY SWITCHES ★

ELECTRO MAGNETIC COUNTERS

P.O. MAJOR TYPE

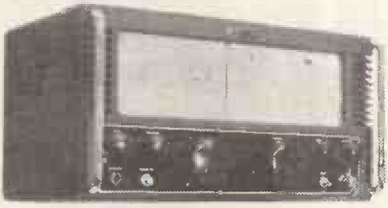
Any D/C resistance **17/6** each

JACK DAVIS (RELAYS) LTD.

PERCY STREET · LONDON · W.1

MUSEUM 7960 LANGHAM 4821

EDDYSTONE COMMUNICATION RECEIVERS



Model 840A illustrated

Now available on attractive Hire Purchase Terms.

		Deposit	12 monthly payments	18 monthly payments	24 monthly payments
840A	£49	£8	£3 15 2	£2 12 5	£2 1 0
750	£68	£11	£5 4 6	£3 12 10	£2 17 0
680X	£106	£16	£8 5 0	£5 14 6	£4 10 0

CARRIAGE PAID

Model 840A, is for A.C. or D.C. 110/250 v. making it especially suitable for universal use. 750 and 680X 110/240 v. A.C. The very large tuning dials are clearly marked with band spread logging. Silky gear driven flywheel loaded tuning mechanism. These sets are the choice of the discerning professional and amateur users. Descriptive literature gladly forwarded.

Latest EDDYSTONE Component Catalogue 1/-.

The Eddystone Specialists

H.P. RADIO SERVICES LTD.,

55 COUNTY ROAD, LIVERPOOL, 4

Telephone: AINTREE 1445 *ESTAB. 1935*

Branch Address: MARKET CROSS, ORMSKIRK

INTERESTING AND PROGRESSIVE APPOINTMENTS AVAILABLE

AT **Plessey** FOR

ELECTRO-MECHANICAL DRAUGHTSMEN
ELECTRONIC DRAUGHTSMEN
JIG & TOOL DRAUGHTSMEN

The posts are permanent and pensionable and offer excellent opportunities for advancement for those with previous experience in electronics, radio, television, aircraft electrical and mechanical accessories, or jig and tool design. Good salary offered to selected candidates.

Please write, phone or call:

THE EMPLOYMENT MANAGER
The Plessey Co. Ltd., Ilford, Essex
Phone: Ilford 3040 Ext. 59

JASON *for* F.M.

STANDARD TUNER £15.17.0

(including tax)

Four valves type Osram Z.77, one being used as a limiter. This tuner has better than average sensitivity, and the tuning drift is negligible. Useful range at least 60 miles from Wrotham.

Ask your local high fidelity dealer for a demonstration or visit one of the following:—

Arthurs (Arthur Gray Ltd.), 150-152, Charing Cross Road, W.C.2. TEMple Bar 5833.
City Sale & Exchange Ltd., 93-94, Fleet Street, E.C.4. CENtral 9391.
Classic Electrical Co. Ltd., 352/364, Lower Addiscombe Road, Croydon, Surrey. ADDiscombe 6061.
Clyne Radio Ltd., 18, Tottenham Court Road, W.1. MUSeum 5929.
H. C. Harridge, 8, Moor Street, W.1. GERrard 7108.
Holley's Radio, 285, Camberwell Road, S.E.5. RODney 4988.
Home Radio of Mitcham, 187, London Road, Mitcham. MITcham 3282.
A. Imhof Ltd., 112-116, New Oxford St., W.C.1. MUS 7878.
Lanes Radio, 11, Gardner St., Brighton. Brighton 20773.
Rogers Developments Co., 116, Blackheath Road, S.E.10. TIDeway 1723.
Tele-Radio (1943) Ltd., 189, Edgware Road, W.2. PAD 4455.
The Gramophone Exchange Ltd., Astra House, 121-123, Shaftesbury Avenue, W.C.2. TEM 3007.
Vortexion Ltd., 257-263, The Broadway, Wimbledon, S.W.19. LIBerty 2814.
Webbs Radio, 100, Dean St., W.1. GER 7308.

In case of difficulty please contact:—

THE JASON MOTOR & ELECTRONIC CO.
328, Cricklewood Lane, London, N.W.2.
SPEedwell 7050.

The Patent Department of

THE GENERAL ELECTRIC CO. LTD.

at their **Research Laboratories, East Lane, North Wembley, Middlesex,**

have openings for young

PHYSICISTS or ELECTRICAL ENGINEERS

The successful candidates will be given opportunities of being trained to qualify as Patent Agents. Previous experience of Patent work is desirable but not essential. Applicants should have some background and interests in the electronic field, telecommunications or radar.

These appointments carry excellent prospects, and a high level of remuneration can be expected on qualification. Candidates should be free of National Service commitments if under 26 years of age.

Apply in writing to the Staff Manager (ref.: RLO/34) giving full particulars of experience, qualifications and age.

H. WHITAKER G3SJ.,

SYCAMORE WORKS, SYCAMORE AVENUE, BURNLEY

Phone: BURNLEY 4924 **(A.R.B. APPROVED)**

Manufacturers of precision Quartz Crystals in a wide variety of bases covering the complete range 40 Kc. to 18 Mc. in fundamental frequencies. All are made to extremely fine tolerances, and frequency adjustment can be given up to .005%. Plated electrodes of gold, silver or aluminium with wired in spot welded contacts are available. Quotations can be given for any type of cut or mode of oscillation including a complete range for filter circuits with zero temperature co-efficient over a sensibly wide temperature range. Our new works is equipped with up-to-the-minute production technique methods, X-ray orientation ensuring accuracy of all cuts. Artificial aging by etching and plating by evaporation under vacuum ensure long term stability of the final calibration. Early delivery can be given of most types. Our regrind service is still available and in some cases we are prepared to quote for lowering the frequency of your existing crystals.

SPECIAL OFFER:

200 kc. DT cut, zero temperature co-efficient over the range—30° centigrade to +55° centigrade. Frequency adjustment .005% or better. Mode: Face shear. Silver-plated electrodes, wire mounted. Basing ¼in. pin spaced. Other bases to order, £1 each.

Solder with LITESOLD

REGD TRADE MARK

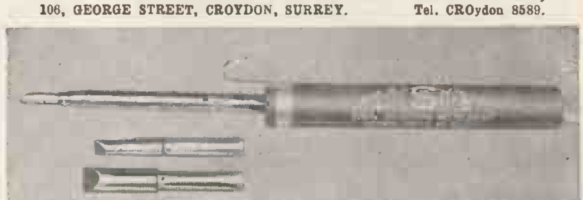
- NO TRANSFORMER NECESSARY
- FOR MAINS OR LOW VOLTAGES.

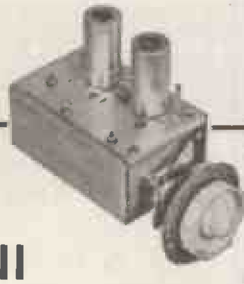
Rapid Heating—Extreme Lightness—Twenty models—Bit sizes, 1/8", 3/16", 1/4", 5/16", 3/8"—Prices from 19/6. Voltages from 6/7 v. to 230/50 v.

Have you tried our "Permabit" instruments or our "Permatip" bits? (Illustrated below). They need no maintenance and last indefinitely. Details in folder S.P.5, sent on request.

Sole Manufacturers and Distributors:

LIGHT SOLDERING DEVELOPMENTS LTD.,
106, GEORGE STREET, CROYDON, SURREY. Tel. CROydon 8589.





TUNERS
for BAND III
COMMERCIAL TELEVISION

Specially developed for incorporating into new T.V. receivers, or for tuning standard receivers for reception of Band III. Price £6.

About 2½ million T.V. sets will probably be tuned for Band III reception. Make sure that you are up to date. Write to us today for fullest details—or visit us on Stand 118 at the RADIO SHOW

Ask also for details of Valradio T.V. Projection Receivers; DC/DC and DC/AC Converters; Vibrator Units.

Valradio LIMITED

New Chapel Rd., High St., Feltham, Middx. Phone: Feltham 4242

STL

Hermetically sealed transformers for tropical conditions

STL TRANSFORMERS

incorporate sound design and are manufactured to the highest standards called for in the electronic and communication fields. Consult us for your next transformer requirements.

STEWART TRANSFORMERS Ltd.

75 KILBURN LANE, LONDON, W.10 · LADbroke 2296/7

THE ENGLISH ELECTRIC CO., LTD.,

LUTON

require

SENIOR ENGINEERS or SCIENTISTS

for

THREE SPECIAL VACANCIES

in

GUIDED WEAPONS SYSTEMS DESIGN

CONCERNED WITH

ELECTRONICS AND RADAR

SERVO MECHANISMS

BALLISTICS

These are permanent posts of unusual interest and applications should be addressed to Dept. C.P.S., 336/7, Strand, W.C.2,

quoting Ref. 1260C.

Z & I AERO SERVICES LTD.,

OFFER THE FOLLOWING GUARANTEED EQUIPMENT:

BONDING TESTERS, A.M. Ref. No. 5G/2126, complete with matched leads with spikes.................. £6 15 0

GENERAL RADIO TYPE 804C U.H.F. SIGNAL GENERATOR, Range 7.5 to 350 mc. in five overlapping bands. Output voltage 20 mV. Power supplies 115/230 v. A.C. In handsome wooden cabinet, guaranteed as new.................. £65 0 0

COMPLETE INSTRUMENT LANDING INSTALLATIONS (I.L.S., TYPE ARN-5A), as per official technical specifications, released to A.R.B. requirements.

Also available separately.

R-89/ARN-5A Glide Path Receivers with crystals £25 0 0

BC-733D Localiser Receivers complete with crystals £15 0 0

BC-732 Control Boxes £2 0 0

Limited quantity of modern version Glide Path Receivers R-89B/ARN-5A.

LAVOIE MODEL 105-SM (TS-127/U) U.H.F. FREQUENCY METERS, range 375-725 mc., accuracy 1 mc.................. £50 0 0

I-222 V.H.F. SIGNAL GENERATORS, range 8-15 mc. and 150-230 mc., with Crystal Check Points, output 100 mV., power supplies 115 v. A.C. Suitable for Band III servicing.

PRICE, brand new and guanteed £12 0 0

Packing and carriage extra.

Please write for full Catalogue to:

Z & I AERO SERVICES LTD.,

19, Buckingham St., London, W.C.2

Telephone: TRAfalgar 2371/2

Please offer us your surplus Radio Equipment.

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: September 1955 issue, Tuesday, July 26th. 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

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Bickford Rd., Witton, Birmingham, 6. Tel. East 0822.
SPECIALIZE in the manufacture of High Fidelity Sound Reproducing equipment, including:—
WILLIAMSON Amplifiers, Tone Control Stages with variable Steep Cut Filters, Crossover Units, High Fidelity Portable Tape Recording equipments ideally suitable for replaying the new EMI pre-recorded tapes, Professional Recording Amplifiers, Microphone Mixing Units, etc. Send for details and leaflets. [0105

SHIRLEY Laboratories, Ltd., 125, Tarring Road, Worthing, Sussex, the precision high fidelity specialists; amplifier type SB/1-15E, 15 watts output, response 15 to 60,000 c/s, bass lift 18 db, cut 18db, treble lift 14 db, cut 20 db, B.V.A. valves, complete with engraved panel, 18gns; with 3 position switched input filter 19gns; also the Jupiter reproducers at 34gns, the WB/U 6-watt amplifier, 12gns; the new Mullard 20-watt EL34 amplifier, tape amplifiers to suit most decks; specialized amplifiers to order for the musical and scientific industries. Tel. Worthing 513, 3571. [0095

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

R103, £5; quality amplifier, 2×6L6 output, £5; offers.—18, Alverley Lane, Doncaster. [4833

MODIFIED 1155 and Power Pack with speaker; £8; demonstration.—Croydon 7744, Ext. 328, 8-5 p.m. [4956

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

BARGAINS in TV 8in and 10in sets, from £5 (not working), £9 (working).—Television Assurance, 7, Stanhope Row, Hertford St., Park Lane, W.1. Gro. 1352. [4931

COMMUNICATION receiver, Eddystone type S.556, 12v supply, as new; also G.E.C. battery charger, 12-6-4-2v, 3 amps, 230v a.c. supply; offers?—Sands, Mill House, Woodborough, Pewsey, Wilts. [4950

WIRELESS WORLD 2R.F. 3-valve quality tuner, M.W. and L.W., complete with fully smoothed power supply unit, unused, ideal for use with all high fidelity amplifiers; £7, including 4 valves, approx. half original price; limited number bargain.—Box 2974. [4817

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECOND-HAND WANTED

URGENTLY required, short wave receivers; we pay immediate cash for clean equipment. K.T. RADIO'S, 156, South Ealing Rd., W.5. Ealing 1303. Open Saturdays. [4899

LOUDSPEAKERS—SURPLUS AND SECONDHAND

VITAVOX Klipschorn, perfect; £50 or offer; American FM/AM tuner wanted.—Box 4992. [4958

NEW TEST EQUIPMENT

TV signal intensity meter (S.I.M.) for aerial checks and installation, etc.; send for full details.—Radio-Aids, Ltd., 29, Market St., Watford. Tel. Watford 5988. [4926

TEST EQUIPMENT—SURPLUS AND SECONDHAND

SPEEDIVAC pumps, Edwards, type 1, with 8in v-pulley, £15; Motorised 230v AC, £21.
VARIACS, type 80C, In: 200-240v, 50c. Out: 220v, 7½ amps, £5/10; Type 500L-2G, In: 180v, 500c; Out: 0-180v, 7+7 amps, £14.
CONSTANT voltage transformers by Advance. In: 204-276v. Out: 240v, 500W, £10.
AUTOMATIC voltage stabilizers for 200-250v AC mains. Ferranti moving coil; 6¼-Kva £70. 1440Va less relay, £28. Ditto 480Va, £18.
MICROAMMETERS, 2½in, M.C., flush, round, centre zero, 250-0-250μa, 22/6 p.f.
ROTARY converters. In: 24v DC. Out: 50v AC, 1 ph, 50c 9 amps, 450W, £7.
MAGSLIPS always in stock. Also Velodynes, Amplidynes, Servo-Motors, Selsyns, Torque-Amplifiers, Iron cored potentiometers, etc.
P. B. CRAWSHAY, 94, Pixmore Way, Letchworth. Herts. Tel. Letchworth 1851. [0097

TEST EQUIPMENT—SURPLUS AND SECOND-HAND

HUNTS bridge type C.R.B.3, latest model; £18; new condition.—Badman, Long Crendon School, Sheringham, Norfolk. [4827

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

FOR sale, Taylor model 20A circuit analyser, £5; Taylor model 65B signal generator, £9; Taylor model 45A valve tester, £9; all working and in good condition.—Apply Sydney S. Jones, Ltd., 161, Albany Rd., Cardiff, Glamorgan. [4864

NEW DYNAMOS, MOTORS, ETC.

1500 cycles altenators 2KVA, 80v.—E.W.S. Co. 69, Church Rd., Moseley, Birmingham. [4601

SPECIAL televison rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va out. 24v, 32v, 50v, 110v, 230v d.o., to 230v out 250va, £28/10 del., also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £25 del. immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield a 24v
TELEVISION converter was tested on Ekco television, 12in tube stated consumption 135 watts d.c. current from battery only 9½ amps, picture and sound were perfect and completely free of interference or flutter.
THE above is the latest product of British manufacture, and is guaranteed for one year.
J.A.P. No. 2A 1.2hp petrol engine, air-cooled, 4-stroke, starting rope, tools; £17/10 delivered.
T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECOND-HAND

EDC convertor 100 d.c.×230 a.c. 80watts; Offers.—45, Queen St., Ramsgate. [4938

ROTARY convertor, 200/220v d.c. in, 230v a.c. out, 500va; £6.—73. Lesh Lane, Barrow. [4828

2,000c/s motor-alternator sets, input 220v d.c., output 80v, 1ph, 2,000c/s, 6.25amps, 500VA, complete with starter, fuses, control panel and voltmeter, all mounted in ventilated steel cabinet 14in×26in×49in high, new in original cases; £16, carr. extra.
P. B. CRAWSHAY, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0096

NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder 76gns.
WEARITE tape decks and component parts.
DISC recording machines and blank discs.
LEAK amplifiers, 10w £17/17; preamp £10/10.
GOODSELL, 5w £13/10, preamp £10/10.
RESLO ribbon microphones and stands.
EVERYTHING for the professional recording studio and quality dealers.
SOUND DISCS (SUPPLIES), Ltd., 178, Bispham Rd., Southport, Lancs. Tel. 88153. [4731

T/R amps 18gns and pre-amps £5/15 for 3-headed decks, inc. p pack and meter level ind.
GRUNDIG, Philips T/R promptly supplied; Reflectograph decks £31, for Lodestar; T/R amps. for Wearite, Truvox, etc., U/L output. TEL. Gla. 1770.
HARDING ELECTRONICS, 120a, Mora Rd., Cricklewood, London, N.W.2. [0032

TAPE recorders for sale, exchange or hire in Greater London, good quality tape recorders wanted for cash, all types of repairs, mechanical and electronic, carried out by specialists, all accessories available, we deal exclusively in magnetic recording equipment.
THE MAGNEGRAPH RECORDING Co., Ltd., 1, Hanway Place, London, W.1. Tel. Langham 2156. [3396

BUY British Ferrograph recorders from an established studio, benefit by our many years' experience; Emitape, microphones, splicers, speakers; transfer your tapes to our wide dynamic L.P.s.—"Eroica" Recording Studios (1949), Peel St., Eccles, M/c. Eccles 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. [0209

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECOND-HAND

M.S.S. 3-speed disc-cutter with R11L amplifier; giving professional results; any trial. —Evng. Alb. 4016. [4921

EASY PAYMENTS ON AERIALITE BAND III AERIALS

(To calculate deposit add 10% to the cash price shown and divide by 9—Balance by 8 monthly payments of the same amount.

WE PAY CARRIAGE!

These aerials have quick fitting elements, al alloy tube construction and polythene low-loss insulators. Retail prices are given below.

Arrays only 1in. mast fixing	
Model 700 XO, 3 element	£2 5 0
Model 701 XO, 4 element	£2 12 6
Model 702 XO, 5 element	£3 0 0
Arrays only 2in. mast fixing	
Model 700 XT, 3 element	£2 7 6
Model 701 XT, 4 element	£2 15 0
Model 702 XT, 5 element	£3 2 6
Aerials cranked arm wall mounting	
Model 700 CW, 3 element	£3 7 6
Model 701 CW, 4 element	£3 15 0
Model 702 CW, 5 element	£4 2 6
Aerials cranked arm chimney lashing	
Model 700 CL, 3 element	£3 17 6
Model 701 CL, 4 element	£4 5 0
Model 702 CL, 5 element	£4 12 6
Drainpipe or 2in. mast end mounting	
Model 706 E (dipole, director)	£2 7 6
Model 707 E (dipole, 2 directors)....	£2 15 0
Model 708 E (dipole, 3 directors)....	£3 2 6
Aerials 6 feet chimney lashing	
Model 700 S, 3 element	£3 17 6
Model 701 S, 4 element	£4 5 0
Model 702 S, 5 element	£4 12 6
Aerials 10ft. × 2in. mast, double chimney lashing	
Model 702 T, 5 element	£7 15 0
Aerials cranked arm mounting off existing chimney brackets	
Models 700 CB, 701 CB, 702 CB—same prices as CW types.	
Indoor Loft Mounting Aerial	
Model 603, 3 element	£1 15 0
Model 605, 5 element	£2 2 6

Send your Remittance to Desk 202

"LAFCO"

3, CORBETTS PASSAGE, ROTHERHITHE NEW ROAD, BERMONDSEY, S.E.16

BERmondsey 4341 (Ext. 1)

SURPLUS

AERIAL MASTS. American Yagi 5 element array AS-46/APG. 30ft. one piece 4in. dia. hollow wood masts. 36ft. 3 section 2in. dia. tubular steel masts. 45ft. 9 section 1½in. dia. American steel masts MS-44. 50ft. Bendix plywood masts MT-7A. 70ft. American plymold masts. 200 mc/s. Birdcage "H" array. 20ft. American tripod base aluminium masts AS/TPX. 9ft. one piece American police whips. 18ft. BC-610 6 section whips.
DIRECTION FINDERS. SCR-206, SCR-291, SCR-503, DFG-20, DFG-24, etc.
TELEPHONE AND TELEGRAPH APPARATUS. 1 + 1 terminals and by-pass filters; 1 + 3 terminals; 1 + 4 terminals and repeaters, S and SX, S and DX, filters; power bays; repeaters; V.F. ringers; perforators; Wheatstone equipment; teleprinters; undulators; switchboards; rectifiers; EE-65, TG-10, etc., etc.
AUDIO EQUIPMENT. R.C.A. squadron announcers (12-25 watt speakers). R.C.A. 25 watt high power speakers. Portable megaphones PA-4.
CONTROL UNITS. RM-6, 7, 12, 13, 21, 25, 29, 42.
AMERICAN TRANSMITTING TRANSFORMERS AND CHOKES. A large variety by Amertran, Kenyon, R.C.A., Thordason, etc., etc.
TRIPLE DIVERSITY RECEIVERS. 1.5 to 30 mc/s. Self contained on rack with all refinements. Full details available.
100 WATT BROADCASTING TRANSMITTERS by Woden. Self contained in 4ft. 6in. cabinet £22/10/- with valves.
RACKS, de luxe, 19 inches wide channel iron sides, 3 x 2, 3ft. 6in., 40/-; carr. 10/-.

Many other items too numerous to mention. Send your requirements. Lists available. All packing and shipping facilities.

P. HARRIS

ORGANFORD DORSET

Telephone: Lychett Minster 212

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECOND-HAND

FOR sale, M.S.S. Recording Equipment, complete, type STR/1, 230/250v, a.c., including recorder, amplifier, speaker unit, 4021 type microphone, cutters and discs.
OFFERS and enquiries to Chief Education Officer, 38, High St., Croydon. [4890

DISC Recorder and Amplifier, Grampian, with accessories, portable, practically unused, perfect, 78 r.p.m. 96/112 gpi. £130; Vortexion Tape Recorder, as new, £62.—12, Maud Rd., Dorchester. [4898

MINIFON pocket recorder, original model in leather case, owner changing to latest model; complete with spare reels of wire, microphone, typist's headset, battery box for larger batteries, etc.; price £30.—Box 4699. [4885

TAPE recorder bargains: Sound Mirror, shop soiled; 45gns; Wright & Weaire tape deck, complete with amplifier, 39gns; office Retalker, cost £60, 2 at 39gns each; new autochangers, 8gns; please add 7/6 carriage.—A. Rose, 134, Lewisham Way, S.E.14. Tideway 2330. [4845

FERROGRAPH model D, in walnut with waterproof carrying cover, outstanding performer, as new in every respect, £55; Garrard transcription motor type 301, unopened, offers; Decca 2-speed motor with twin head pick-up C and D, £6; older type 78 motor and pick-up, 25/-; G.E.C. metal cone speaker, unused, £4/10; Manchester area.—Sale 5475 or Box 4983. [4960

NEW COMPONENTS

FM, new W.W. design; coilsets, parts, available now; BEL, FM and transistor pioneers. —Marlborough Yard, London Archway, N.19. Arc. 5078. [0185

NEW mains transformers, fully shrouded, 210-230-250v, primaries 350-0-350 150ma, secondaries, 6.3v 4 act, 6 3v 2a, 5v 3a fly leads, 42/6; 400-0-400 200ma 6.3v 4 act, 6.3v 3 act, 5v 3a, 63/-.—C. S. F. Steward, 6, Broughton Rd., Hadleigh, Essex. [4585

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; 400, 6v, 1×2in, lug, 1/9; 250+250, 6v, 1×2in, lug, 2/-; 40, 150v, 1×2, clip, 2/6; 20+20, 275v, 1×2, lug, 3/3; 16+32, 275v, 1/2, lug, 3/3, 16+16, 275v, 1×2, clip, 3/3; 100, 275, 350v, 1⅛×3, clip, 3/6; 32+12, 350v, 1⅜×2, clip, 4/-; 16, 350v, ¾×2, lug, 1/9; 10, 450v, ¾×2, lug, 1/6; 16, 450v, ⅞×2, tag, 2/9; 15+15, 450v+20mf 25v, 1⅛×3, lug, 4/6, 200, 6v ⅝×1¾, clip, 1/6; 75, 12v, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 250, 12v, ¾×1¾, wire, 2/3; 40+40, 275v, 1⅜×2, clip, 3/3; 24+24+16, 350/425v, 1⅜×2, clip, 4/9; 4, 150v, ⅝×1¾, clip, 1/1; 500, 12v, 1⅜×2¾ clip, 2/-; 8, 350v, ¾×2, clip, 1/9. 32+32, 350/425v, 1⅜×2, clip, 4/6; 2, 450/525v, ¾×1¾, tag, 1/6; 8, 450v, ¾×2, clip, 1/9; 64+120, 275v, 1¾×4½, clip, 5/6; 16+16, 350/425v, 1⅜×2, clip, 4/-; 100+200, 350/425v, 2×4½, clip, 6/9; 60+250, 275/350v, 1¾×4½, clip, 6/3; all ali cans, some with sleeves, all voltages, WKG, surge where marked, new stock guaranteed.
5mA meters, moving coil, bakelite case, 2in square, flush mounting new, boxed; 7/- post paid; 50mA, 8/6.
MAINS trans., 250-0-250v, 80ma 6.3v, 2.5A, 6.3v, 0.6A, Pri. 0-210-230-250v 12/- post paid.
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 strips, 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, 12/- post paid.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 156. [0016

METAL-GLASS seals: single-way, hermetically sealed terminals for soldered connections and fixing; mostly 1kv and 2kv sizes, new (surplus), 65/- per 1,000 assorted.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

WANTED, EXCHANGE, ETC.

EXTRUSIONS by Marley.

BUYERS requiring rigid and flexible tubes and sections in thermoplastic materials should ask for a quotation from Marley Extrusions, Dept. 129, Lenham, Maidstone, Kent. Harrietsham 381. [4735

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

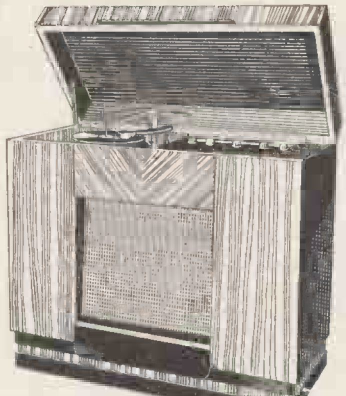
3000 type P.O. relays with 5,000ohm coils wanted in quantity.—Box 4623. [4880

WANTED, tuning units, TN17, TN18, TN19, for R54/APR4 £50 each offered.—Box 4963. [0261

MINE detectors required, Government surplus No. SCR 625, condition new/unused. —Details to Box 4984. [4961

WANTED, set manufacturers' or ex-Government radio equipment, large or small quantities of valves, electrolytics, speakers, meters, also components.
LOWE BROS., 9a, Diana Place, Euston Rd., N.W.1. Eus. 1636/7. [4485

CABINETS



We can supply any Cabinet to YOUR OWN SPECIFICATION. The one illustrated can be obtained in walnut, oak or mahogany for £19/15/-, or as a COMPLETE RADIOGRAM incorporating:

5-VALVE SUPERHET, 3-speed Plessy Autochanger and 10 in. W.B. Speaker	**£48.0.3**
8-VALVE ARMSTRONG F.C.48, 3-speed Collaro Autochanger and 10in. W.B. Speaker	**£60.14.8**
14-VALVE ARMSTRONG EXP 125/c, 3-speed Garrard Autochanger and 12in. Goodmans speaker	**£95.5.11**

Alternative arrangements of Chassis, Speaker and Autochanger can be supplied.

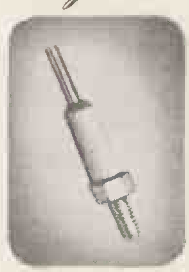
Send 1/- for complete Catalogue of Cabinets, Chassis, Autochangers and Speakers (refunded on receipt of order). H.P. can be arranged.

LEWIS RADIO COMPANY

120, GREEN LANES, PALMERS GREEN, LONDON, N.13. BOWes Park 6064

Excellence in design..

Specialists in Sub miniature Telecommunication Components.



STAND OFF INSULATOR

For 1500 volt working
Overall height 1.1".
Over chassis .86".
Silver plated spill .35".
6BA hexagon stud chromium plated.

(Illustrations approximately actual size)

MINITRIMMER

Standard maximum capacities up to 13pF. Voltage 500 DC. Base ⅜" square with fixing centres for 10 BA ¼" apart.

Details from—

OXLEY DEVELOPMENTS CO. LTD.

ULVERSTON, NORTH LANCS

Tel: ULVERSTON 3306

"AUTOMAT" CHARGERS and POWER PACKS

as supplied to Ministries, Airline Co.s, etc., up to 600 watts. Correct design, best materials and workmanship.
Selenium rectifier stacks, 40 ma. to 10 amp., with or without transformers.

"AUTOMAT" SELF REGULATING CHARGERS "Export" model as illus. for 6 v./12 v. 5 amps., using S.T.C. selenium rectifier, damp-proof, ultra reliable, wt. 16lb., for 215/245 v. A.C., £6/5/-. Carr. 4/6 extra. Gtd. 12 months. Also our well known 12 v. 3 amp. charger with protective ballast and glow indicator, 69/6, ditto, 6 v. 2 amp./12 v. 2 amp., 69/6. ditto, 12 v. 1 amp., 42/6, postage 1/10, wt. 8lb.

FOOLPROOF CHARGER KITS. Genuinely trouble free and ultra reliable. As sold for 11 years through "W.W." with full data sheet and instructions. **No. 1 Kit.** Westalite 3 amp. rectifier, 65 watt tapped, impregnated trans., ballast bulb, for 2 v. 6 v., 12 v. charger, all rectifier troubles eliminated, 46/-, p.p. 1/10. Handsome steel case, ready punched, louvred, enamelled, 12/6. **No. 1A Kit.** 3 a. rectifier, 65 watt trans., ballast, res., ammeter for 2 v., 6 v., 12 v., 3 a., 52/6, p.p. 1/10. **No. 2 Kit.** 12 v. 2 amp. rect., 45 watt trans., ballast/indicator bulb for 2 v., 6 v., 12 v. charger, 36/6. Case 12/6, p.p. 1/10. Wt. 8lb. with case. **Minor Kit,** 6 v. 2 amp., 32/-, p.p. 1/10, case 12/6 extra. **Senior Model,** for 6 v./12 v. at 4 to 5 amp., 12 v. 5 amp. S.T.C. rect., 85 watt trans., ballast bulb, 64/-, p.p. 2/-. **Slider Kit,** 120 watts trans., 14 v. 6 amp., large finned type rect., slider res., high grade ammeter, wt. 17lb., for 6 v./12 v. charger, £4/13/-, carr. 4/-.

SELENIUM RECTIFIERS, new stock not surplus, 6 v. 1 a., 4/-, 2 a., 7/6, 4 a., 15/-, 12 v. 0.5 a., 5/-, 1 a., 7/6, 2 a., 9/6, all p.p. 6d. 12 v./14 v. 3 a. to 3.4 a., 15/6, 5 a., 27/-. Large finned 6 a., 32/-, p.p. 10d. 24 v. 50 mA., 2/9. 24 v. 0.3 a., 9/-, 1.5 a., 15/-, 3 a., 27/-, 5 a., 42/-, 8 a., 62/-, all p.p. 10d. 50 v. 1 a., 24/-, 2 a., 47/-. 230 v 1 a., 97/-, p.p. 1/6. H.T. rectifiers, 120 v. 80 mA. R.M.2, 3/4, 135 v. 30 mA. elim., 5/6, 250 v. 60 mA., 7/-, 250 v. 100 mA. bridge, 14/6. All p.p. 6d. Many other L.T. and H.T. types in stock.

CHAMPION PRODUCTS

43, Uplands Way, LONDON, N.21. Phone LAB 4457

ARKAY WORLD'S FINEST KITS

RADIOS PHONOGRAPHS TV TEST EQUIPMENT HI-FI
Write for FREE Brochure

Radio Kits, Inc. • 120 CEDAR STREET
NEW YORK 6, NEW YORK • U.S.A.

WEST END RADIO

BAND 3 AERIALS. Attachment 22/6. H type 59/6. P. & P. 1/6.

CANADIAN MARCONI No. 9 receivers 89/6. P. & P. 7/6.

109 RECEIVERS vib. pack and spkr. 65/-. P & P. 7/6.

VENNER TIME SWITCHES. Clockwork 45/-. Mains 65/-. P. & P. 2/6.

10in. SPEAKERS in cabinet, slightly soiled, 25/-. P. & P. 2/6.

HT/LT BATTERIES 60-1.5v. layer-built, tested, 2/6. P. & P. 9d.

CLOCKWORK FLASHERS, 120 flashes per min., 9/6. P. & P. 1/-.

SAVAGE AUTO TRANS. 4Kva. 100/230 in/out. £8/15/-. Carriage free.

MINIATURE BLOWERS 24v. 1/135 H.P., 5,000 revs. 15/-. P. & P. 1/-.

COIL TURRETS. Rotary, 8 coils in case, 7/6. P. & P. 1/-.

SYLVANIA RED EF50 7/6 ea. P. & .P. 6d.

POWER PACKS 500-0-500v. 250 M/A., 6.3v. 5A., from mains, double smoothed for 5U4 Rec., 45/-. P. & P. 7/6.

1,000 BARGAINS FOR CALLERS!

WEST END RADIO LTD.
14, LISLE STREET, LEICESTER SQUARE, LONDON, W.C.2.
Phone: GER 7341 OPEN ALL DAY SATURDAY

BUSINESS AND PROPERTY

LONG-ESTABLISHED small radio, TV, electrical; £2,950 freehold; good living accommodation; modern stock at value; Portsmouth area; owner retiring.—Box 4372. [4808

SOUTH Devon.—Coastal resort, radio/television business, all main agencies, no opposition; t/o of £8,000, can be vastly improved; pleasant living accom. with delightful sea views; freehold and business, £7,500, s.a.v.—Bettesworth, Greenslade & Co., 29, Fleet St., Torquay. [4848

BUSINESS OPPORTUNITIES

YOUR invention or idea considered for outright purchase or production on a royalty basis by firm of electronic engineers.—Apply Box 4124. [4734

WORK WANTED

EXACT translations French/Spanish/English.—For details apply to Smart, 4, June Close, Coulsdon, Surrey. Tel. Uplands 8549. [4849

CAN we help Your development or production; assembly and wiring service at your disposal.—R.A.E. Mfg. Co., 135a, Kentish Town Rd., N.W.1. Gul. 7011. [0219

CAPACITY available for small plastic moulds and stamping tools; highest limits, clean work, reasonable prices; speciality; hearing aids and electronic components.—Tool maker, 23b, St. Stephens Ave., London, W.12. [0084

DESIGN development and prototype construction facilities available in all fields from power supplies to band 5 front ends, A.M./F.M., etc.; enquiries from the smaller manufacturer especially welcome.—Tel. Granby 1300, Imperial Radio and Television Co., Buxton St., Leicester [4977

CAPACITY AVAILABLE

WAVE winding capacity available.—Avis & Baggs, Ltd., Gosbrook Rd., Caversham, Reading. [0094

DUE to further expansion of our works and facilities manufacturers are advised that immediate capacity is available for the manufacture of transformers, chokes, and inductances, including wave-winding of all types.
HADFIELDS solventless varnish vacuum impregnation and enveloping processes to approved specifications.
MACHINE engraving on metal and plastics.—Enquiries to Melton Electronics, Ltd., 387, Ashley Rd., Parkstone, Dorset. Tel. Parkstone 230. [4911

MISCELLANEOUS

FERROGRAPH 2/AN as new L70, Reslo ribbon micr., used tapes half price.—Box 4989. [4974

PETTER type M paraffin engine, with 110-volt D.C. generator, in perfect condition, with service manual; nearest £10 secures.
W. W. BLEASDALE & Co., Radio and T/V Engineers, 7, Blackburn Rd., Accrington, Lancs. Tel. Accrington 2822. [4937

LP and 78 tape-to-disc sub-contract work available. Send fullest details of equipment intended to use, references, charges.—Box 4990. [4975

COPPER winding wires ex stock, competitive prices, 17 to 48 swgs, plain enamel, tinned, synthetic, silk, rayon, cotton covered and Litz types.—Box 4414. [4819

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., (G4B1).—Chapman St., Loughborough. [0208

YOUR own tape recording transferred to disc.—Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [4957

BUILD your own TV and learn about its operation, maintenance and servicing; qualified engineer-tutor available whilst you are learning and building.—Free brochure from E.M.I. Institutes, Dept. WW.58, London, W.4. (Associated with H.M.V.) [0180

LET professionals transfer your tape recordings; record your broadcasts; supply your requirements. D.s. 10in disk 15/6; 12in 18/6. Also LP-S Disk vouchers with tapes purchased from Sound News Productions, 59, Bryanston St., London, W.1. Amb. 0091. [4976

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod, headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gdns., London, E.4. [0138

BUILD your own highly efficient aerial for F.M. commercial TV, etc.; we supply an ex-radar antennae display consisting of moulded bakelite insulator, stand-off mounting bracket, dipole elements and director easily adjusted to suit whatever band required; these aerials have cost several pounds to manufacturer; our special price only 15/- plus 1/6 packing and postage.—Walton's Wireless Stores, 48, Stafford St., Wolverhampton. [0145

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

BENSON'S BETTER BARGAINS

BRAND NEW ORIGINAL CARTONS R.F. UNITS. TYPES 26 or 27, 27/6; 24, 10/-. (Postage 2/6.) RF25, Soiled, 10/-.
I.F. Amplifier Type 178, new, 22/6. **Power Packs,** 250 v. 80 mA., D.C. and 6.3 v. 3 a. A C, smoothed fuse, etc. In case, 40/- (carr. 6/-). Relays, small 6 v. 2 br. 1 m., 1/6.
DYNAMOTORS, D.C. (approx. 250 v. 80 mA., at 6 v.), 8/6. 12 v. input, 250 v. 60 mA. and 6.3 v. outputs, P.M. field, 7/6. Filters for these, 2/6. Eddystone, cased, smoothed, 12 v. D.C. to 190 v. 75 mA., 15/-; 12 v. to 300 v. 200 mA., 17/6 (carr. 6/-). Hallicrafter, 12 v. to 250 v. 75 mA. (vibrapack) and 300 v. 165 mA. dyn., both on cased chassis, smoothed and filtered, new, 50/- (carr. 8/6). **TRANSFORMERS,** new, std. mains input: 6.3 v. 3 A. (twice), tapped 4 v. and 5 v., 9/6; 230 v. to 6.3 v. 5 a. and 10 a., 17/6; 2 kV. 5 mA., 2 v. 2 a., 17/6; 740-0-740 v. 165 vA., 470-0-470 v. 220 vA., 4 v. 8 a., C.T. (twice), 30/- (carr. 6/-). 350-0-350 v. 120 mA., 6.3 v. 4 a., 4 v. 2 a., 16/- (post 2/- each).
RX161, valves 2/EF54, 1/EC52, 1/CV66, VHF, with rotary coil selector, 17/6.
CO-AXIAL RELAYS 12/24 v. Type G, 7/6; **R1155** Coilpacks, new, 12/6; used 9/6; I.F. Filters, 2/6; Condensers, tub. .3×.1 mfd., 1/-. **BELLS,** under-dome A.C. 50 v., 3/6, Generators, hand 50 v. A.C. 5/6. **CLOCKWORK** Contactors, 2 impulses per sec., 8/6; 1 minute dial, in quarters, for these, 12 v. inching relay, 2/6.

METERS—BRAND NEW—BOXED

FSD	Scale	Size	Type	Fit	Price
500uA		3½in.	MC	Fl.Rd.	25/-
2mA		2in.	MC	Pr.Rd.	10/6
10mA		3½in.	MC	Fl.Rd.	7/-
10mA		4½in.	MC	Fl.Rd.	20/-
20mA	200A	3½in.	MC	Fl.Rd.	7/-
25mA	50A	3½in.	MC	Fl.Rd.	7/-
30mA		2in.	MC	Pr.Rd.	6/-
40 & 120mA		2in.	MC	Fl.Sq.	7/6
100mA	300mA	2in.	MC	Fl.Sq.	5/-
100mA		3½in.	MC	Fl.Rd.	7/-
150mA		2in.	TC	Fl.Sq.	7/-
200mA		2in.	MC	Fl.Sq.	6/-
250mA		3½in.	MC	Fl.Rd.	7/-
1A		2/2½in.	TC	Pr.Rd.	7/-
1A		2½in.	MC	Pr.Rd.	7/-
2.5A		2½in.	MC	Pr.Rd.	8/-
3A		2in.	TC	Pr.Rd.	6/-

List and enquiries. S.A.E. please! Terms. Cash with order. Postage extra. Immediate despatch. Closed 25 July-1 Aug.

Callers and Post
W A BENSON (WW)
308 Rathbone Rd.,
Liverpool 13.
STO 1604.

Callers
SUPERADIO
(W'chapel) LTD., 116 Whitechapel, Liverpool 1. ROY 1130.

ARC 1 VHF Transmitter/Receivers installations.
R89B/ARN5 Glide Slope Receivers.
ARN7 Radio Compass installations.
The above and many other American radio equipments in stock at Croydon Airport.

PHONE, WRITE OR CALL:

AVIONICS LIMITED,
CROYDON AIRPORT, SURREY

Telephone: CROydon 8396/7/8. 'Grams: Aeradio, Croydon.

Introducing the:—

TYANA TRIPLE THREE

Reg. Design No. 867884

MAKE SOLDERING A PLEASURE

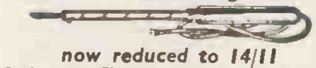
SMALL SOLDERING IRON

Complete with detachable BENCH STAND **19/6**

The smallest high-power soldering iron. Length only 8½in.; adjustable long bit dia. 3/16; mains voltages 100/110, 200/220, 230/250.

The "STANDARD"

Popular Soldering Iron



now reduced to 14/11

Replacement Elements and Bits for both types always available.

KENROY LIMITED
152/297 UPPER ST., ISLINGTON, LONDON, N.1.
Telephone: Canonbury 4905-4663

PUBLIC APPOINTMENTS

ASSISTANTS (scientific).—The Civil Service Commissioners invite applications for pensionable posts; applications may be accepted up to December 31st, 1955, but early application is advised as an earlier closing date may be announced either for the competition as a whole or in one or more subjects; interview boards will sit at frequent intervals.
AGE at least 17½ and under 26 years of age on January 1st, 1955, 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 2 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 2 or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
INCLUSIVE salary scale £262 (at 18) to £545 (men) or £469 (women); starting pay up to £402 (men) or £362 (women) at 25; women's pay subject to improvement under Equal Pay Scheme; somewhat less in provinces; opportunities for promotion.
FURTHER particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1. quoting No. S 59/55. [4843

ATOMIC Energy Research Establishment, Harwell, invites applications for the post of analogue computer programme engineer to assist a section leader in the development and operation of analogue computers for the investigation of a variety of problems concerning the overall control and safety of nuclear power plant; duties will include liaison with other engineering groups, reactor physics and electronics divisions; applicants should be at least 26 years of age and possess minimum qualifications of Higher National Certificate in electrical engineering or Higher School Certificate in science subjects, or equivalent qualifications; a degree in science or electrical engineering subjects is desirable together with a knowledge of electronics; experience of analogue computing techniques, light electro-mechanical devices, automatic control or servo-mechanisms would be an advantage; the successful candidate will be appointed with the grade of experimental officer (£775—£945 p.a.) and will be required to join the authority's contributory superannuation scheme.—Requests for application form should be sent on a post-card to the Establishments Officer, U.K. Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/292. [4842

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 *or a woman aged* 18-59 *inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order* 1952.

LIAISON Engineers.

JUNIOR Engineers who would like to widen their experience and feel they have a flair for selling are offered the opportunity of building a career with the Plessey Components Division. Applicants, who should not be over 28 years of age, must possess a sound engineering background. A pleasing personality, good appearance and the ability to mix easily are essential qualities. This Division of the Company sells to the radio, television and electronic industries and knowledge in these fields would be advantageous. The appointments carry an excellent salary dependent on age and experience, are permanent and offer unusual opportunities for advancement in a rapidly expanding organisation. The Company operates a generous life assurance and pension scheme.
PLEASE reply to:
THE Employment Manager,
THE Plessey Company, Limited, Ilford, Essex. [4929

V.H.F. radio link engineer required

FOR the maintenance of Multi-Channel Links. Previous telephone and radio experience essential.
APPLY, giving full details of experience to Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [4891

KENT EDUCATION COMMITTEE.

NORTH-WEST Kent College of Technology, Dartford.
DEPARTMENT of Electrical Engineering.
REQUIRED September Assistant Lecturer in Electrical Engineering.
APPLICANTS should be graduates of a British University or hold equivalent qualifications and should have industrial experience in Electronics or Telecommunications. Teaching experience would be an added qualification. Salary Burnham Technical Scale according to the qualifications, either Grade A (£450×£18—£725) or Grade B (£525×£25—£820) plus graduate and other appropriate allowances.
FURTHER particulars and application forms obtainable from the Principal, North West Kent College of Technology, Miskin Rd., Dartford. [4862

OPPORTUNITIES IN RADIO

Get this FREE Book!

'ENGINEERING OPPORTUNITIES' reveals how you can become technically qualified at home for a highly paid key-appointment in the vast Radio and Television Industry. In 144 pages of intensely interesting matter, it includes full details of our up-to-the-minute home study courses in all branches of **TELEVISION and RADIO, A.M. Brit. I.R.E., City & Guilds, Special Television, Servicing, Sound Film Projection, Short Wave, High Frequency and General Wireless Courses.**

We definitely Guarantee

"NO PASS—NO FEE"

If you're earning less than £15 a week this enlightening book is for you. Write for your copy today. It will be sent **FREE** and without obligation.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
388b COLLEGE HOUSE,
29-31, WRIGHT'S LANE,
LONDON, W.8.
BIET

CABLE CHEAPER IN SMALL COILS

All coils 20-49 yds. in length, unless requested shorter. All prices per 100 yd. lot, less supplied, add 5%. Full 100 yd. coils are available add 5% to any price.

TWIN FLAT	1/044	3/029	3/029 W/E	7/029 W/E
Rubber or Plastic	50/-	64/6	78/6	135/-
Single V.I.R.	23/-	28/6	—	48/6

EARTH WIRE 7/029 tinned copper 10/- a 100-ft. lot. Send for lists of other cables, flexes, wiring accessories and surplus switch and fuse gear. (We buy surplus electrical items, send details.) Add part carriage to small orders please.

BRITISH DISTRIBUTING Co. (Desk W), 591, Green Lanes, London N.8.

WAFER SWITCHES
TO SPECIFICATION

One or more type "H" switches having any desired contact arrangement or wafer spacing made from parts supplied by A.B. Metal Products Ltd.

Most types despatched within 48 hours.

Send for Price List of 82 "standard" arrangements and switch design chart

Orders and enquiries by post only:

SPECIALIST SWITCHES
24 CRANBOURN STREET, LONDON, W.C.2

SITUATIONS VACANT

SENIOR Draughtsmen.

DUE to expansion of the Electronics Division of the Plessey Company, Ltd., 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 Co., Ltd., Vicarage Lane, Ilford, Essex. [4771

ENGINEERS & Physicists.

FERRANTI, Ltd., in their new Laboratories are engaged in a programme of electronic development of great industrial importance. The work involves the use of digital computers to control machines and industrial processes and covers a wide and expanding field of application, offering long-term interest to those engaged in it.
DEVELOPMENT activity for these projects is taking place in the field of electronic circuitry (including pulse technique), digital computers, magnetic recording and servomechanisms; engineers and physicists having experience as well as interest in one or more of these subjects are invited to apply.
THE appointments are permanent and offer full scope for initiative in an expanding organization; a salary commensurate with the qualifications required will be paid; staff pension scheme; application form will be sent on request (quoting Ref./EP/AL) to—The Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [4718

SUNVIC CONTROLS, Ltd.

TESTERS required for type testing in connection with the design and manufacture of a wide range of electrical control equipment and instrumentation for the Test Department of a rapidly expanding company; applicants must have had industrial experience and suitable technical qualifications, preferably Higher National Certificate; housing accommodation can be arranged where necessary.—Write giving particulars of training, experience, etc., to Works Manager, Sunvic Controls, Ltd., Eastern Industrial Estate, Harlow, Essex. [4992

TRINITY HOUSE, London.

RADIO Maintenance Assistants wanted:—
RADIO Maintenance Assistants are required to maintain radio and radar equipment in Lighthouses and Light Vessels.
CANDIDATES must possess a knowledge of the fundamental principles of radio and radar and must have had practical experience in the maintenance and use of such equipment.
WHEN not engaged at out-stations successful candidates will be required to work at the Trinity House Depot, Blackwall, London, E.14. Salary scales £565, rising to £695 (minimum linked to age 26), or £452/10, rising to £610 (minimum linked to age 25), depending on qualifications and experience.
APPLICATIONS to be made in writing to The Secretary, Trinity House, London, E.C.3 not later than 15th August, 1955, stating age, present occupation, qualifications, experience and enclosing copies of testimonials. [4955

OPPORTUNITIES in Australia

FOR
ELECTRONICS development and design engineers.
MECHANICAL design engineers,
PRODUCTION methods engineers.
AUSTRALIA'S largest radio and electrical organisation requires a number of professionally qualified development and design engineers at the laboratories and factory in Sydney, New South Wales.
SPECIALISED knowledge in almost any field of tele-communications design could be used to advantage and there are excellent prospects for men of ability and initiative in a progressive company situated in a rapidly developing country.
APPLICANTS should preferably be in the age group 28-35 years, and commencing salaries would be from £A1,350-£A1,750, depending on qualifications and experience.
APPLICATIONS are also invited from engineers outside this age group, who possess special qualifications or experience.
ASSISTANCE would be given towards sea passages to Sydney of successful applicants and their families.
PLEASE write to Amalgamated Wireless (Australasia), Limited (App.), 99, Aldwych, London, W.C.2. [4972

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

TRANSFORMER Design
A VACANCY has arisen at the Feltham laboratories of this active company for an engineer to work on transformer design and development. The person we are looking for will have at least Ordinary National and preferably have had some experience in the field; but this is not a pre-requisite for consideration. The post is pensionable, and prospects are excellent.—Please send your first reply to Personnel Dept. (ED/235), E.M.I. Engineering Development, Ltd., Blyth Road, Hayes, Middlesex. [4897

SOUTHERN RADIO'S
WIRELESS BARGAINS

TRANSRECEIVERS. Type "38" (Walkie-Talkie). Complete with 5 valves. In metal carrying case. Ready for use. Less external attachments. 30/- per set.
ATTACHMENTS for use with "38" **TRANSRECEIVER: HEADPHONES** 15/6; **THROAT MICROPHONE** with lead and plug, 4/6; **JUNCTION BOX** 2/6; **AERIAL** 2/6; **SPECIAL OFFER** of used "38" **TRANSRECEIVERS** less valves but complete with **ALL COMPONENTS.** Excellent for **SPARES.** 11/6 per set. P. & P. 2/-.
TRANSRECEIVERS. Type "18" Mark III. TWO UNITS (receiver and sender) contained in metal case. Complete with six valves, microammeter, etc. LESS EXTERNAL ATTACHMENTS. £4/10/-.
RECEIVERS. Type "109." 8 Valve S.W. receiver with VIBRATOR PACK for 6 volts. Built-in speaker, METAL CASE. £5.
BOMBSIGHT COMPUTERS. Ex R.A.F. BRAND NEW. A wealth of components. GYRO MOTORS; REV. COUNTERS; GEAR WHEELS; etc., etc. Ideal for model makers, experimenters, etc. £3.
LUFBRA HOLE CUTTERS. Adjustable ¾in. to 3½in. For metal, wood, plastic, etc. 6/6.
RESISTANCES. 100 ASSORTED USEFUL VALUES. Wire ended. 12/6 per 100.
CONDENSERS. 100 ASSORTED. Mica, metal cubular, etc. 15/- per 100.
PLASTIC CASES. 14 x 10¾in. Transparent. Ideal for maps, display, etc. 5/6.
STAR IDENTIFIERS. Type I A-N. Covers both hemispheres. In case. 5/6.
CONTACTOR TIME SWITCHES. In sound-proof case. Clockwork movement, 2 impulses per sec., thermostatic control. 11/6.
REMOTE CONTACTORS for use with above. 7/6.
MORSE TAPPERS. Standard 3/6. Midget 2/9.
Postage or carriage extra. Full list of RADIO BOOKS 2½d.

SOUTHERN RADIO SUPPLY LTD.
11 LITTLE NEWPORT STREET
LONDON, W.C.2 Gerrard 6653

PRECISION SHEET METALWORK

We specialise in manufacturing of Chassis in all metals, large or small quantities to your own specifications.

V. W. BEAMISH

Shardeloes Garage, Shardeloes Rd., New Cross, London, S.E.14.
Telephone: TIDeway 4795

QUARTZ CRYSTAL UNITS

Q.C.C.

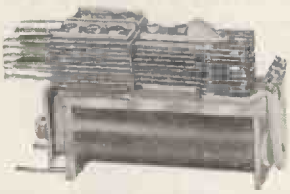
Type **B7**

The type B7 unit is mounted in the standard B7G valve envelope and is hermetically sealed and fully evacuated.
Available for the frequency ranges from 100 kc/s. to 500 kc/s. and from 3 Mc/s. to 16 Mc/s. Gold electrodes applied by cathodic sputtering give permanence of calibration. Normal adjustment accuracy 0.01% Max. adjustment accuracy 0.003%.

Early delivery can be given of some frequencies, and we will be pleased to quote for your specific requirements.

THE QUARTZ CRYSTAL Co. Ltd.
63-71 Kingston Road,
NEW MALDEN, SURREY
Telephone: MALden 0334 *Cables, etc.:* QUARTZCO NEWMALDEN

RELAYS TYPE 3000

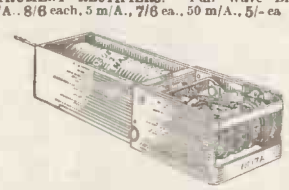


BUILT TO YOUR SPECIFICATION—EARLY DELIVERY—QUOTATION BY RETURN—PLEASE STATE RESISTANCE OF COIL REQUIRED AND CONTACT BUILD UP.

TEST METER FSD 1M/A. Scaled 0/100. Resistance 75 ohms 2½in. Flush Round. Fitted in metal case 7in. × 5¼in. × 2½in. Ideal for making a universal Test Meter. 35/-. Post 2/-.
GENALEX EXTRACTION FANS. 230/250 volt, 50 cy. Induction motor 1,350 r.p.m., 85 watts, 9in. blades, silent running. £6/15/-. Carriage 7/6.
CELL TESTING VOLTMETERS. 3-0-3 volts. In leather case with prods. 25/-. Post 2/-.
RATIO ARM UNITS by H. W. Sullivan. Brand new. 600 ohms +600 ohms. 50/-. Post 2/-.
WHEATSTONE RESISTANCE BRIDGE. Manganin. 1 to 10,000 ohms. £5.
GALVANOMETER. Mirror type. 5 Microamps FSD. Table Model in case 8 × 5½ × 5½in., scaled 0/5, 0/25, 0/125 microamps. £10.
MICROPHONE. A most attractive professional crystal mike with beautiful friction slide, adjustable heavy floor stand and 12ft. screened cable, £6/6/-. Post 2/6.
MICROAMMETERS. 250 FSD 3½in. FLUSH MODEL 837. Specially scaled for test meters. Knife edge pointers, magnetic shield. Brand new, 55/-.
BLOWER MOTORS. Dual voltage 12-24 volts. Recommended for car cooling or heating, 25/-. Post 2/-.
RECEIVER R1155. BRAND NEW. AERIAL TESTED. In maker's original transit case. Now is the chance to get one from the best delivery we have had from the Ministry. Carr. 10/6. £11/19/6. Send S.A.E. for further details or 1/3 for publication giving circuit diagrams etc.
45 Mc/s PYE IF STRIP. These vision units are brand new and complete with 6 EF50 valves and EA50. Our price only 65/-. Post 2/6.

TELEPHONE SETS

FOR PERFECT COMMUNICATION BETWEEN 2 OR MORE POSITIONS
WALL TYPE. One. pair of units, £5. Batteries 5/6. Twin wire 5d. yd. Post 2/6.
DESK TYPE now available, latest modern style. Two complete units with battery, ready for use, £8/17/6. 3 core flex required at 5d. per yard.
RACKS P.O. STANDARD for 19in. panels. Steel channel sides, correctly drilled. Heavy angle base Height. 4ft. 10in. or 6ft.
VACUUM PUMPS or Rotary Blowers. Ex-R.A.F. Brand new, 7 cu. ft. per min. 10lb. per sq. in. at 1,200 r.p.m. Ideal for a brazing torch, etc. Size 6in. × 4in., shaft 2 × ½in., 22/6 each. Post 2/-.
SLOW MOTION DIALS. 6in. Scaled 0-100, reduction 200 to 1 or direct. 5/6 each. Post 1/6.
VOLTMETERS. 0/300 for A.C. Mains 50 cy. Clear 5in. dial., 60/-; 0/15 volts A.C./D.C. 2½in. flush, 15/6.
VOLTMETERS. 0/300 D.C. 2in. flush square with external resistance. 10/6; post 1/-. Easily converted to read A.C. by using a 5 Milliamp meter rectifier. at 7/6. Post 6d.
VOLTMETERS. 0-20 M.C.2. Flush 10/6 ea. Post 1/-, also 0 300 2½in. round with 1 M/A movement 30/-.
AMMETERS. 2in. Flush 0/20, 10/6 each. 20-0-20, 12/6 each. 0/30 10/6 each. Moving Coil D.C.
INSTRUMENT RECTIFIERS. Full Wave Bridge. 1 m/A., 8/6 each, 5 m/A., 7/6 ea., 50 m/A., 5/- ea



ELECTRO MAGNETIC COUNTERS. Post Office type 11A, counting up to 9,999, 2 to 6 volts D.C. 3 ohm coil, 12/6 each. Post 1/-. Many other types in stock, lists sent with order or send S.A.E.
HEADPHONES. HIGH RESISTANCE. 4,000 ohms. Type CHR. New. 12/6 pair. Post 1/6.
ACFIL PUMPS. These pumps enable you to fill all accumulators on the bench with the carboy at floor level. Brand new, only 30/-. Post 2/-.
ROTARY CONVERTERS. Input 12 volts D.C., output 230 volts A.C. 50 cycles, 100 watt, 92/6 each Also available with 24 volt input, carr. 7/6.
LISTS AVAILABLE. Meters. Potentiometers. Resistances. All types including High Stability Carbon and Wire wound. Send large S.A.E.

L. WILKINSON
(CROYDON) LTD. DEPT. W.W.
19, LANSDOWNE ROAD, CROYDON

SITUATIONS VACANT

FEDERATION of Nigeria.

VACANCIES exist in the Posts and Telegraphs Department of the Federation of Nigeria for Engineers, Area Engineers, Staff Engineers and Assistant Staff Engineers.
DUTIES include the supervision of staff; installation and maintenance of equipment, particularly carrier and V.H.F.; planning, construction and maintenance of telegraph and telephone systems and overhead and underground lines; general duties at H.Q., study of maintenance methods; fault control, etc.
APPOINTMENTS are on contract in the salary range £1,116-£2,250 per annum gross according to the particular post, with a gratuity of £150 per annum. Engineers may also be appointed on pensionable terms in the salary range £910-£1,560 per annum gross. Quarters are provided. Generous leave. Free first-class passages.
CANDIDATES for Engineers appointments should be between 25 and 35 years of age and must have passed or be exempt from Sections A and B of the examination for A.M.I.E.E. or be Assistant Engineers in the British Post Office with experience in modern telecommunications practice. Experience with V.H.F. multichannel equipment an advantage: for Area Engineers, must be Corporate Members of the Institution of Electrical Engineers or have passed the British Post Office examination for Executive Engineers and have at least five years' experience in a responsible position in industry or as an Executive Engineer: and for Staff Engineers and Assistant Staff Engineers, must be either Corporate Members of the Institution of Electrical Engineers or have passed the British Post Office examination for Executive Engineers and have at least seven years' experience. Post Office candidates for Staff Engineers should hold the rank of Senior Executive Engineer.
FURTHER particulars on application in writing to Director of Recruitment, Colonial Office, S.W.1. quoting the Reference No BCD 108/14/05 D26, and post of which particulars are required. All Post Office candidates should submit applications through their Personnel Department.
CLOSING date for receipt of initial enquiries 31st August, 1955. [4934

NORTHAMPTON Polytechnic, E.C.1.

DEPARTMENT of Electrical Engineering.
REQUIRED, Senior Laboratory Technician. Post offers experience in all aspects of electrical engineering with either light current or electrical power specialisation; facilities available for higher education. 5 weeks' paid holiday annually.
SALARY £401 by annual increments of £25 to £503, plus supplement for approved educational qualification. Post superannuable.—Applications to Head of Department. [4831

E. K. COLE. Ltd. (Malmesbury Division).

THE Malmesbury Division of E. K. Cole is engaged in the development and production of radar and communication equipment associated with high priority defence projects. Vacancies exist in the Development Department for Project Engineers, Engineers and Assistant Engineers with training and experience in the following fields:
PULSE Circuits
PULSE Modulators.
STROBE Systems.
VIDEO Amplifiers.
TIME Base Generators, etc.
H.F. AND V.H.F. Communication—airborne and ground receivers, transmitters and aerial systems.
APPLICANTS should have had technical training to Degree or Higher National Certificate standard, and in the case of project engineers and engineers appropriate technical design experience is necessary.
COMMENCING salaries will be dependent on qualifications and experience and will compare favourably with scales prevailing in the radio industry. A superannuation scheme is in operation. Applicants should apply in the first instance for a technical staff application form to Personnel Manager, E. K. Cole, Ltd., Malmesbury, Wilts. [4702

ELECTRICAL/electronic/radio engineers.

A NUMBER of vacancies exist in the design organisation of Vickers-Armstrongs (Aircraft), Ltd., Hursley Park, nr. Winchester.
THE work will include development, design and testing of latest specialised installations in aircraft; applicants with varying qualifications up to Degree standard are invited to apply; salary commensurate with experience and ability; recommendation may be made for housing after qualifying period.
APPLY: Personnel Department. Vickers-Armstrongs (Aircraft), Ltd., Hursley Park, nr. Winchester. [4607

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

REDEVELOPMENT Authority.
A VACANCY has arisen for a Senior Electronics Engineer who will be prepared to take over, on behalf of the company full responsibility for a radar or communications system used by the Services. His main tasks will be to formulate plans for redevelopment with special reference to increasing the reliability and extending the use of the equipment. The post carries an attractive salary and is pensionable and holds out great opportunity for the right man.—Reply in the first instance to Personnel Dept. (ED/240). E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middx. [4898

—TUNERS—

AM and FM

FM81

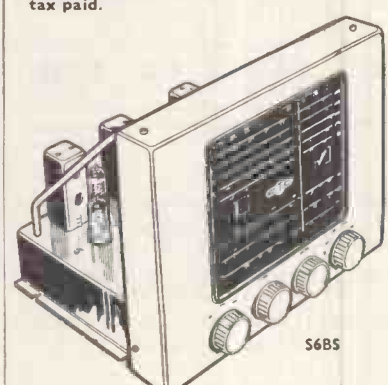
Our FM tuners provide excellent reproduction with absence of background noise and are tunable between 87.5 Mc/s-100 Mc/s and will receive the proposed National B.B.C. Frequency Modulated V.H.F. transmissions as and when installed within approximately 60 miles of the transmitter.

Using the latest valves and techniques they are available in three forms:

FM81 illustrated above, £21 tax paid.

FM82 with pre-set station selection, output 1-2 volts, self-powered 200-250 volts, £24 tax paid.

S5/FM all waves AM and FM tuner, £32/10/- tax paid.



S6BS

S6BS 9 Band (6 Electrical band spread) with R.F. F.C. 2 I.F. Delayed Amplified A.V.C. Variable Selectivity. Fly Wheel Tuning. Tropicalised. Suitable for use with any High Quality Amplifier. £44. Tax paid.

S6 A new model similar to the well-known S6BS but only 3 Wave Bands; 16m-50m. 195m-550m, 800m-2,000m. £30. Tax paid.

S6E As S6 but 4 Wave Bands: 12.5m-37m, 35m-100m, 90m-250m, 190m-550m. £30. Tax paid.

S5 3 Wave Bands. 16m-2,000m, R.F. pre-Amplifier, variable selectivity I.F. Delayed Amplified A.V.C. very low distortion. £21/6/8. Tax paid.

S5E As S5 but 12.5m-550m. £21/6/8. Tax paid.

S4 The Standard high-quality Feeder Unit Specification as S5 but without R.F. amplifier. £16. Tax paid.

A modified version of all models is available for use with Leak, Acoustical and other High Quality Amplifiers.

C. T. CHAPMAN (Reproducers) LTD.
RILEY WKS., RILEY ST., CHELSEA, S.W.10
FLAxman 4577/8
Export Enquiries Invited

RADIO/RADIOGRAM CHASSIS

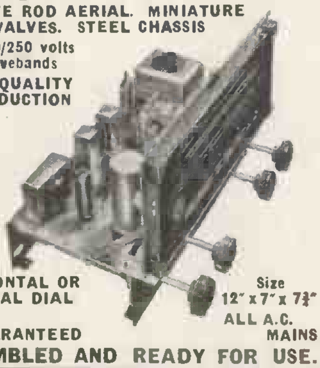
BUILT TO HIGHEST TECHNICAL STANDARDS FOR THE CONNOISSEUR OF QUALITY MUSIC REPRODUCTION

New Range of Models with Latest Features

FERRITE ROD AERIAL. MINIATURE (BVA) VALVES. STEEL CHASSIS

A/C 200/250 volts
3 wavebands

HIGH QUALITY REPRODUCTION



HORIZONTAL OR VERTICAL DIAL

Size 12" x 7" x 7¾"

FULLY GUARANTEED

ALL A.C. MAINS

ASSEMBLED AND READY FOR USE.

5 VALVES chassis, 4 watt output, wide range tone control. **£13.18.3**

7 VALVES PUSHPULL chassis, 6 watt output, separate bass and treble controls **£17.17.9**

Negative feedback applied from output transformer secondary.
Gram switching on wave-change switch.
Plug-in connections for pickup, speaker, gram motor.

Available AUGUST.
F/M TUNERS
T.V BAND III ADAPTORS

FULL TRADE FACILITIES
DETAILED LIST AND DIMENSIONS.
DIRECT FROM THE MANUFACTURER

THE DULCI CO. LTD.
97 VILLIERS ROAD, LONDON, N.W.2.
Telephone: WILLESDEN 6678.

THE
CHAFFEY
CABINET COMPANY
63a, CHELTENHAM RD., LONDON, S.E.15
TEL: NEW CROSS 4766

AUTOMATIC (TIME) SWITCHES

New and reconditioned 15 day clockwork and electric switches

from **35/-**

Send S.A.E. for illustrated details to:—
DONOHOE (TIMERS) GEORGE STREET NORTH SHIELDS, NORTHUMBERLAND

SOLDERING?

You can't beat a
PRIMAX
balanced grip
SOLDERING GUN
in unbreakable case

70/- *post free*

★ For the Radio-T.V.-Telephone mechanic or amateur ★ Heats instantly ★ Permanent alloy tip ★ Loop for hanging ★ 110,200/220, 220/250 v. A.C. only.

Sole Distributors:
S. KEMPNER LTD.
29, Paddington St., London, W.1 Tel: HUN. 0755

SITUATIONS VACANT

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

MICRO-WAVE Design Work.
AN engineer is required at the company's Feltham laboratories to collaborate on micro-wave component design and to investigate problems arising from quantity manufacture of micro-wave components and aerials. Applicants should have 4-6 years' experience and a degree of science or engineering would be a distinct advantage. An attractive salary is proposed for this pensionable post and prospects in the company, which is steadily expanding, are considerable.—Please reply in the first instance to Personnel Dept. (ED/245). E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middlesex. [4896

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

INSTRUMENTATION Engineers.
AN attractive vacancy exists for an electronic instrumentation engineer (one senior and one junior) for the design and development of electronic instruments and instrumentation systems. APPLICANTS should have a sound engineering background (preferably with a degree) and appropriate experience in the design and development of electronic instruments and systems, or closely allied equipment, is essential. In the case of the senior engineer, experience in the supervision of small development teams is necessary.
THE posts are pensionable and offer excellent opportunities for engineers with an inventive and progressive outlook
PLEASE send full details of training, qualifications and experience, in confidence, to Personnel Dept. (ED253), E.M.I. Engineering Development, Ltd., Hayes, Middx. [4899

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

A VACANCY has arisen for an electrical/radio engineer at the company's laboratory at Feltham. This post would be especially suitable for a H.N.C. man with service experience as a radar or communications craftsman. The salary for this pensionable post is good, and prospects are excellent.—Please reply in the first instance to Personnel Dept. (ED/242), E.M.I. Engineering Development, Ltd., Blyth Road, Hayes, Middlesex. [4895

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

EXPERIENCED Valve Engineer.
AN interesting vacancy has arisen at the company's Feltham laboratories for a valve engineer with 4-6 years' experience of both valves and micro-wave generators. Applicants, who should be qualified, will have some knowledge of testing both in quantity, and for special purposes, will be able to design suitable test equipment, and have some applications experience. The salary offered for this pensionable post is attractive, and the prospects in this active company are excellent.—Please address your first reply to Personnel Dept. (ED/252), E.M.I. Engineering Development, Ltd., Blyth Road, Hayes, Middlesex. [4894

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

AIRCRAFT Electronic Equipment.
AN extremely interesting vacancy has arisen within the company for an engineer to take responsibility for the solution of problems associated with the installation of all types of electronic equipment in aircraft. The successful applicant must have had wide experience in this field; he must appreciate both the aeronautic and the electronic engineer's viewpoint. The post is pensionable, the salary will be commensurate with ability and experience, and the prospects are excellent.—Please reply in the first instance to Personnel Dept. (ED/241). E.M.I. Engineering Development, Ltd., Blyth Road, Hayes, Middx [4892

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

ASSISTANT Trials Planner.
AN assistant is required for trials planning at the company's Feltham laboratories. The engineer we are looking for will have H.N.C. or similar qualifications, and 3-6 years' experience, preferably in trials activity, and should be willing to travel. A knowledge of telemetry will be a distinct advantage. The salary for this pensionable post is attractive and prospects in this active and steadily expanding company are excellent.—Please reply in the first instance to Personnel Dept. (ED/246), E.M.I. Engineering Development, Ltd., Blyth Road, Hayes, Middlesex. [4893

SENIOR Technician (Aeradio) required by the EAST Africa High Commission Directorate of Civil Aviation for permanent and pensionable employment subject to a probationary period of two years. Established civil servants could be appointed on "temporary transfer" terms. Salary scale (including inducement pay and present 10% temporary allowance) £1,320 rising to £1,498 a year. Free passages. Liberal leave on full salary. Candidates should have served an engineering apprenticeship and possess up-to-date knowledge of modern telecommunications practice with particular reference to aeronautical radio ground station equipment including radar and radio aids to navigation. They should also have a knowledge of radio workshops servicing methods and practice. Preference will be given to candidates with City and Guilds Full Technological Certificate in Telecommunications Engineering.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/40898/WF. [4905

THE MODERN BOOK CO.,

Britain's Largest Stockists of British and American Technical Books.

Elements of Servomechanism Theory by George J. Thaler. 53s. 6d. Postage 1/-.

Mathematics for Telecommunications Vol. I by D. F. Spooner and W. H. Grinsted. 10s. 6d. Postage 6d.

Thermionic Valve Circuits by Emrys Williams. 21s. 0d. Postage 6d.

Radio and Television Engineers' Reference Book edited by E. Molloy. 70s. 0d. Postage free.

The Radio Amateur's Handbook by A.R.R.L. 30s. 0d. Postage 1/-.

Elsevier's Dictionary of Television and Radar and Antennas. 120s. 0d. Postage free.

Radio Engineers' Servicing Manual by E. Molloy. 42s. 0d. Postage 1/-.

Radio Data Charts by R. T. Beatty. 7s. 6d. Postage 6d.

The Williamson Amplifier reprinted from "*Wireless World.*" 3s. 6d. Postage 3d.

Simple Electronic Musical Instruments for the Constructor by Alan Douglas. 5s. 0d. Postage 3d.

Transistors and Crystal Diodes by B. R. Bettridge. 5s. 0d. Postage 3d.

R.C.A. Receiving Tube Manual compiled by Radio Corporation of America. 8s. 0d. Postage 6d.

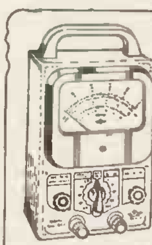
Radio Valve Data compiled by "*Wireless World.*" 3s. 6d. Postage 3d.

Please write or call for our catalogue.

19-23 PRAED STREET
(Dept. W.6.)
LONDON, W.2
'Phone: PADdington 4185
Open 6 days 9-6 p.m.

OUR NEW
GOVERNMENT SURPLUS CATALOGUE No. 12
containing over 400 items price 1/6d. post free. 2/6d. overseas seamail.
ARTHUR T. SALLIS (W.W.)
93 NORTH ROAD, BRIGHTON, SUSSEX. *Tel.: BRIGHTON 25806*

THE
Cape 25
AUDIO AMPLIFIER for the acoustics laboratory or with a
CAPE FOUR STAGE PREAMPLIFIER forming a high fidelity reproducer which sets a new standard of performance.
AMPLIFIER £25. PREAMPLIFIERS from £10.
Illustrated leaflets upon request.
CAPE ELECTROPHONICS LTD.
43-45, Shirley High Street, Southampton.
Telephone: Southampton 74251.



PULLIN
SERIES 100
TEST METER
AC/DC 10,000 Ω/V
21 RANGES
100μA to 1000V
COMPLETE IN DIE-CAST CASE WITH TEST LEADS CLIPS AND PRODS
FULLY GUARANTEED

SENT POST FREE FOR **£2.10s.**
deposit & eleven further monthly payments of **£1.** Cash Price **£12.7.6.**

Frith RADIOCRAFT *Ltd*
PHONE 58927
69-71 CHURCH GATE LEICESTER

SITUATIONS VACANT

TECHNICIANS (Aeradio) required for the EAST Africa High Commission Directorate of Civil Aviation for permanent and pensionable employment subject to a probationary period of two years. Established civil servants could be appointed on "temporary transfer" terms. Salary scale (including inducement pay and present 10 per cent temporary allowance) £772 rising to £1,122 a year. Free passages, liberal leave on full salary. Candidates should preferably have served an engineering apprenticeship and should have experience in the repair and maintenance of modern aeronautical telecommunications equipment including radio and radar aids to navigation. They should also possess an up-to-date knowledge of workshops practice. Preference will be given to candidates with a City and Guilds Certificate in Radio Servicing or equivalent qualification.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/40902/WF. [4903

WIRELESS operator mechanics required by FALKLAND Islands Dependencies Survey for service at isolated British Bases in the Antarctic. Must be able to transmit and receive morse at 20 words a minute (plain language or code) and be capable of elementary maintenance of wireless transmitting and receiving equipment. Salary according to age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Candidates should be keen young men, between 20 and 30 years, preferably single, of good education and high physical standard with a genuine interest in polar research and travel and willing to spend 18 or 30 months under conditions which are a test of character and resource.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41024/WF. [4941

LEADING manufacturers require radio and television SERVICE Engineers for their Service Department situated close to Central London. Permanent staff positions offering opportunities of progress to suitable applicants. Five-day week. —Write, giving details of training and past experience, to Box A.237, c/o Central News, Ltd., 43, London Wall, E.C.2. [4953

SENIOR radio superintendents required for the EAST Africa High Commission Directorate of Civil Aviation for permanent and pensionable employment subject to a probationary period of two years. Established civil servants could be appointed on "temporary transfer" terms. Salary scale (including inducement pay and present 10 per cent temporary allowance) £1,320 rising to £1,498 a year. Free passages. Liberal leave on full salary. Candidates, preferably between 30 and 40, must have had ten years in civil aviation with considerable experience of flying or aeronautical ground station operating. They should have had extensive experience in installation and maintenance work and the organization of communication and maintenance systems. Preference will be given to candidates with a City and Guilds Full Technicological Certificate.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/40835/WF. [4902

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge, offer:—
EXCELLENT opportunities for junior and senior development engineers in the electronics and communications field.
DUTIES include development work on H.F., V.H.F., microwave and recording equipments.
APPLICATIONS from persons possessing B.Sc., Higher National or Ordinary National Certificates especially welcomed.
GOOD facilities available, however, to keen young men wishing to train and study in these fields.
PLEASANT working conditions in modern factory; single accommodation available.
WRITE, giving fullest details to Personnel Manager. [4622

MULLARD RESEARCH LABORATORIES require experienced WIREMEN for interesting work on electronic equipment; applicants must be able to work from theoretical wiring diagrams; high frequency wiring experience with knowledge of components assembly preferred; staff conditions of employment; salary accoding to age and experience; 5-day week; pension scheme.—Apply Mr. G. A. Taylor, Mullard Research Laboratories, Cross Oak Lane, Salfords, Near Redhill, Surrey. [4906

SCIENTIFIC Assistant (Ionospheric) required by FALKLAND Islands Dependencies Survey for service in the Antarctic for 1 or 2 seasons involving absence from the U.K. of approximately 19 or 30 months under conditions which are a test of character and resource. Commencing salary according to age in scale £400 rising to £540 a year with all found including clothing and canteen stores. Candidates, preferably single and aged 21-28 years, must be of good education and high physical standard and have a real enthusiasm for hard work under trying conditions. They should have a sound knowledge of physics and of radio maintenance. Possession of a physics degree an advantage. The selected candidate will be required to undergo three months' training in the U.K. before departure.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/35263/WF. [4904

SITUATIONS VACANT

SUPERVISING Technicians (Aeradio) required by the
EAST Africa High Commission Directorate of Civil Aviation for permanent and pensionable employment subject to a probationary period of two years; established civil servants could be appointed on "temporary transfer" terms: salary scale (including inducement pay and present 10% temporary allowance) £1.161 rising to £1,280 a year; free passages; liberal leave on full salary: candidates should preferably have served an engineering apprenticeship and should have had at least five years' experience in the installation and servicing of aeronautical telecommunications equipment including radio and radar aids to navigation: they should have an up-to-date knowledge of workshop practice with experience in servicing diesel generators; preference will be given to candidates who possess a City and Guilds Intermediate Certificate in Radio Communications or equivalent qualification.—Write to the Crown Agents. 4. Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/40899/WF. [4909

EX-NAVAL R.E.A.s, R.E.s or R.A.F. air or ground radar fitters.
APPLICATIONS are invited for employment on development and prototype testing of radar and guided weapon equipments; there is plenty of scope for enthusiastic men with initiative and ability; the work is interesting and working conditions are good; the positions offered are permanent and are covered by a contributory pension scheme; salary according to age and experience.
APPLICATIONS should be made to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. Ref. RG/B. [4710

SENIOR TV engineers required; must drive; salary from £650 p.a.—Apply E. Coyne, 120, Ladbroke Grove, W.10. Bay. 1947.

RADIO Engineer, able to drive, extremely attractive salary for speedy work. South West London area.—Apply Box 4961. [4949

ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, nr. Didcot, Berks, has vacancies for
SENIOR experimental officers and experimental officers in its geological instrument group. Duties are concerned with the design, development and servicing of electronic radiation measuring equipment for use in geological prospecting for radioactive minerals. The successful candidates will be based either in London or at A.E.R.E., Harwell, but will be expected to undertake periods of field service overseas. These periods will normally be of a few weeks' duration, but may, in some cases, extend to several months. Applicants should be at least 26 years of age and possess minimum qualifications of Higher School Certificate in science subjects or equivalent qualifications. They should have received training in radio, electronics or physics and preferably have had several years' experience in the design and development of electronic equipment. Experience with radiation measuring equipment is not essential but would be an advantage. Appointments will be made either in the grade of senior experimental officer (£1,090-£1,285 p.a.) or experimental officer (£775-£945 p.a.) according to age, experience and qualifications, and selected officers will be required to join the Authority's contributory superannuation scheme. —Request for application form should be sent on a post card to Establishment Officer, U.K. Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/333. [4886

TECHNICAL writer (radar) required by manufacturer in the London area to compile literature on radar equipment.
A GOOD general educational and engineering background is necessary, with H.N.C. (including electronics) as the minimum technical standard.
THE principal requirement, however, is the ability to assimilate information supplied by laboratory technicians and to prepare this in a clear logical sequence suitable for publication as a handbook.
SALARY will be commensurate with experience and ability, but a minimum of £750 per annum is offered and, for a qualified radar engineer who is able to meet the requirements described above, there is scope beyond the position now vacant
WRITE, in confidence, giving full particulars of past experience, qualifications, age and salary required, to Box 4624. [4882

TOP grade radio service engineers required for expanding company; excellent salary and prospects.—Apply to Telefonic Radio, Ltd., 3a, Church St., Slough, Bucks. [4739

SALESMAN wanted for radio and television component suppliers. Good prospects. Permanent position. Some technical knowledge an advantage.
LASKY'S RADIO. 42, Tottenham Court Rd., London, W.1. Museum 9315. [4901

A LEADING firm of radio and television manufacturers invites applications from qualified and experienced field service engineers for the post of
MOBILE Technical Liaison Officer for the Midlands area. The appointment is progressive, permanent and pensionable and affords unusual opportunities for a man with thorough theoretical and practical knowledge of modern vision and sound receivers, including high fidelity reproducing equipment.—Write with full details of past career to Box A.235, c/o Central News, Ltd., 43, London Wall, E.C.2. [4952

SITUATIONS VACANT

COMPETENT TV and radio engineer, able to drive; excellent salary and prospects; S.W.3 district.—Box 3140. [4588

R. B. PULLIN & Co., Ltd., invite applications for the following vacancies in their recently formed and expanding Electronic Development Division:—

(A) SENIOR Development Engineer: applicants should possess an Honours Degree or equivalent qualifications, and should have had several years experience of the development of electronic circuits, preferably including work on electrical servos and magnetic amplifiers.

(B) JUNIOR Development Engineer: qualifications to O.N.C. or H.N.C. standard together with some previous experience of valve circuit design.

THE positions are of a permanent nature; they offer excellent prospects and the opportunity to work in a newly equipped laboratory on a variety of projects requiring considerable individual technical responsibility and initiative.

A COMMENSURATE salary will be paid; contributory pension scheme, canteen and recreational facilities; applications will be treated as confidential, and should be made to the Superintendent, Electronic Development Division, R. B. Pullin & Co., Ltd., Phœnix Works, Great West Rd., Brentford, Middlesex. [0200

APPLICATIONS are invited for the following vacancies in the radio receiver designs department of the Ever Ready Co. (GB). Ltd., Radio Section, Park Lane, Wolverhampton.

RADIO Development Engineer for the design and development of domestic radio receivers for both A.M. and F.M. and for specialized work on transistors, printed circuits, etc. Applicants should possess qualifications to at least Grad. Brit. I.R.E. standard or C. & G. Full Tech. Cert. in Telecomm. Engineering and have had practical experience in at least one of these fields.

LABORATORY Assistant, to assist in the design and construction of domestic receiver prototypes in connection with the work outlined above. Applicants should possess qualifications to the third year standard of the C. & G. in Telecomm. Engineering.

THESE are staff appointments and good salaries will be paid to suitable applicants, who will also be eligible for the Company's very comprehensive non-contributory pension scheme.

WRITE giving all relevant information to the Chief Engineer at the above address. [4873

RADIO and television engineers required.—Please apply to Imhof's Service Centre, 9a, Mildmay Grove, Islington, N.1, or Tel. Canonbury 1281. [4881

THE MULLARD RADIO VALVE Co., Ltd., has a number of vacancies for Technical Asistants in the following Divisions at its Mitcham factory:—

CATHODE Ray Tube Division.
VALVE Making Division.
SEMI-CONDUCTOR Division.
VALVE Applications & Measurements Division.
GAS Discharge Valve
&
PHOTO Electric Cell Division.

IN each field of work vacancies exist in the Production Development and Technical Departments. Applications are invited from persons holding the General Certificate of Education at Ordinary level in science subjects and at Advanced level, and others who possess either the Ordinary or Higher National Certificate in Electrical Engineering.

THE posts give an opportunity for further training in the electronic field and there are facilities for further study leading to higher qualifications. There are, in addition, considerable opportunities for promotion in varying and expanding fields of electronic work.

COMMENCING salaries will be according to age, experience and qualifications and can be considered as progressive. There is a Company Pension Scheme and Long Service Holiday Plan.

APPLICATIONS in writing, which will be treated with the strictest confidence, should be addressed to The Personnel Officer, The Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey.

QUOTING reference JFG/TECH/GEN. [4866

SERVICE engineer required for duties in Singapore. A young single man would be preferred, but good experience with radar and echo sounding equipment is essential.

AN initial two-year term of duty would be renewable by arrangement. There are generous leave and salary provisions for competent engineers and a training period covering the company's products would be given before taking up duties abroad.

WRITE, giving full particulars of age, experience and salary required, to Box 4800. [4919

RADIO mechanics required for workshops and flight duties.—Apply, Chief Engineer, Eagle Aircraft Services, Ltd., Blackbushe Airport, Camberley, Surrey. Tel. Yateley 2371. [4834

RADIO and/or television engineer required for bench and outside repairs, driver; references, age, experience, salary expected.—Field's Radio, Ltd., 52, Hall Gate, Doncaster. [3542

ELECTRICAL SERVICE (EDGWARE), Ltd., require good service engineer, bench and outside; clean licence; top salary; permanent; congenial.—93, Edgware Rd., W.2. Pad. 2342. [4797

DRAUGHTSMAN required for detail work on Radio Components. Apply in writing to Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, S.W.18. [0059

SITUATIONS VACANT

TECHNICAL writers required by large precision instrument manufacturers in the following fields:—
BOILER house and process control gear. Aviation instruments. Radar and other electronic navigation equipment.
AN engineering background is desirable but not essential, and applicants should be familiar with at least one of the fields mentioned above, and be able to write technical service literature.
SALARIES are in accordance with experience and qualifications but are based on a generous scale. The positions are permanent and favourable pension and payment during illness arrangements, etc., are in operation.
APPLICATIONS, which can be made in the strictest confidence, should be addressed to The Personnel Manger, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [4883

LOUDSPEAKER Development Engineer. An extremely interesting vacancy exists for a Loudspeaker Development Engineer having the following qualifications:—
(1) THOROUGH knowledge of the acoustic, electrical, magnetic and applied mechanical theory underlying loudspeaker practice.
(2) SUFFICIENT draughting ability to secure the direct assistance of workshop facilities.
(3) THE capacity to pursue a suggested basic idea to a logical detailed conclusion by reasoning and supporting experiment.
(4) A mind free from prejudice and preconception.
(5) THE ability to evolve designs compatible with the production facilities of the company.
APPLICATIONS, initially in writing, should include details of all training and prior experience and an indication of the salary required and should be addressed to The Managing Director, Reproducers and Amplifiers, Ltd., Frederick Street, Wolverhampton, Staffs. [4859

RELAY compact setters required, preferably experienced with G.P.O.-type relays. Good wages and overtime. Excellent prospects for advancement.—Please apply Keyswitch Co., 126, Kensal Rd., W.10. [4839

TELEVISION/RADIO service engineer required, permanent position for reliable man with progressive dealer, good pay according to experience.—H. F. Sheffield, 45, High St., Abbots Langley, Herts. [4932

FERRANTI, Ltd., Moston, Manchester, have a number of vacancies in their Computer Department arising out of the continuing progress of this new and important part of the Ferranti organization. They are as follows:—
(1) ELECTRICAL Engineers and Physicists for design groups concerned with all aspects of electronic computing systems including circuitry, storage systems, visual displays, etc., and for basic research on new techniques.
(2) MECHANICAL Engineer to be concerned with design problems arising from the high-speed rotation of discs and cylinders and possessing a sound knowledge of the problems arising in such structures due to heating and centrifugal effects and with high-precision work involved in overcoming bearing and balancing problems. A knowledge of small motor design would be an asset.
(3) MAGNETIC Recording Engineer for investigations into special recording heads and magnetic coatings.
(4) ELECTRICAL Engineer for investigations into special power supplies and methods of speed control for magnetic drums and for the design of synchronising circuits in co-operation with Computer Circuit Engineers. Permanent staff appointments with pension benefits.—Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote reference CD (M) 1, 2, 3 or 4. [4747

PROCESS Engineer required by Pye, Ltd., of Cambridge, to be responsible for maintaining the quality and efficiency of all processes connected with the manufacture of printed circuit assemblies.
A SUITABLE candidate would be aged 23-28 years of age, and would have education in scientific subjects to G.C.E. advanced level or Inter B.Sc. standard, some industrial experience and plenty of drive and intelligence.
PLEASE apply in writing to Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4930

TECHNICIAN required for electronic equipment development and testing.—Write, stating previous experience and salary, to J. B. Andrews (Electro-Mech), Ltd., Wrafton Works, Hartfield Crescent, S.W.19. [4916

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for many parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

PHYSICIST required for development on electronic temperature and humidity control in relation to process control; prospects of becoming personal assistant to Development Engineer; Guildford, Surrey, district.—Box 4837. [4920

ELECTRONIC engineer of graduate or H.N.C. standard required for original design work of electronic circuits in an interesting new field. Commencing salary £800 p.a. Expanding company in North London area.—Box 4799. [4918

DYNATRON RADIO require radio and television service engineer; first-class experience, pleasing personality and a good driver essential; salary in accordance with experience. —Apply Service Manager, The Firs, Castle Hill, Maidenhead. Tel. 3811. [4936

DESIGNERS and DRAUGHTSMEN

are invited to apply for a number of interesting vacancies with

THE ENGLISH ELECTRIC CO.'s GUIDED WEAPONS DIVISION at LUTON, BEDS., and STEVENAGE, HERTS.,

as follows:—

DESIGNER DRAUGHTSMAN—for layout of Radar and Electronic equipment to be used in ground or airborne installation. Experience of miniaturisation or potting techniques a useful asset. Ref. 2813.

DESIGNER DRAUGHTSMAN—for layout of Electronic Equipment employed in Laboratory Measurements and Monitoring. Previous experience of R.C.S. 1000 very desirable. Ref. 2814.

DRAUGHTSMAN—for preparation of Circuit or Wiring Diagrams relating to construction or installation of Electronic or Electro-Mechanical Equipment. Ref. 2915.

DRAUGHTSMAN / CHECKERS — with approximately five years workshop experience and at least five years Drawing Office service, together with specialist knowledge in Electronic, Instrument or Electrical Engineering. Ref. 2802.

These posts are permanent and offer attractive commencing salaries and good promotion prospects to the right men. Housing assistance can be given in many cases, especially to successful candidates from the Greater London Area.

Please apply to Dept. C.P.S., 336/7 Strand, W.C.2, quoting appropriate Ref. No. and also Ref. 1119T.

SITUATIONS VACANT

RADIO and TV testers and fault finders, Pye, Ltd., Cambridge, have vacancies in London and Cambridge for men with factory production experience; attractive rates of pay and prospects of promotion.—Reply to Ref. 124, Pye, Ltd., Personnel Dept., Cambridge. [4968

DEVELOPMENT draughtsmen required for interesting and varied work on aircraft components, associated with lighting equipment. Experience of moulding techniques and production methods essential. Progressive positions for applicants with initiative and drive. CONTRIBUTORY life assurance and pension fund. Canteen and welfare facilities. APPLY: Personnel Manager in writing (quote B.3845), Ferguson Radio Corporation, Ltd., Gt. Cambridge Rd., Enfield. [4914

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

McMICHAEL RADIO, Ltd., Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invitd to write fully to the Chief Engineer, Equipment Division. [0198

RADIO Development Engineer (Senior) required, fully experienced and able to work on own initiative. Excellent prospects with permanency. Pension scheme.—Masteradio, Ltd., Fitzroy Place, London, N.W.1. Tel. Eus. 2628. [4954

SENIOR Transformer Designer required to take charge of design office dealing with small transformers, power, audio, pulse, etc. Excellent prospects for an engineer with practical experience as well as academic knowledge. London area.—Box 3026. [4528

ENGINEER required, able to repair apparatus fitted with cathode ray tubes; to work in repair department; also service engineer, prepared to travel; the situations offered are at staff level, with pension scheme, summer holidays arranged.—Box 4892. [4935

SENIOR and junior design engineers required for high fidelity sound reproduction projects.—Applicants should give full details of qualifications and experience by letter to Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4917

DRAUGHTSMAN for modern toolroom, some knowledge press tool design preferred but not essential; write full details of experience, age, salary required, etc., or telephone for appointment.—Goodmans Industries, Ltd., Lancelot Rd., Wembley. Tel. Wembley 1200. [4858

METHODS engineer required for interesting progressive post in capacitor firm in S.W. London; previous capacitor experience not necessary but training to O.N.C. standard is desirable.—Please write giving details of experience, age and salary required to Box 4843. [0061

SALES.—Electrical Relay Manufacturers, members of large industrial group, wish to engage a really competent man to handle top level sales activities.—Write in first instance, stating full qualifications, to Managing Director, Besson & Robinson, Ltd., Harlow, Essex. [4832

ELECTRONIC Laboratory Assistant required for experimental work and electrical measurements; superannuation scheme; write, stating age, qualifications and/or experience and salary required to—Personnel Manager, The The Telegraph Condenser Co., Ltd., North Acton, W.3. [4724

ELECTRONICS: technical author for instruction books on electronics and radar subjects; sound practical and theoretical knowledge, and ability to write good English essential; author experience preferred, but engineers with suitable literary ability considered; London area.—Box 4589. [4867

A. H. HUNT (Capacitors), Ltd., require Draughtsmen, preferably with mechanical and electrical experience, for work on special purpose machines. Write giving age and previous experience to Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, S.W.18. [0057

TECHNICAL Publications.—Electronic Development Engineers, Senior and Junior, with a leaning towards Technical Writing to undertake the preparation of Instruction Manuals for Radar and like projects. A working knowledge of Pulse Circuitry and Microwave Techniques essential. SENIOR Illustrator required, with experience of preparation of circuits, block diagrams, perspective and exploded views.—Apply, giving full details of experience, age, etc., to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry.

TRANSFORMER Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply, stating age, qualifications and experience, to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [0260

PYE, Ltd. Radio Works, Cambridge, invites applications for positions as technical authors and illustrators for the compilance of maintenance handbooks dealing with radio equipment; applicants must possess command of English and some technical knowledge.—Applications in writing to Assistant Personnel Officer. [4704

SITUATIONS VACANT

AIR MINISTRY.—Technical Class (Grade III). The Civil Service Commissioners invite applications for a pensionable post at No. 248 Maintenance Unit, R.A.F., Chessington. Surrey. Duties include repair, calibration and modification of electronic apparatus used in R.A.F. hospitals.
AGE at least 25 on 1st July, 1955. Candidates must have served an apprenticeship, or have had industrial experience or Service training, in the electronic field; they must also have Intermediate Certificate of the City and Guilds Institute in Telecommunications Engineering or equivalent, or produce evidence of equivalent standard of technical education.
STARTING salary £530 (women £501) at age 25 to £590 (women £564) at age 28 or over; maximum £680 (women £611). Women's scales being improved under equal pay scheme. Promotion prospects.
PARTICULARS and application forms from Secretary, Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1, quoting S 4484/55. Completed application forms must be returned by 11th August, 1955. [4963

DESIGNER draughtsman required for radio factory in Southern Rhodesia, must be experienced in surface lay-out and mechanical design for commercial receivers, single man preferred; free air passage, salary £850 or in accordance with ability and experience.—Please reply to Box 4926. [4944

TECHNICAL authors, senior and junior, required for the preparation of maintenance handbooks and technical sales literature for television transmitting and receiving equipment; should have sound electronic background and be able to write in clear, concise English, accurate descriptions of complex equipment.
TELEVISION engineers with an interest in writing may also be considered for training in this work, salary commensurate with qualifications and experience, 5-day week, pension scheme in operation, canteen and sports facilities.—Apply Chief Engineer, Pye, Ltd., St. Andrew's Road, Cambridge. [4940

ASSISTANT engineers required for radio communication development work, good prospects for men with H.N.C. or equivalent, commencing salary according to age and experience.—Apply in writing, stating age, experience, etc., to Siemens Brothers & Co., Ltd., Ref. 744/20, Woolwich, S.E.18. [4945

INSPECTOR required to start new department for test and inspection of electronic equipment; adequate technical knowledge and ability to work with minimum supervision; excellent prospects for advancement in expanding company.—Rivlin Instruments, Ltd., 7a, Maitland Park Villas, London, N.W.3. Gul. 2960. [4970

MECHANICAL development engineer, with qualifications to at least ONC (Mech.) standard, required for work on radio and television receiver details; previous experience in light mechanical engineering desirable.—Apply, Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4967

ENGINEERS required for new and expanding research laboratory in the Surrey/Hampshire area, the work consistes of fundamental studies in a variety of branches of electronics; the posts offer scope for initiative, considerable freedom of action and opportunities for advancement Vacancies exist for the following posts:—
(1) One senior engineer to take charge of a group studying initially problems of microwaves.
(2) One senior engineer to take charge of a group engaged initially in a mathematical and experimental study of modulation.
APPLICANTS, who should be graduates or equivalent, should have had several years' experience in research or development work, although not necessarily in the field indicated above. Commencing salary, according to qualifications and experience, in the range £800 to £1,200.
(3) Four engineers to work in the above groups.
APPLICANTS should preferably possess a degree or H.N.C. and have had some experience in electronic development Commencing salary according to qualifications and experience, in the range £700 to £900.
(4) Four draughtsmen to work on the above projects.
(5) Three instrument makers to work on the above projects.
THESE positions are permanent and facilities are available for company insurance and superannuation. Please reply, in confidence, giving full details of qualifications and experience, to Box 4625. [4884

SENIOR and junior electrical and mechanical draughtsmen required for the electronics drawing office of the British Thomson-Houston Company, Blackbird Road, Leicester. Please apply in writing to Manager, Drawing Offices, British Thomson-Houston Company, Ltd., Rugby, giving details of age, experience, etc. [4889

AIRCRAFT radio aerials.—Gloster Aircraft Co., Ltd., Gloucester, have a vacancy for an electronic engineer (H.N.C. or equivalent) to work on the development of suppressed aerials for aircraft; the work involves theoretical and practical knowledge of measurements from "H.F." to "X" bands and of the properties of different types of suppressed aerials. A SMALL laboratory is being established for the work: an elementary knowledge of aircraft design and construction would be an advantage. —Applications, stating age, previous employers and experience, etc., should be addressed to the Employment Officer. [4533

FERRANTI LTD.

LONDON COMPUTER LABORATORY

The Company invites applications for important positions in a new and rapidly expanding DEVELOPMENT ESTABLISHMENT IN THE LONDON AREA from

ENGINEERING DESIGN DRAUGHTSMEN

(Mechanical and Electrical)

(age 25-40 for work on commercial and Government projects. The positions offer ample scope for initiative and eventual advancement to

ENGINEER STATUS

in the Engineering Design Group. The work is in the following fields:—

1. Process and Manufacturing Automatic Control Equipment, involving servo-mechanisms, gear systems, clutches, etc.
2. Experimental and Production Machines for automatic and semi-automatic circuit assembly.
3. Analogue and Digital Computers.
4. Computer Constructional techniques.
5. Magnetic Recording Equipment.
6. Digital Conversion Mechanisms.
7. Circuit Design and Layout Engineering.
8. Information Storage Mechanisms.

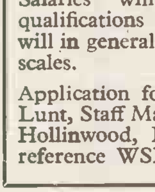
Desirable qualifications are possession of Higher or Ordinary National Certificate, or equivalent, some practical workshop experience and experience or interest in one or more of the above fields.

A staff Pension Scheme is in operation.

Salaries will depend on age, qualifications and experience but will in general be based on excellent scales.

Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote reference WSE/10/3.

MORSE CODE Training



COURSES for BEGINNERS and OPERATORS, also a SPECIAL COURSE for passing the G.P.O. Morse Test for securing an AMATEUR'S TRANSMITTING LICENCE.

Send for the Candler BOOK OF FACTS. *It gives details of all Courses.*

Fees are reasonable

Terms; Cash or Monthly Payments.

THE CANDLER SYSTEM CO.

(55W) 52b ABINGDON ROAD, LONDON, W.8

Candler System Co., Denver, Colorado, U.S.A.

SITUATIONS VACANT

DRAUGHTSMEN required for development of electronic equipment for M.o.S. and similar contract work. Applicants must have experience in this field. Permanent and progressive positions offered to enthusiastic men. Salary commensurate with qualifications demanded. Contributory life assurance and pension fund. Canteen and welfare facilities. APPLY in writing to: Personnel Manager (quote B.3846), Ferguson Radio Corporation, Ltd., Gt. Cambridge Rd., Enfield. [4913

DRAUGHTSMAN (junior) required for power capacitor work at New Addington, Surrey; permanent position and good prospects for suitable man; pension scheme.—Apply in writing stating age, experience and salary required to Personnel Officer, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, S.W.18. [0060

SALES engineer required by electrical components manufacturer; these components are being used by leading radio and television manufacturers, and experience in this field is desirable; H.N.C. or equivalent an advantage; the successful applicant will be based on London West End office, current driving licence necessary.—Apply Box 4838. [4923

ELECTRONIC engineer required for strain gauge department to assist in maintenance and development of equipment for the measurement of vibration and stress in helicopters and fixed-wing aircraft; applicants should be of degree standard and should write to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlesex, under reference R.D.T.

THE MULLARD RADIO VALVE CO., Ltd., has a number of vacancies for electrical engineers or physicists to undertake applied research work in the applications of transistors and kindred devices. The field offers opportunities for original work and at times requires considerable ingenuity. Further advanced studies and publication of results is encouraged. IT is intended that the posts will eventually carry considerable technical responsibility in an expanding organisation. For this reason, applicants should possess a good Honours degree and some previous experience or, alternatively, a real interest in electronics would be an advantage.
COMMENCING salary will be according to individual qualifications and experience and will provide progressive remuneration for increased responsibilities. Applications in writing, which will be treated in confidence, should be addressed to Mr. J. F. Gogarty, Personnel Officer, The Mullard Radio Valve Co., Ltd., New Rd., Mitcham Junction, Surrey, quoting reference H.1. [4844

SENIOR Electronic Engineer required for the development of a new project ancillary to the commercial use of large-scale electronic computers in the LEO project of J. Lyons & Co., Ltd. The starting salary will be in the range of £800 to £1,000 according to qualification and experience.—Write, giving full details, to Control Office, Cadby Hall, London, W.14. [4847

YOUNG men required for assembly, wiring and testing of electronic aparatus, some experience with scientific instruments an advantage, technical school education, must have completed National Service; pension scheme 5-day week, canteen; Camden Town district; salary according to age and experience.—Please apply, stating age and experience, to Box 3389. [4625

DEVELOPMENT engineers; a leading manufacturer of domestic radio and television equipment invites applications from qualified men with experience in this field for responsible positions in the laboratories.—Those interested should write, giving brief details of qualifications and experience, to the Personnel Manager (Ref. D.E.), Box 4594. [4872

TECHNICAL Sales Assistant with experience, preferably gained in the wholesale trade or as manufacturers' representative, of marketing radios, televisions, cinema equipment and allied items, is required by an old-established British company in Bangkok; good education and appearance, age 23-27.—Write, with full particulars of previous experience, to Box JN/132, c/o 95, Bishopsgate, London, E.C.2. [4933

ELECTRONIC/electrical engineer required by London manufacturers of radio components to take charge of measurements laboratory and test gear design, experience of measurements either capacitors, inductors or telecommunication cables an advantage; salary range £750 to £900; company rapidly expanding.—Write details of experience, qualifications, age and present salary Box 4568. [4861

MAINTENANCE technician required by the National Film Board of Canada for duty in sound recording studios in Ottawa and Montreal. Applicant must have had several years' experience in either Film Broadcasting or Recording studios and should be familiar with transmission testing of audio equipment. Salary $5,500 by yearly contract with air transportation paid.—Box 4998. [4978

AVO.—The manufacturers of Avo electrical and electronic instruments invite applications from young men having completed National Service, for a post of Assistant Technical Sales Engineer. Applicants must have Ordinary National Certificate, City and Guilds Radio II, or similar qualification, and will, in addition to other duties, be expected to take a special interest in data relating to receiving valves.—Applications to Mr. R. E. Hill, Acweeco, Ltd., Westminster, London, S.W.1, or Tel. Victoria 3404 [4951

MONEY BACK GUARANTEE **DUKE & CO**

621 ROMFORD ROAD, LONDON, E.12
CWO or COD • TEL: GRA 6677

TRANSFORMER SALE

MAINS POWER. 325-0-325, 500 m.a. 6v. heater @ 5 amp., 4 v. @ 5 amp., 4v. 5 amp. isolated. Extra isolated winding for 2v. or 4v. tubes. 29/6 plus 2/6 post.

MAINS E.H.T. 5Kv. and 2v. heaters, 200-250v. primary. 29/6 plus 2/6 post.

MAINS. 350-0-350v. 6v. and 5v. heaters 80 m.a. 200-250 Primary. 9/9 plus 2/3 post.

MAINS. 350-0-350v. 4v. and 4v. heaters 80 m.a. 200-250v. Primary. 3/9 plus 2/3 post.

MAINS. 350-0-350v. 12v. and 4v. heaters 80 m.a. 100-250 Primary. Ideal auto trans. 5/9 plus 2/3 post.

HEATER TRANS. 200-250v. primary either 4v. or 6v. 12/9 plus 1/9 post.

O.P. TRANS. 42-1 ratio. 2-5 ohms salvage guaranteed. 2/- plus 9d. post.

O.P. Salvage standard 2-5 ohms matching. 1/9 plus 9d. post.

CHOKES. 250 m.a. 5 Henrys salvage guaranteed. 10/9 plus 1/9.

CHOKES. 250 m.a. salvage guaranteed. 10/9 plus 1/9 post.

CHOKES 80 m.a. salvage guaranteed. 6/9 plus 1/9 post.

CHOKES. 60 m.a. salvage guaranteed. 4/9 plus 1/9 post.

COIL PACKS. 9/9. 3 band, including I.F.'s. Post 1/3.

T.V. TUBES 14" Wide Angle £8/10/-. 6 months' guarantee.

T.V. TUBES. 17" Wide Angle £12/10/-. 6 months' guarantee.

T.V. TUBES. 12" Round £5. Well-known make, 6 months' guarantee, other makes 3 months' guarantee All tubes are plus 15/6 ins. carr.

1124 VHF RECEIVER 17/6 complete with 6 valves. Ex W.D. good condition, 6 channel switching. Receives T.V. sound, police, fire and amateurs. 30.5 to 40 mc/s. I.F. 7 mc/s. Post 2/6. Drawing and conversion data free with each set.

1125 VHF RECEIVER. 7/9 complete with 2 valves. New and boxed. This receiver requires a little modification to put it into service.

R.F. UNIT 24. 12/6. New and packed Tuning 20-30 mc/s. Including 3 valves Post 2/-.

SPEAKERS. 10/9. 8", 6½", 5" or 3½" unrepeatable offer. Std. P.M. 2-5 ohms +1/9 post with O.P. 13/9.

SPEAKERS. 2/9. 8" M.E. Field 1K., 2K. and 5K ohms or with O.P. Trans. 4/9 plus 1/9 post.

RADIO-GRAM CHASSIS. 29/9 including L. Speaker. 5 valve s/het., 3 w/band, A.C. mains complete, less valves. All used, tested, guaranteed. FREE drawings with orders. Post 4/6. Knobs (set of four) 1/6 extra.

RADIO CHASSIS. 7/9. A.C. or universal, s/het receivers, less valves, dial and electrolitics. Otherwise believed to be in working order. NOTE: Our 8" M.E. speaker fits some of these sets. We match on request with order. P. & P. 3/6.

RADIO CHASSIS. 14/9. As above with three band coil packs. 465 I.F.s. All used bargains. P. & P. 3/6.
2½d. stamp only for complete catalogue.

ELECTRONIC ENGINEERS

The British Tabulating Machine Co., Ltd., Letchworth, Herts, manufacturers of "HOLLERITH" high-speed punched card accounting and statistical machinery, offer excellent prospects to men wishing to find employment on the application of Electronics to CALCULATING and COMPUTING MACHINES.

This is an expanding and progressive organisation, employing over 5,000 personnel under congenial working conditions.

Qualifications required include a University Degree in Electrical Engineering, Physics or Mathematics, Higher National Certificate or equivalent.

Salaries will be commensurate with experience and qualifications. Housing assistance may be given. Pension Fund. Write giving personal history to the Personnel Superintendent, quoting Ref. WW/19.

LOCKWOOD

makers of

Fine Cabinets

and woodwork of every description for the Radio and allied trades

LOCKWOOD & COMPANY

Lowland Rd., Harrow, Middlesex. Byron 3704

RADIO & TELEVISION COMPONENTS

WE OPERATE A PROMPT & EFFICIENT MAIL ORDER SERVICE

"VIEW MASTER"&"TELE-KING" specialists

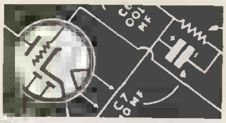
Easy terms available. Stamp (only) for lists

JAMES H. MARTIN & CO.,
FINSTHWAITE NEWBY BRIDGE, ULVERSTON, LANCS.

SERVICE SHEETS

One you require in dozen assorted.

10/6



RADIO **BULLS** VALVES

246 HIGH ST. HARLESDEN

Physicists and Electronic Engineers are required for the Chemical & Metallurgical Division of the Plessey Co. Ltd. Attractive posts are available for junior and senior grades in new, well equipped and expanding Physics and Electronics Laboratories.

Applicants should be interested in the development and application of semiconductors, electrical ceramics, magnetic materials or electrolytic capacitors.

Positions offered are permanent and pensionable and offer considerable scope for creative work. Salaries will be generous and commensurate with qualifications and experience. Write in confidence to the Technical Manager, The Plessey Co. Ltd., Towcester, Northants.

SITUATIONS VACANT

ENGINEERS required for climatic testing of components and complete equipments. Work involves electrical testing measurement. Commercial or Services experience of electrical or telecommunications equipments desirable. Possession of H.N.C. or O.N.C. an advantage.—Reply, in writing, stating age, qualifications and experience, to The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [4878

A SENIOR mechanical designer is required by a Midlands manufacturer engaged in the complete engineering and production of a variety of electronic products.—First-class men with experience of design work in the light engineering field are invited to write, giving brief details of career and qualifications, to the Personnel Manager (Ref. S.M.D.), Box 4595. [4871

ELECTRONIC Engineer with good knowledge of H.F. measurements and interference suppression required for work in connection with measurement of radio and television interference; superannuation scheme; write giving full details of age, qualifications, experience and salary required to—Personnel Manager, The Telegraph Condenser Co., Ltd., North Acton, W.3. [4722

TECHNICAL Representative required for the Northern Counties by Advance Components, Ltd., Marlowe Rd., Walthamstow, London, E.17. Applicants must have comprehensive knowledge of electronic test equipment, previous commercial and selling experiences and be willing to reside on the territory (car provided).—Apply, in strict confidence, giving full personal history, to Mr. J. H. Head, General Manager. [4846

DRAUGHTSMAN for interesting work in expanding new division of the company where knowledge of mechanical engineering and workshop experience will be an asset. Some design qualifications preferred but not essential. Write full details of experience, age, salary required, etc., or telephone for appointment.—Goodmans Industries, Ltd., Lancelot Rd., Wembley. Tel. Wembley 1200. [4857

EX-SERVICE radar and radio technicians are invited to apply for posts as test engineers for work on radar and other electronic products of a large Midland manufacturing organization; further training will be given where necessary; 5-day week; excellent prospects.—Apply, giving details of experience to date, to the Personnel Manager (Ref. E.S.R.), Box 4592. [4870

THERE is a great future for qualified radio, television and electronic engineers; this is YOUR opportunity to train for a well-paid career; E.M.I. Institutes offer a 3-year course in telecommunications engineering commencing September 14th; on successful completion employment is assured.—Full details from E.M.I. Institutes, Dept. WW38, 10, Pembridge Square, London, W.2. [4971

JUNIOR Electronic Engineers/Radio Mechanics wanted for installation, maintenance and operation small radio transmitting stations in U.K. and abroad; candidates must have good basic training in radio and some industrial experience; must be single and medically fit and prepared to travel abroad; excellent prospects; U.K. salary up to £500 after training and very much more abroad —Write Box 4017.

BANGKOK.—Eastern merchants require salesman for well-known makes of radio, also electrical equipment. Good technical background essential, knowledge stock-keeping an advantage. Age about 25; bachelor; annual increments; cost-of-living allowance; provident fund; pension scheme; free accommodation and passage.—Write Box 1428, c/o Abbotts, Eastcheap, London, E.C.3. [4948

TV and radio chief of test; progressive position offered in a North London factory for a man with experience of production testing TV and radio sets; qualifications to include C. & G. Telecom. III or equivalent, substantial practical experience and established ability to control staff; experience of test equipment design or maintenance desirable; substantial salary and prospects of promotion. REPLY to Ref. 246 Pye, Ltd., Personnel Dept., Cambridge. [4969

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

STEWARTS AND LLOYDS, Ltd., have vacancies in their iron and steel works at Corby, Northamptonshire, for maintenance instrument mechanics, where the town, with modern housing, is rapidly expanding and prospects of obtaining a house are good; full instrument apprenticeship or five years' experience maintenance electrical or mechanical instruments essential.—Apply to Labour Service Officer, Stewarts and Lloyds, Ltd., Corby. [4835

RADAR and Telecomms.—Service engineers required by British firm in Aden. Applicants should have at least 5 years' experience in marine radio and radar servicing and preferably some V.H.F. experience. Ex-technical officers and senior N.C.O.s from H.M. Forces are particularly invited to apply. Free accommodation, medical attention and first-class passages for wife and family. Commencing salary is dependent upon qualifications and experience but would not be less than £1,000 per annum. Pension scheme.—Apply in writing, stating nationality, personal details, education and experience, to Box 4473. [4841

SENIOR ENGINEERS

are required by

THE ENGLISH ELECTRIC CO., LTD., at LUTON,

to devise equipment and/or direct activities to investigate the effects of vibration and other environmental conditions on Guided Weapons.

Experience in this field is unnecessary but applicants should possess a Degree or H.N.C. and preferably have had some experience in the Electronic Industry. Housing assistance can be given if required.

Please write stating age, qualifications and experience to **Dept. C.P.S., 336/7 Strand, W.C.2,**

Quoting Ref. 1000G.

"The Chemical & Metallurgical Division" of the Plessey Co. Ltd. is engaged in the development of interesting new products for the electronics, radio and T.V. industries.

Physicists and Electronic Engineers are required for development, applications and instrumentation work on semiconductors, electrical ceramics, magnetic materials or electrolytic capacitors.

Attractive posts are available for junior and senior grades in new, well equipped and expanding Physics and Electronics Laboratories.

Positions offered are permanent and pensionable and offer considerable scope for advancement. Salaries will be generous and commensurate with qualifications and experience.

Write in confidence to the Technical Manager, The Plessey Co. Ltd., Towcester, Northants.

The Plessey Company Ltd.

Vacancies exist in new, well equipped and expanding laboratories of the Chemical & Metallurgical Division for junior and senior Physicists and Electronic Engineers with progressive ideas. Experience in any of the following fields an advantage.

- Magnetic measurements
- Acoustics
- Piezoelectricity
- Design of electronic apparatus
- Radio interference suppression
- Design of electromagnetic devices.

Positions offered are permanent and pensionable and offer considerable scope for advancement. Salaries will be generous and commensurate with qualifications and experience.

Write in confidence to the Technical Manager, The Plessey Co. Ltd., Towcester, Northants.

ELECTRONIC ENGINEERS

are required by

THE ENGLISH ELECTRIC CO., LTD.,

to fill vacancies in the Company's Laboratories at

LUTON and STEVENAGE

1. **SENIOR MICROWAVE ENGINEER**—Applicant should have a good theoretical background to degree standard and experience of design or engineering of microwave equipment. The work includes investigation of new methoas of construction with a view to miniaturisation and weight reduction.

2. **SENIOR ENGINEER**—to lead a group of engineers in the development of specialised electronic test gear.

3. **SENIOR ENGINEER**—for work on general circuit development, with sound fundamental knowledge of electronics and the ability to apply it.

4. **SENIOR INSTRUMENTATION ENGINEERS**—with a degree or H.N.C. and experience of the design of equipment for use in the instrumentation field.

5. **SENIOR RADAR AND ELECTRONIC ENGINEERS**—for development and field and flight experiments of radar equipment. Degree or H.N.C. standard preferred but applicants without these qualifications but with a wide experience of this work considered.

6. **SENIOR ENGINEER**—for missile telemetry installation planning. Applicants must be familiar with existing telemetry systems and measuring techniques, suitable to a man with trials experience.

7. **JUNIOR ENGINEERS AND LABORATORY ASSISTANTS**—are required to assist in the above work. Vacancies also exist for Junior Staff with experience of, or an interest in Microwaves.

Housing assistance may be given in some cases.

All the above posts are permanent and progressive and pensionable after qualifying period, attractive salaries are offered to the successful applicants. Applications to Dept. C.P.S., 336/7, Strand, W.C.2.

Quoting Ref. 1260E.

SITUATIONS VACANT

HIGH-DEFINITION FILMS invite applications by television development engineers of degree standard for a number of posts in the interesting new field of electronic film making; applicants, who must have had television experience, will be paid a salary in the range £500-£1,200 according to qualifications and experience.—Apply Chief Development Engineer. High-Definition Films. Ltd., 98, Highbury New Park, London, N.5. [4907

A. T. & E. (BRIDGNORTH), Ltd., Bridgnorth, Shropshire (subsidiary of Automatic Telephone & Electric Co., Ltd.) engaged in the development and manufacture of radio communications equipment require a qualified engineer to specialise in transistor applications. Salary according to experience and qualifications. Company superannuation scheme; 5-day week.—Apply with full details to Chief Engineer at Bridgnorth. [4888

SENIOR checker required for drawing office staff of approximately 20. Duties to include checking of commercial and M.o.S. contract drawings of electronic equipment. Excellent opportunity for the older man. Contributory life assurance and pension fund. 5-day week. Canteen and welfare facilities.—Apply in writing: Personnel Manager (quote B.3847), Ferguson Radio Corporation, Ltd., Gt. Cambridge Rd., Enfield. [4915

THE BRITISH THOMSON-HOUSTON Co., Ltd., has a vacancy in its research laboratory at Rugby for a qualified electrical engineer or physicist for work on radio interference problems; the work covers investigation of the mechanism, measurement and suppression of radio interference over a wide and interesting range of sources; applicants should write to The Director of Research, British Thomson-Houston Co., Ltd., giving their age and qualifications, and quoting the reference RIS. [4693

SENIOR and junior design draughtsmen reqd. for interesting work in connection with electronic equipment, commercial radio and television and/or light electro-mechanical engineering; London area; the positions vacant offer ample scope and opportunity for future advancement to men of good ability; a high salary will be paid to the selected candidates; all recognized staff privileges available.—Please reply, giving full details of experience, to Box 4293. [4772

MAINS RADIO have vacancies in their development department for men with good knowledge of radio and television circuits and their practical application; the work will include the design and construction of radio and television receivers and test gear and should prove very interesting to those with a flair for experimentation; good salary, progressive staff positions.—Please apply to the Personnel Manager, Mains Radio Gramophones, Ltd., 359, Manchester Rd., Bradford, 5. [4925

RADIO and television service manager required, 10 miles from Manchester; main agencies; applicant must have had similar previous experience and be able to take complete control, engaging his own staff when necessary; permanent post with prospect of directorship in private company; salary £800 per annum rising to £1,000. No accommodation provided; successful applicant will be expected to purchase own house in district.—Apply, in confidence, to Box No. 4985. [4962

PHILIPS HAMILTON WORKS, Ltd., have vacancies for electrical laboratory technicians of at least ordinary National Certificate or equivalent City & Guild (telecommunications) standard; the work consists of the construction, calibration and maintenance of electronic test gear as used in the field of light current engineering.—Applications stating age, qualifications and experience to the Personnel Manager, Philips Hamilton Works, Ltd., Wellhall Road, Hamilton, Lanarkshire. [4943

SALES correspondent required by The Telegraph Condenser Co., Ltd., North Acton, W.3. Applicants must be experienced in conducting semi-technical correspondence, submitting quotations and generally dealing with customers. Knowledge of electrical/radio industry an advantage but not essential. Superannuation scheme up to 55 years of age. —Write, giving full details of experience, age and salary required, to Personnel Manager, T.C.C., Ltd., North Acton, W.3. [4887

APPLICATIONS are invited from senior project engineers with a specialised knowledge of the manufacture of electrical and mechanical products; applicants should have a good practical engineering background and a sound technical experience of tool design and planning and be capable of putting new projects on a sound production basis; these vacancies offer excellent opportunities to men seeking permanent and progressive positions; London area.—Applications, which will be treated in confidence, should give full details of experience and salary required and be addressed to Box 4395. [4927

AIR MINISTRY requires scientific officer (male) at R.A.F. Station near Maidenhead, Berks. for operational research duties, theoretical studies and development work in the field of communications and general electronics. Qualifications: First or Second Class Honours degree in physics or electrical engineering, or equivalent. Salary: Within range, £467 10s. to £845. Post unestablished with possibilities of establishment through the Civil Service Commission for successful candidate whilst remaining under age 31. Opportunities for promotion to higher grade posts on staff of Scientific Adviser to Air Ministry. Application forms, quoting A113/5A, from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1. [4840

Good Investments

PRECISION TEMPERATURE CONTROL OVENS. 230 volts 50 cycles for Quartz Crystals. Will give stability with suitable crystals of better than two parts in one-million. Fitted precision thermostat and thermometer. Temperature adjustable 40/60 degrees cent. £9/10/-, crg. 5/-.
R.C.A. WAVEMETER type T.E.149. New surplus, 200 kc/s to 30 Mc s, accuracy guaranteed 0.005%. In original case with spares, instruction book, crystal and charts.
FREQUENCY METER. B.C.221, as new. accuracy guaranteed 0.005%. Battery Model with charts and crystal; range 120 kc/s to 20 Mc/s.
NIFE BATTERIES. Long life alkaline cells 12 volts 45 a.h. in wood crate, £12/10/-, crg. 10/-. Single 1.2 volt 45 a.h. cells 30/-, post 2/-. Write for particulars.
RESISTANCES. Double slate formers wound graded resistance wire, in vent. metal case, geared movement and hand wheel, F.O.B. mounting 72 ohms 1.5 to 4 amps. 85/-, crg. 3/6. 160 ohms 0.6 to 10 amps. £8/10/-, crg. 15/-.
POWER REGULATORS, 56 ohms 5 amps. protected type, double slate sliders on channel irons with I/C switchfuse and Ammeter 0-10 amps. fitted, £5/10/-, crg. 15/-. Write for special list.

Leslie Dixon & Co.

Dept. A, 214 Queenstown Road, London, S.W.8

Telephone : MACaulay 2159

VACANCIES IN GOVERNMENT SERVICE AT CHELTENHAM

1. Instrument Makers with fitting and machine shop experience in light engineering.
2. Radio and Electronic Mechanics and Assembler Testers with experience of telecommunications equipment.

BASIC PAY
£7/18/10 plus merit pay up to £2/10/-, assessed at interview, based on ability and experience.
Opportunities for permanent and pensionable posts.
Apply to: Personnel Officer, G.C.H.Q. (Foreign Office), 53, Clarence Street, Cheltenham.

VACANCIES FOR SKILLED CRAFTSMEN IN GOVERNMENT DEPARTMENT AT CHELTENHAM

Applicants required with experience of:—
(a) Maintenance and Installation of Teleprinters, Auto-transmitters, Perforators, Re-perforators
or experienced in
(b) Cabling, Wiring, Distribution frames, Jack fields
or a knowledge of
(c) Long distance radio communication systems, Line telegraph systems (e.g. V.F.) Multiplex and five-unit telegraph code.

BASIC PAY: £7/18/10 plus merit pay up to £2/10/-, assessed at interview, based on ability and experience. Opportunities for permanent and pensionable posts.

5-day week—good working conditions—single accommodation available.
Apply to: Personnel Officer, G.C.H.Q. (Foreign Office), 53 Clarence Street, Cheltenham.

SITUATIONS VACANT

MURPHY RADIO have a vacancy for a radar mechanic for liaison work with the Services in connection with navigational aids; applicants should have experience in maintenance and testing of both ground and airborne equipment of this type; the work will be based on Welwyn, but will involve travelling to sites where equipment is to be installed and used.—Apply in writing to Personnel Department (RM), Murphy Radio, Ltd., Welwyn Garden City, Herts. [4877

APPLICATIONS are invited for position of post design services officer; the work includes the supervision of drawing and other information on airborne radio and radar equipment, also technical liaison with the Services and aircraft manufacturers; a retiring R.A.F. signals officer would be suitable.—Applicants should write giving details of career to date and salary expected to Personnel Department (PDS), Murphy Radio, Ltd., Welwyn Garden City, Herts. [4876

SCIENTIFIC Information. A research laboratory on the outskirts of London is setting up a section for the collection of information on a wide variety of subjects. Applications are required from Graduates in Science (physics and mathematics for this post, which offers great scope for the man or woman in charge of the work.) Housing accommodation could be made available to the successful applicant.—Write Box W.U2099, A.K Advg., 212a, Shaftesbury Ave., London, W.C.2. [4852

RADAR, television and radio testers; practical men with a sound basic knowledge of electronics and preferably some experience in one of the above categories are required by the test department of a leading Midlands manufacturer; the work is of considerable interest and offers scope for technical advancement; ex-Service technicians are particularly suitable.—Applicants should write, giving details of experience, to the Personnel Manager (Ref. R.T.R.), Box 4591. [4869

DESIGNER (25-55 years) required by old-established firm of electrical component manufacturers in N.W. London. Applicants must possess sound knowledge of radio frequency circuits, pulse forming networks and experience in the electronic, radio and/or television industry would be an advantage. Superannuation scheme. Write, stating age, experience and salary required, to Personnel Manager, Box 3M S4590, A.K. Advg., 212a, Shaftesbury Ave., W.C.2. [4665

ASSISTANT chief engineer required by the Electronics Division of a well-known radio company in the Home Counties; excellent prospects exist for a first-class man with an up-to-date knowledge of electronic equipment design, in particular radio communication and radar systems, and the ability to plan and organise research and development work in these fields.—Applications, which should give full details of experience, qualifications, age and salary expected, are invited to Box 380, 6, Aldford St., London, W.1. [4966

RADIO engineer/administrator (age 49) in radio and electronics for the whole of his working life, seeks executive appointment with a company of standing where experience is important. A wide radio engineering experience including design and development organization and administration, production methods, government and inspection procedures and close liaison with Ministry departments is offered for a permanent post with a salary in the region of £1,000 per annum.—Please write Box 4436. [4900

DESIGNER draughtsman required for interesting development work on the design of small electro-mechanical mechanisms for use in switches, thermostats and similar devices; salary up to £825 per annum according to experience and qualifications; contributory pension scheme, canteen, holiday arrangements honoured with pay.—Write, call or telephone for an appointment to Chief Draughtsman, "Diamond H" Switches, Ltd., Gunnersbury Ave., W.4. Chiswick 6444. [4874

TECHNICAL Liaison Officers. A leading electronics company has vacancies in London for senior and junior staff to participate in the development and marketing of radar equipment, computing devices and industrial electronic apparatus. Salary range £600-£1,000 per annum. Applicants should have technical qualifications, preferably to degree standard, and should have experience in dealing with Government establishments or senior staff in industry. The company is expanding rapidly in the electronics field and offers progressive careers and excellent staff conditions to capable men.—Applications, in writing, stating age, experience and salary desired, should be addressed to Box No. 4541. [4850

LABORATORY technicians required for development work in connection with an interesting range of electronic equipment, including communications, computors, transistors, and measuring and test apparatus. Applicants should have, as a minimum, the Ordinary National Certificate or appropriate C. and G. Certificates, and in addition, several years experience in the manner of operation construction and testing of electronic or other light current equipment. Applicants with shorter experience but in possession of Higher National Certificates in radio or other light current subjects will be considered; these posts carry attractive salaries and conditions of employment including Pension and Life Assurance Scheme. 5-day week.—Apply, Mr. G. A. Taylor, Personnel Officer, Mullard Research Laboratories, Cross Oak Lane, Salfords, near Redhill, Surrey. [4733

COUNTY BOROUGH OF BOLTON EDUCATION COMMITTEE
BOLTON TECHNICAL COLLEGE

Full-time Course in Electronic Engineering

A three-year, full-time course in Electronic Engineering is now available. Candidates should be in the age range of 16 to 18, and have taken, or be taking, General Certificate courses at the Ordinary level in Mathematics or Physics, or equivalent courses in technical institutions.

This rapidly developing industry offers new and attractive openings to qualified men.

The next course commences September, 1955. Early application for entry is desirable. Further particulars from the Principal, Technical College, Manchester Rd., Bolton.

Education Offices,
Nelson Square,
Bolton.

W. T. SELLEY,
Chief Education Officer

FERRANTI LTD.
LONDON COMPUTER LABORATORY
RADIO MECHANICS AND WIREMEN

are urgently required for interesting work on the development and assembly of prototype Electronic Computers and Allied Equipment.

Good rates of pay and excellent working conditions. Lunch voucher scheme. Write for application form to 21, Portland Place, London, W.1.

THE POLYTECHNIC

309 REGENT STREET, W.1

ELECTRICAL ENGINEERING DEPARTMENT

Head of Department: D. O. Bishop, Ph.D., M.I.E.E.

FULL-TIME DAY COURSES are provided in Electrical and Telecommunications Engineering. The courses, which extend over a period of three to four years, prepare for the Higher National Diploma and professional examinations and for the B.Sc. (Eng.) Degree of the University of London.

Session 1955-1956 begins on September, 20th, 1955.

EVENING COURSES in the above subjects and also in Radio and Television Service Work commence on Monday, 26th September. The courses prepare for the Ordinary and Higher National Certificates and for the City and Guilds of London Institute examinations. New students will be enrolled on 21st September, 5-8 p.m.

Prospectuses may be obtained on application to the undersigned.

J. C. JONES,
Director of Education.

HOUSING AVAILABLE

Assistant Sales Manager for progressive manufacturer of Scientific Instruments and Electro-mechanical Equipment required in the Hertfordshire area. Sales experience essential. Technical qualifications H.N.C. Pension scheme. Send details of age and past experience to Box No. 4545.

MARCONI'S WIRELESS TELEGRAPH CO. LIMITED, invite applications from MECHANICAL DESIGNERS and DRAUGHTSMEN with experience in the Electronics field.

Permanent, pensionable and progressive careers are available to suitable applicants both at Chelmsford and London.

Social and Athletic Club.

Modern Canteen.

Write, stating age, experience, qualifications and salary required, to Dept. C.P.S., 336/7, Strand, W.C.2., quoting Ref. 142M.

MARINE Radar and Communication equipment. Marconi's Wireless Telegraph Company Limited, Chelmsford, have vacancies in their Development laboratories for both Junior and Senior Engineers and Physicists for interesting work in the above field. The appointments are permanent and pensionable and offer excellent prospects for promotion in this world famous organisation. Please apply, quoting ref. no. 2140A, to Dept. C.P.S., 336/7 Strand, W.C.2.

ELECTRONIC ENGINEERS
Marconi's Wireless Telegraph Company Limited, Chelmsford

are expanding their activities in the field of black, white and colour television.

There are openings for both Junior and Senior Engineers and Physicists for work in connection with the development of cameras, transmitters, telecine and associated equipment.

These appointments offer excellent opportunities for promotion to suitable applicants. Please apply, quoting Ref. 2220B to Dept. C.P.S., 336/7, Strand, W.C.2.

SITUATIONS VACANT

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radiotelegraphy; selected candidates will be considered later for permanent pensionable posts.—Application should be made to The Inspector of Wireless Telegraphy, Radio and Accommodation Department, Wireless Telegraph Section, Union House, St. Martins le Grand, London, E.C.1. [4635

HONOURS graduate in Physics or Electrical Engineering is required to work in a laboratory engaged in research and development on frequency control problems relating to communication systems. The position, which is in the South of England, is open to men and women and affords excellent opportunities for detailed study of the theoretical and practical aspects of the subjects. Living accommodation, for single or married persons, could be made available.—Write Box W.U2141, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [4853

PHYSICISTS and Electrical Engineers are required for advanced work in a research laboratory on the outskirts of London dealing with ultrasonic vibrations in elastic media. Men or women applying for the posts must have an Honours Degree, and preferably should have studied mathematics to a post-graduate stage. The work involved is of great interest, and ready promotion is available to the person having the necessary ability. Housing accommodation could be made available to the successful applicant.—Write Box W.U2113, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [4851

HONOURS graduates in Physics or Electrical Engineering are required for advanced work in a Quartz Crystal Laboratory situated in the South of England. The positions offered afford excellent opportunities for men and women to specialize in the study of piezoelectric materials from both the theoretical and practical viewpoints. An interest in mathematics and electronics would be an advantage for this work. Living accommodation, for single or married persons, could be made available.—Write Box W.U2127, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [4854

STANDARD TELEPHONES & CABLES, Ltd., North Woolwich, London, E.16, require engineer to work on the development of a wide variety of high frequency and audio testing equipment in a telecommunications laboratory associated with the design of telephone and television cables. The laboratory is small but very well equipped with ready access to all the facilities of a large organisation. Applicants should be of University Degree standard and some electronic experience is desirable.—Write, stating age, qualifications and salary required, to Personnel Manager. [4837

LECTURER required at School of Electronics (Ministry of Supply), Malvern, Worcs, to teach electronics and mathematics to Higher National Certificate standard. Candidates should hold a University degree or equivalent qualification and preferably have had some teaching and industrial experience. Salary payable in accordance with Burnham Scale—£965×£25—£1,065. The appointment is subject to the Teachers' Superannuation Acts.—Details and forms from Principal, to whom completed forms must be returned by 8th August, 1955. [4965

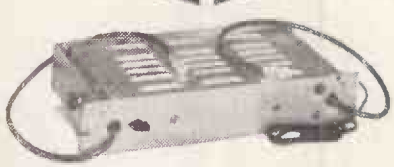
B.B.C. invites applications for post in Recording Section of Engineering Designs Department; University degree or equivalent in electrical engineering essential, experience in audio frequency electronics and design of light mechanisms desirable; work is largely on own initiative in carrying out investigations and development work in connection with various methods of sound recording; salary, according to qualifications and experience, within range £725 to £1,280.—Requests for application forms to Engineering Establishment Officer, Broadcasting House, London, W.1, quoting reference E.210./W.W. [4908

FERRANTI, Ltd., Edinburgh, have a vacancy for an Electronic Engineer in the capacity of a Technical Author to prepare technical, operational and maintenance publications; applicants should have qualifications to degree standard; technical authors join the design engineers, participate in field trials and assist with service introduction in order that they may have a full understanding of the design and operational use of the system on which they are preparing a publication, irrespective of whether this system is ground, airborne, or seaborne. Authors are responsible for the entire publication, ensuring that the appropriate illustrations, artists' impressions and line drawings are prepared.

APPLICATIONS, quoting Ref. 59/TA/TID, should be addressed to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5.

D.S.I.R. require assistant experimental officer at Radio Research Station, Datchett, Berks, for abstracting scientific and technical articles on radio research and development; quals. in Physics or Electrical Eng.. Min.: G.C.E. (Advanced Level) in two scientific subjects, or equiv. Candidates over 22 expected to have pass degree, H.N.C. or equiv. Some knowledge and experience radio research and development necessary, ability to read technical French and German an advantage; 45½-hour week; men £297 (age 18)-£659; women, £297 (age 18)-£570 p.a., subject to improvement under equal pay scheme.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting A 114/5A. [4964

TELENG



WIDE BAND CHAIN AMPLIFIER

MARK III

40–220 mc/s

Gain 20 db ± 2 db over Bands I and3 or ± 0.5 db over any single T/V channel. 75 ohm unbalanced in and out. Output up to 1.1 volt R.M.S.

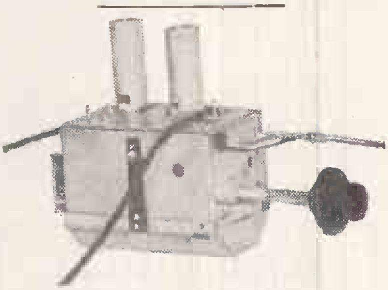
Also

WIDE BAND LINE REPEATERS

Type 2

40—70 mc/s (Band I)

Gain 33 db ± 0.5 db 75 ohm in and out. Input circuit specially designed to maintain load characteristic through band. Indoor and outdoor models available.



TURRET TYPE TUNERS

12 CHANNEL, T/V

(in quantity production)

STD I.F. OR MODELS FOR conversion of receivers with 13 to 19 mc/s I.F.

H.F. INDICATOR METER TYPE 2

20 mv–2.5 v. in 3 ranges. 3 to 300 mc/s. Small probe. Shunt C at R.F. only 1.5 pf. Stabilised Valve Bridge Circuit. A sensitive R.F. transfer indicator for lab. or test bay.

CO-AXIAL CABLE TEE-ING UNITS, EQUALISERS, ETC.

Telefusion (Engineering) Ltd.
Teleng Works, Church Road, Harold Wood, Romford, Essex.
Ingrebourne 2901

SITUATIONS VACANT

ELECTRICAL/electronic draughtsman for London, W.1, with current experience preparing circuit and wiring diagrams for electronics equipments; able produce finished work suitable for handbook illustrations from rough circuit layouts.—Box 4590. [4868

RADIO & ALLIED INDUSTRIES, Ltd., have an immediate vacancy for a senior development engineer; excellent prospects and opportunity for advancement.—The Personnel Manager, Radio & Allied Industries, Ltd., Hirwaun Industrial Estate, Aberdare, Glam. [4875

ELECTRONIC engineers are wanted in large Midland engineering plant, the positions are progressive and interesting requiring qualified and experienced electronic engineers, senior and junior for rapidly expanding laboratory engaged upon measurement and control problems.—State age, qualifications and experience fully, in confidence to Box 3686. [4678

CIVILIAN Instructors (male), Grade III. in the trades of air radio fitter, air and ground radar fitter, air and ground wireless fitter, and instrument fitter, required by Air Ministry in provinces. Appointments temporary but good prospects of becoming pensionable. Trade training, practical experience and ability to teach are essential. Pay £535 at 26 rising to £665.—Apply to Air Ministry, S.5(g), (CIV 9), Cornwall House, Waterloo Rd., London, S.E.1. [4860

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

B.B.C. requires men (British, minimum age 20) in engineering operations and maintenance department at transmitters, studios and television centres throughout U.K.; must have completed National Service; degree in electrical engineering or physics. H.N.C. in electrical engineering, C. & G. Final Certificate in telecommunications, or success in examination for Graduateship for I.E.E. or Graduateship with maths. of Brit. I.R.E. essential. Experience in radio or telecommunications desirable; promotion prospects; starting salary £620 p.a., rising by 5 annual increments to £830; appointments permanent and pensionable subject to 2 years' probation; requests for application forms to—Engineering Establishment Officer, Broadcasting House, London, W.1, quoting reference EX.42. W.W. [4865

AERONAUTICAL OPPORTUNITIES

A well-known firm in the aircraft industry is starting a new project in a London Office. It is anxious to recruit staff to form an Assessment Group. Vacancies with unusual opportunities for rapid promotion exist to meet the following approximate requirements:—

Assessment Group

GROUP LEADER — Age 30/37, or Science Engineering degree standard, experienced in aircraft, or G.W. project or assessment groups, with knowledge of performance and servo-mechanism problems and analysis of flight and laboratory tests. Personality is important.

SECTION LEADERS — Ages 27/35, Science or Engineering degree standard, general experience as for Group Leader but to a lesser extent.

Staff to fill these sections, with various capabilities from Computing to Honours degree in Science or Engineering.

The age groups specified are given for guidance only and need not deter candidates outside these limits.

Monthly staff appointments carry a compulsory Pension Scheme and Weekly staff a voluntary Superannuation scheme Write in confidence, giving full details of age, previous experience, qualifications held, etc., to: Box No. A.C. 08412, Samson Clarks, 57/61, Mortimer St., London, W.1.

SITUATIONS VACANT

SENIOR methods engineer required by a large and progressive engineering company situated in the London area; applications are invited from men with good engineering qualifications and experience in the manufacture of radio, television and services equipment; the accepted candidate will have extensive experience of this class of work and will be acquainted with the most up-to-date production methods, including work study and standard costs; for a man with the required knowledge, initiative and drive this vacancy provides excellent prospects; salary range from £800 to £1,500 per annum.—Please reply, in confidence, giving full details of previous experience to Box 4333. [4928

MINISTRY OF SUPPLY requires Engineer in London to help plan production and progress wide range Army radar, signals equipment, associated liaison work. Qualifications: British of British parents. Recognized engineering apprenticeship or equivalent in electronics, and A.M.I.C.E. or Mech.E. or E.E. or exempting qualifications. Sound knowledge electronic equipment and experience modern production methods essential. Experience radar equipment, servo-mechanisms or any centimetric wavelength work advantageous. Salary: Within £675 (age 25)—£1,035. Not established but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D 267/5A. [4855

MINISTRY OF SUPPLY requires Engineers at an R.A.F. station in Buckinghamshire for investigation of problems connected with pulse type radio navigational aid systems (ref. D 268/5A), or installation design of radio telegraph telephone terminal offices and/or major receiving and transmitting stations in world-wide system (ref. D 269/5A). Qualifications: British of British parents. Recognized engineering apprenticeship and A.M.I.C.E. or Mech.E. or E.E. or exempting qualifications. Sound knowledge and experience pulse techniques used in radio nav. aids, or of modern telegraph telephone techniques used in radio circuits and/or of modern long-distance radio equipment including aerials. Salary: Within £645 (age 25)—£995. Not established but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting appropriate references. [4856

SITUATIONS WANTED

MANS seeks post teaching radio at evening classes (London).—Box 4435. [4830

MAN seeks post as assistant to domestic radio receiver designer.—Box 6020. [4879

RESEARCH engineer, long and wide experience in radio and radar fields, shortly available for work in South London or South Coast area.—Box 4588. [4863

EXPERIENCED electronic and electro-medical development prototype wireman fitter seeks position Southern England.—219, Handside, Welwyn Garden City. [4959

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. WW.47, London, W.4.

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

COVENTRY TECHNICAL COLLEGE.

SESSION 1955-56.
ELECTRONIC engineering.
APPLICATIONS invited for entry to next three-year full-time course commencing September, 1955, from those requiring comprehensive training to an advanced level in electronic engineering, qualifying for technical posts in radio, telecommunications, television and industrial electronics. Syllabus will cover requirements of City and Guilds, Brit.I.R.E., and I.E.E. examinations. Entry age 16 or over. APPLICATION forms and further information from Principal, Coventry Technical College.

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. [0172

WIRELESS operating; attendance and postal courses.—Stamp for reply to Manager, The Wireless School, Manor Gdns., London, N.7.

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

The "BANDIT" IS the Answer to BAND III

Send for Lists

TELECRAFT LTD.

Quadrant Works, Wortley Rd. West Croydon, Surrey

THOrnton Heath 1191-2-3

TUITION

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.

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. 387A), 29, Wright's Lane, London, W.8. [0116

THE Institute of Practical Radio Engineers have available home study courses in every phase of radio and television engineering, specialising in the practical training of apprentices in the retail trade, enrolments limited, fees moderate.—The Syllabus of Instructional Text may be obtained post free from the Secretary, I.P.R.E., Fairfield House, 20, Fairfield Rd., Crouch End, London, N.8. [0088

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 organisation; moderate fees.—Write to E.M.I. Institutes, Dept. WW28, London, W.4.

WIRELESS telegraphy.—Merchant Navy offers to youths 16 upwards after qualification, lucrative positions as radio officers.—Apply British School of Telegraphy, 179, Clapham Rd., S.W.9. (Est. 1906). Recognised by Ministry of Education, moderate fees, modern equipment, day and evening tuition; also postal courses in theory of wireless telegraphy for P.M.G. Certs. and Amateur Transmitting Licence. [0124

BOOKS, INSTRUCTIONS, ETC.

I.P.R.E. technical publications, 5,500 Alignment Peaks for Superheterodynes, 5/9, post free, data for constructing TV aerial strength meter, 7/6, sample copy "The Practical Radio Engineer," quarterly publication of the Institute 2/-; membership and examination data, 1/-.—Sec., I.P.R.E., 20, Fairfield Rd., London, N.8.

BOOKS WANTED

WANTED: "Wireless World," Feb., 1943; "Wireless Engineer," March, 1954.—Price to Head of Electrical Dept., Rutherford College of Technology, Newcastle-upon-Tyne. [4924

A. V. ROE & CO., LTD.

have the following vacancies in their

WEAPONS RESEARCH DIVISION

at

WOODFORD

TECHNICIANS

For design and development work in a guided weapon project. At least 3 years' experience in electronics or H.N.C. is necessary.

JUNIOR AND SENIOR DRAUGHTSMEN

For design work in precision instrumentation. At least 3 years' experience in design precision engineering or H.N.C. is necessary.

GOOD SALARIES AND PROSPECTS

PENSIONS AND LIFE ASSURANCE SCHEME

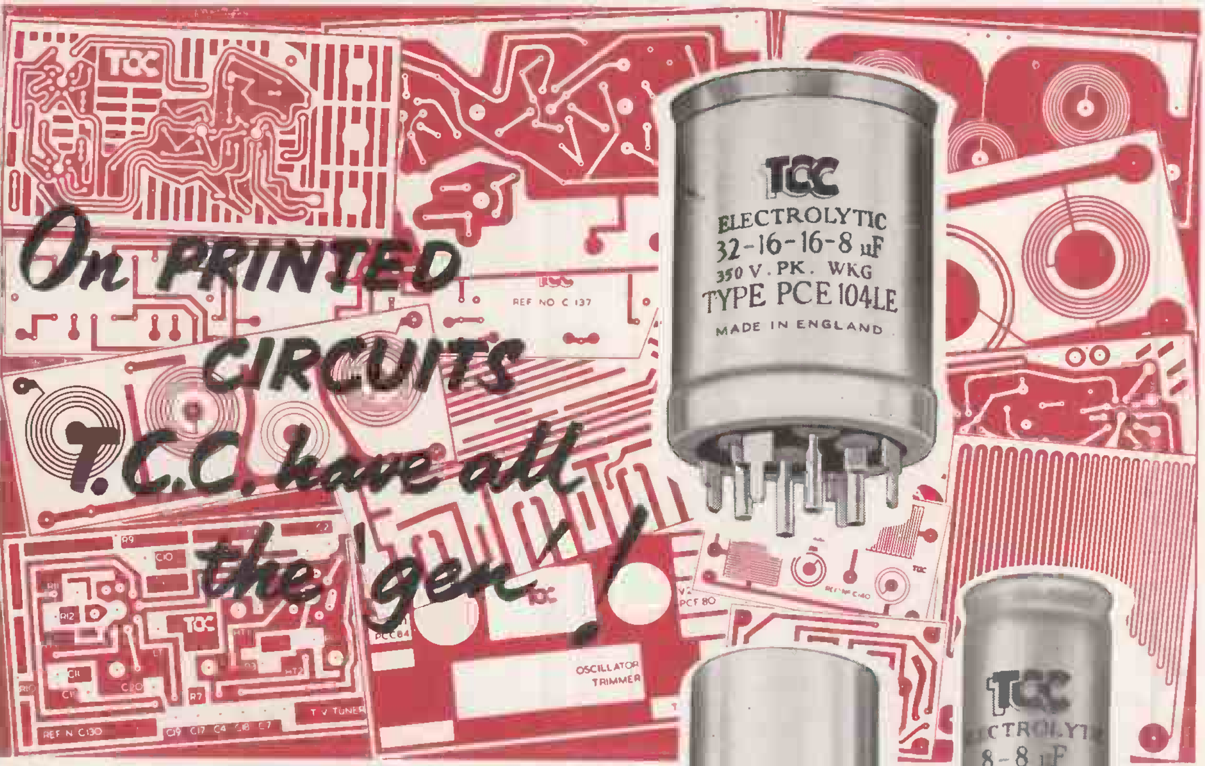
Application giving full particulars of age, qualifications and experience to be addressed to:

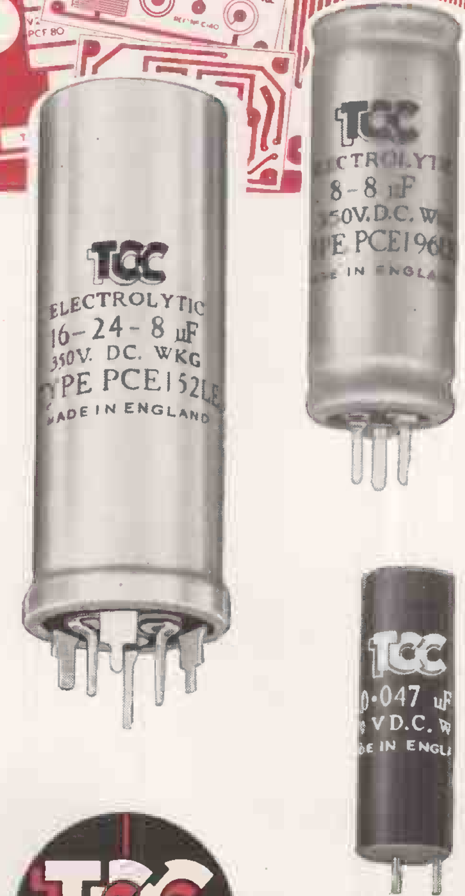
A. V. ROE & CO. LTD., WEAPONS RESEARCH DIVISION, WOODFORD, CHESHIRE.

INDEX TO ADVERTISERS

	PAGE
A.A. Tools	164
Acoustical Mfg. Co., Ltd.	24
Acru Electric Tool Mfg. Co., Ltd., The	136
Adcola Products, Ltd.	44
A.D.S. Relays, Ltd.	112
Advance Components, Ltd.	19
Airmec, Ltd.	9
Allen Components, Ltd.	71
Alpha Radio Supply Co., The	127
Altham Radio Co.	138
Ambassador Radio & Television	83
Amplex Appliances (Kent), Ltd.	130
Anders Electronics, Ltd.	81
Antex	78
Antiference, Ltd.	53
Appointments Vacant 124, 138, 139, 141, 142, 143, 144, 146, 148, 150, 161, 162, 165, 166, 167, 168, 169, 170,	171
Arcolectric Switches, Ltd.	66
Ardente Acoustic Laboratory, Ltd.	76, 81
Ariel Sound, Ltd.	110
Armstrong Wireless & Television Co., Ltd.	60, 153
Ashworth, H.	56
Associated Broadcasting Co., Ltd.	67
Associated Rediffusion, Ltd.	67
Automatic Coil Winder & Electrical Equipment Co., Ltd., The	1
Automatic Telephone & Electrical Co., Ltd.	28
Autoset (Production), Ltd.	78
Avionics, Ltd.	154
Beamish, V. W.	156
Bel Sound Products, Ltd.	108
Bell, John, & Croyden	132
Belling & Lee, Ltd.	93
Benson, W. A.	154
Bentley Acoustic Corporation, Ltd.	82
Berry's (Short Wave), Ltd.	112
Birmingham Sound Reproducers, Ltd.	88
B. K. Partners, Ltd.	109
Bradmatic, Ltd.	80
Britain, Chas. (Radio), Ltd.	134
British Broadcasting Co., Ltd.	82
British Communications Corpn., Ltd.	17
British Distributing Co.	156
British Institute of Engineering Technology	156, 160
British Insulated Callender's Cables, Ltd.	Cover ii
British National Radio School	150
British Physical Laboratories	12
British Sarazol, Ltd.	150
Brookes Crystals, Ltd.	72
Brown, S. G., Ltd.	74
Bulgin, A. F., & Co., Ltd.	Edit. 403
Bull, J., & Sons	166
Bullers, Ltd.	111
Candler System Co.	165
Cape Electrophonics, Ltd.	158
Cathodeon Crystals, Ltd.	31
Cementation (Muffelite), Ltd.	62
Chaffey Cabinet Co.	158
Champion Products	154
Chapman, C. T. (Reproducers), Ltd.	157
CinemaTelevision, Ltd.	11
City Sale & Exchange, Ltd.	140
Classic Electrical Co., Ltd.	74
Clyne Radio, Ltd.	120, 121
Cosmocord, Ltd.	92
Cossor, A. C., Ltd.	96
Coventry Radio	160
Croydon Transformers, Ltd.	162
Daly (Condensers), Ltd.	48
Davies, A., & Co.	160
Davis, Jack (Relays), Ltd.	145
Demant, W.	170
Denco (Clacton), Ltd.	70
Dependable Radio Supplies	155
Direct T.V. Replacements	136
Dixon, L., & Co.	168
Donohoe (Timers)	158
Duke & Co.	169
Dulci Co., Ltd., The	158
Duode Natural Reproducers	159
Easco Electrical (Holdings), Ltd.	164
Edison Swan Electric Co., Ltd.	14, 47, 99
Egen Electric, Ltd.	56
E.K.E.	162
Electrical Instrument Repair Service, The	162
Electrical Instruments (H'ton), Ltd.	145
Electro-Acoustic Developments	163
Electro-Acoustics Industries, Ltd.	45
Electro-Methods, Ltd.	16, 18
Electro-Winds, Ltd.	136
Electronic Precision Equipment	104, 105, 106, 107
Ellison Transformers, Ltd.	110
E.M.I. Institutes	51, 94, 97, 102
English Electric Valve Co., Ltd.	13
Enthoven Solders, Ltd.	22
E.W.A.	138
Excel Sound Services	136
Ferranti, Ltd.	15
Fisher Electronics Co., Ltd.	61
Foyle, W. & G., Ltd.	130
Fringevision, Ltd.	144
Frith Radiocraft, Ltd.	158
Furzehill Laboratories, Ltd.	75
Galpins	153
Gardners Radio, Ltd.	71
Garrard Engineering & Mfg. Co., Ltd.	32
Gee Bros., Radio, Ltd.	126
General Electric Co., Ltd.	37
Gilson, R. F.	163
Glaser, L., & Co.	164
Glover, W. T., & Co., Ltd.	62
Goodmans Industries, Ltd.	38, 39, 46
Goodsell, Ltd.	110
Gray, Arthur, Ltd.	144
Grayshaw Instruments, Ltd.	108
Grundig (Gt. Britain), Ltd.	108
Hall Electric, Ltd.	64
Ham's Shop, The	149
Hanney, L. F.	142
Harris, P.	152
Hartley, H. A., Co., Ltd.	52
Harvey Electronics, Ltd.	140
Hatfield Radio	147
Heath Spring & Notion Co., Ltd.	78
Henley's, W. T., Telegraph Works Co., Ltd.	161
Henry's (Radio), Ltd.	131
Hivac, Ltd.	69, 76
Homelab Instruments, Ltd.	147
H.P. Radio Services, Ltd.	145
Hunt, A. H. (Capacitors), Ltd.	10
Hunton, Ltd.	109, 130
Iliffe Books	74, 87
Industrial Electronics	83
International Correspondence Schools	112
Jackson Bros. (London), Ltd.	72
Jason Motor & Electronic Co.	148
Kaye Electrical Mfg. Co.	134
Kelly Laboratories, Ltd.	126
Kempner, S., Ltd.	158
Kenroy, Ltd.	154
Keyswitch Co., The	126
Kolectric, Ltd.	76
Koskie, B.	132
Labgear (Cambridge), Ltd.	66
Lafco Compounds, Ltd.	152
Lancaster High-Fidelity	134
Lasky's Radio	122, 123
Leak, H., & Co., Ltd.	103
Leevers-Rich Equipment, Ltd.	145
Legal Finance Co., Ltd.	142
Lewis Radio Co.	152
Light Soldering Developments, Ltd.	148
Lockwood & Co.	165
Lowther Mfg. Co.	75
L. R. Supply Co., Ltd.	109
Lyons, Claude, Ltd.	80
Lyons Radio, Ltd.	171
Magnetic Coatings, Ltd.	54
Magnetic Devices, Ltd.	2
Mail Order Supply Co.	65
Malvyn Eng. Co.	162
Marconi Instruments, Ltd.	49
Marconi's Wireless Telegraph Co., Ltd.	95, 98
Marks, C., & Co. (Newport, Mon), Ltd.	124
Martin, J. H.	165
McMurdo Instruments Co., Ltd.	50
Metropolitan-Vickers Elec. Co., Ltd.	29
Midland Instruments Co.	112
Minnesota Mining & Manufacturing Co., Ltd.	36
Modern Book Co.	158
Modern Electrics, Ltd.	82
Modern Techniques	147
Morris, H.	160
M.R. Supplies, Ltd.	74
Mullard, Ltd.	3, 21, 30, 90
Multicore Solders, Ltd.	Cover iv
Multitone Electric Co., Ltd.	52
Murex, Ltd.	69
Northern Radio Services	25
Nu-Swift, Ltd.	162
Oddie, Bradbury & Cull, Ltd.	160
Osmor Radio Products, Ltd.	42
Oxley Developments Co., Ltd.	152
Painton & Co., Ltd.	35
Parker, A. B.	136
Parsonage, W. F., & Co., Ltd.	164
Partridge Transformers, Ltd.	151
P.C.A. Radio	81
Pearce, T. W.	159
Philips Electrical, Ltd.	70
Plasticable, Ltd.	128
Post Radio Supplies	160
Power Controls, Ltd.	6
Premier Radio Co.	84, 85, 86, 87
Proops Bros., Ltd.	129
Pye, Ltd.	26, 27, 34, 57
Pye, W. G., Ltd.	43
Quartz Crystal Co., Ltd.	156
Radio & Electrical Mart, The	146
Radio & TV Components (Acton), Ltd.	125
Radio Component Specialists	135
Radio Corporation of America	33, 41
Radio Kits, Inc.	154
Radio Resistor Co., Ltd., The	8
Radio Servicing Co.	113
Radio Supply Co. (Leeds), Ltd.	118, 119
Radio Traders, Ltd.	128
Radiospares, Ltd.	164
Reproducers & Amplifiers, Ltd.	55
Robinson, F. C., & Partners, Ltd.	140
Rogers Development Co.	73
Rola Celestion, Ltd.	7
Rollet, H., & Co., Ltd.	160
Salford Electrical Instruments, Ltd.	73
Sallis, A. T.	158
Samsons Surplus Stores	144
Savage Transformers, Ltd.	155
Sherman's Supply Co.	167
Sifam Electrical Instruments Co., Ltd.	60
Simmonds, L. E., Ltd.	147
Simon Sound Service, Ltd.	113
Sky-masts	172
Smith, G. W. (Radio), Ltd.	133
Smith, H. L., & Co. Ltd.	162
Sound Sales, Ltd.	102
Southern Radio Supply, Ltd.	158
Specialist Switches	156
Specto, Ltd.	137
Spencer-West	164
Standard Telephones & Cables, Ltd.	20, 91, 100
Stanley Sound & Vision Products, Ltd.	132
Star Metal Plate Works	128
Steatite & Porcelain Products, Ltd.	40
Stern Radio, Ltd.	114, 115, 116, 117
Stevenage Relays, Ltd.	110
Stewart Transformers, Ltd.	149
Stratton & Co., Ltd.	68
Suflex, Ltd.	23
Sugden, A. R., & Co. (Engineers), Ltd.	54
Supacoils	159
Superior Radio Supplies	79
Super-Vision, Ltd.	142
Sutton Coldfield Electrical Engineers	170
Tannoy Products, Ltd.	170
Tektronix Inc.	4
Telecraft, Ltd.	170
Telefusion (Engineering), Ltd.	169
Telegraph Condenser Co., Ltd.	Cover iii
Telegraph Construction & Maintenance Co., Ltd.	50
Tele-Radio (1943), Ltd.	161
Teletron Co., The	167
Trianon-Electric, Ltd.	42, 72
Trix Electrical Co., Ltd.	Edit. 401
T.R.S.	130
Truvox, Ltd.	48
Unitelex (London), Ltd.	77
Universal Book Co.	162
Universal Electrical Instruments Corpn.	132
Universal Electronics	79
Valradio, Ltd.	149
Venner Accumulators, Ltd.	44
Verdik Sales, Ltd.	160
V.E.S. Wholesale Services, Ltd.	126
Vitavox, Ltd.	46
Vortexion, Ltd.	101
Walmore Electronics, Ltd.	124
Watts, Cecil E.	164
Wayne Kerr Laboratories, Ltd., The	63
Webber, R. A., Ltd.	138
Webb's Radio	164
Weir Electrical Co.	128
West-End Radio, Ltd.	154
Westinghouse Brake & Signal Co., Ltd.	68
Weymouth Radio Mfg. Co., Ltd., The	80
Wharfedale Wireless Works	58, 111, 134
Wharton Instruments, Ltd.	140
Whitaker, H.	148
White, S. S., Co. of Gt. Britain, Ltd., The	59
Wilkinson, L.	157
Willesden Transformer Co., Ltd.	64
Wilson, Ronald	162
Wolf Electric Tools, Ltd.	77
Wright & Weaire, Ltd.	5
Young, C. H.	146
Z. & I. Aero Services, Ltd.	149

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.


On PRINTED CIRCUITS T.C.C. have all the 'gen'!
TCC
ELECTROLYTIC
32-16-16-8 µF
350 V. PK. WKG
TYPE PCE 104LE
MADE IN ENGLAND
OSCILLATOR TRIMMER
T V TUNER


TCC
ELECTROLYTIC
16-24-8 µF
350V. DC. WKG
MADE IN ENGLAND
TCC
8-8 µF