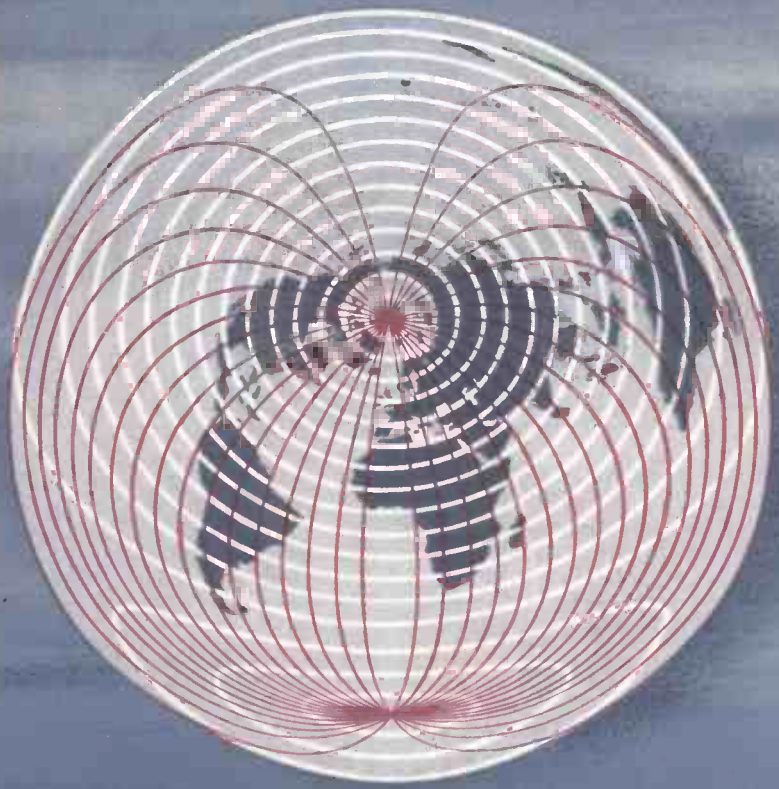
JANUARY 1955 TWO SHILLINGS

Wireless World

Radio · Electronics · Television



FORTY-FOURTH YEAR OF PUBLICATION

This low frequency oscillator costs only £75

(Bench stands 1 gn. extra)

This reasonably-priced low frequency oscillator is extensively used in the aircraft industry and elsewhere as a convenient source of signals down to 1.15 c.p.s. for the testing and calibration of vibration recorders, servo systems etc. It is also widely used in medical research and clinical work for the calibration of biological amplifiers and recorders, and low frequency wave analysers.

Brief Specification:

TYPE	FREQUENCY RANGE	OUTPUT	INPUT	CONSTRUCTION
Resistance capacity, with automatic amplitude control effective over the whole frequency range.	1.15 c.p.s. to 5,500 c.p.s.	Sine wave 50 volts peak to peak push-pull, with built-in attenuator.	200-250 volts, 40-60 c.p.s.	Standard 19" rack mounting, but also suitable for bench use. Bench stands available.

NOTES. An incremental switch is fitted. Provision is made for mixing other signals with the output.

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Wireless World

RADIO, TELEVISION, ELECTRONICS

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JANUARY 1955

In This Issue

VOLUME 61 NO. 1
PRICE: TWO SHILLINGS

FORTY-FOURTH YEAR OF PUBLICATION

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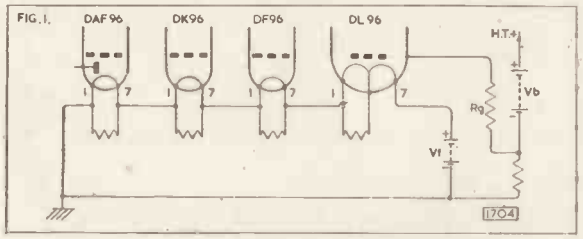
VALVES, TUBES & CIRCUITS

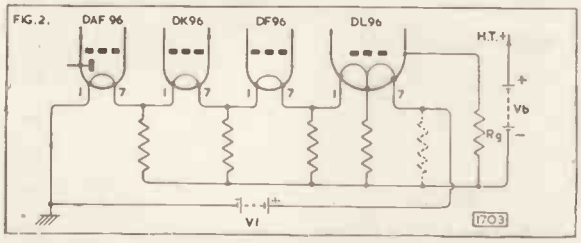
25. DAF96, DK96, DF96 and DL96, in ABC Receivers

The design of 25mA filament chains for ABC receivers is governed by the need to provide satisfactory conditions for the output valve. With the simple series chain of shunted filaments given in Fig. 1, the DL96 bias is derived mainly from the voltage drop across the other filaments. It is, therefore, highly dependent



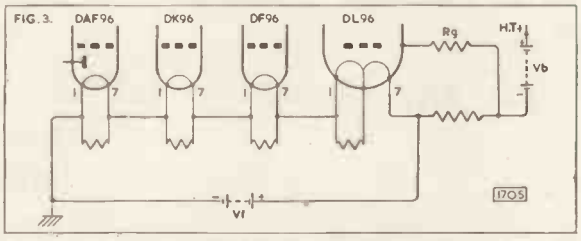
on the l.t. voltage. When the h.t. and l.t. batteries are new, the bias is about 3 x 1.5V = 4.5V, and the h.t. is 90V. Satisfactory operation will continue until the l.t. battery voltage has fallen to 1.1V per cell, when the bias will be 3.3V and the h.t. may be about 65V. If the l.t. battery is renewed at this stage, the bias will increase and the output will be reduced to a very low value. If, instead, the h.t. battery is renewed, the high h.t. voltage and low bias will produce an excessive cathode current in the DL96. Tests in a receiver have shown extremes of 1.5mA and 5.0mA for the DL96 cathode current under these varied battery conditions. Separately renewable h.t. and l.t. batteries can thus be used only if the DL96 bias does not include the voltage drop across the other valves.

This is achieved if the DL96 is placed at the earthy



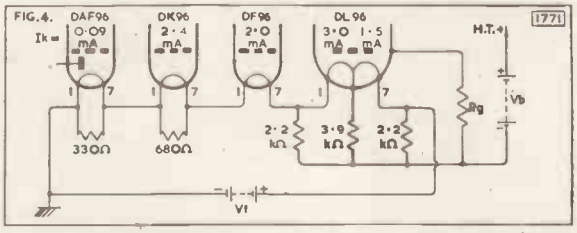
end of the filament chain, with bias taken solely from a resistor in the h.t. negative lead. But three difficulties arise: AGC provision is complicated; decoupling of the filaments will be difficult if the DAF96 is at the positive end of the chain; and, if the DL96 is the next valve in the chain to the DAF96, its filaments may act as a common cathode resistance —producing multivibrator action.

If the h.t. and l.t. negative lines are separated (Fig. 2) the DL96 cathode current is held, in a typical receiver, between 2.4mA and 5.0mA; but dependence on AGC is increased. (One resistor in Fig. 2 is shown



dotted, as it has a high value and it does not greatly affect the operation of the circuit).

High stability (3.0mA to 5.0mA) is achieved with the circuit shown in Fig. 3. There are two additional advantages: the DL96 cathode current falls as the l.t. voltage falls; and valves may be added to the chain without increasing the cathode current variation. But there are two disadvantages: the h.t. current flows through the l.t. battery and increases its consumption by about 30%; and the bias resistor



has to produce the required bias plus 2 x 1.4V, therefore it must be a high-value close-tolerance component.

Similar stability, with the extra battery drain reduced from 30% to 12%, is given by the recommended circuit (Fig. 4), which provides satisfactory DL96 conditions at the cost of this smaller increase in l.t. battery consumption. This cost is adequately compensated by the ability of the circuit to work down to low voltages. Practical resistor values, for typical cathode currents, are shown in Fig. 4. Notes on the calculation of resistor values will be included in the reprint of this advertisement. Details of the requirements for mains operation have appeared in the *Additional Notes* to advertisement No. 23 in this series.

Reprints of "Valves, Tubes, and Circuits" (with Additional Notes) are obtainable without charge from the address below.

Wireless World

JANUARY 1955 VOL. 61 No. 1

A New Master?

IT must have sounded revolutionary to suggest, as we did last month, that the time had at last come to relieve the Post Office of some of its powers of control over radio. The present system has survived without basic change for over 50 years; we all tend to be conservative in these matters; the more surprising, therefore, that hardly any real objection has been raised against our proposals. Indeed, most of the criticisms have urged something more drastic, in some cases going so far as to say *all* executive and administrative power should be transferred to an independent body. Anyway, it seems clear that none of the radio interests are fully satisfied with the present position. Dissatisfaction has also been expressed in the House of Commons, where C. Ian Orr-Ewing said it would be wise to try to take the responsibility of frequency allocations from the Post Office and leave it to an independent body.

What kind of body should replace the G.P.O. as the controlling authority? When this kind of question crops up the Federal Communications Commission of the U.S.A. always comes to mind, and we have spent some time studying its history and constitution. The F.C.C. is "an independent Federal establishment" responsible to Congress. It is administered by seven Commissioners appointed by the President. Commissioners hold office normally for seven years. Not more than four Commissioners may be members of the same political party.

What does the F.C.C. do? Roughly, it exercises all the licensing and controlling functions over radio that come under the G.P.O. in this country. In addition, it regulates internal and external wire communications, but does not license U.S. Government stations. Frequency allocations for these are made by an inter-departmental committee with which the F.C.C., however, works in close collaboration. Technical functions of the F.C.C. include the maintenance of a laboratory dealing with such things as studying propagation and investigating interference; the operation of over 20 monitoring stations, the holding of technical examinations for operators and the inspection of stations. Administrative functions include the regulation of telegraph and telephone charges and the assumption of at least some responsibility for the content of broadcast programmes.

For the year 1951 (the latest for which a report is available) the F.C.C. was run by a total staff of 1,205 persons. The number of transmitters licensed numbered 425,000. For all this the cost was $6,600,000, which does not seem high, allowing for the vast size of the country and the large number of stations. It should also be remembered that much of the work of the F.C.C. is brought about by the intensely competitive nature of American radio. Taking everything into account, a safe guess is that a "B.C.C." would be far less costly than its American prototype.

Can the F.C.C. model be fitted with a right-hand drive for use in this country? We can see no insuperable difficulties, though we must admit some of the organizational problems involved are rather outside our province. For instance, which of the Ministers would replace the Postmaster-General in assuming responsibility in Parliament for radio matters? Not, we should hope, the head of any of those Ministries which are large users—and, it is to be feared, often prodigal users—of radio channels.

In the interest of economy the sale of broadcast receiving licences, the tracking-down of "pirates" and the investigation of interference with broadcast reception should remain in the hands of the Post Office. Such tasks as the allocation of channels and licensing of stations, monitoring, inspection and the examination and licensing of operators should be transferred to the new controlling body.

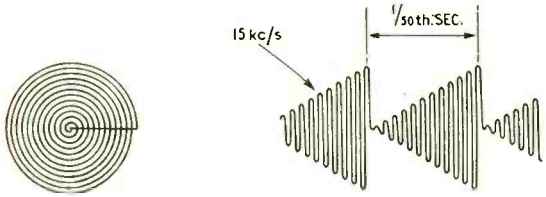
All but the most fervent of revolutionaries are apt to have some doubts when a sweeping change is proposed. Is it worth while passing over from the known to the unknown? Our thoughts go back to a talk with an American visitor a year or two ago. After we had explained in some detail the way British radio was controlled, he said, "I see; near enough, then, F.C.C. is American for G.P.O." To make a change for the sake of a new set of initial letters would indeed be foolish, but there are in fact real differences. The G.P.O. is both an interested party and it is tied up with politics.

SPIRAL SCANNING

Simple Method for Industrial Television Equipment

WHEN F. P. Hughes conducted his public search in the pages of *Wireless World* for the Simplest Possible Scan* he started with a point, proceeded to a line and ended with a Lissajous figure generated by two slightly different frequencies. With the wisdom that comes after the event one can now see that he missed out what is perhaps the simplest possible Lissajous figure—the circle. This has the advantage that the two sine waves applied to the *x* and *y* deflection systems of the c.r. tube are of the same frequency, although displaced 90° in phase. It is then only necessary to linearly modulate the amplitude of these two waves to produce a series of circles of increasing diameter which will completely fill in the tube face—in short, a spiral.

The spiral scan, of course, is not exactly new and



Form of the spiral scan is shown at (a) while (b) is the waveform used to produce it

has been used in oscillography for a good many years, but it is to the credit of the French firm Laboratoires Derveaux that they have successfully adapted it to television purposes. A description of the industrial television equipment they have developed on this principle is given in *Toute la Radio* for November, 1954. The scanning waveform, shown at (b) of the diagram, is a 15-kc/s sine wave modulated with a 50-c/s sawtooth (to produce the variation in circle diameter). One such signal is applied to the horizontal deflector coils of the camera tube and receiving c.r. tube and another one, 90° displaced in phase, to the vertical deflector coils. Each "tooth" of the sawtooth waveform contains 300 cycles of the 15-kc/s sine wave, so this means that one complete sweep of the spiral, from the centre of the tube to the outside, involves 300 revolutions of the spot. If the tube face is bisected by an imaginary line this gives the equivalent of 600 lines in a conventional raster.

Of course, the two components of the scanning waveform have to be kept in very strict phase and frequency relationship, so the 50-c/s sawtooth is produced by frequency dividing from the 15-kc/s source. Brightness modulation is applied to the receiving c.r. tube in the normal way. In addition it is necessary to apply a brightness correction waveform (of sawtooth form) to compensate for the fact that the spot has a lower "tracking" speed in the centre and the trace is consequently brighter there than at the outside of the spiral.

This variation in the speed of the spot, as it describes circles of increasing circumference, brings up an interesting point about definition. In the centre of the picture, where information is scanned and transmitted at low speed, the bandwidth required for the system is considerably less than at the outside, where the picture information is being scanned at high speed. In practice, using a fixed and limited bandwidth, this means that the definition will be higher in the centre than at the outside. However, Laboratoires Derveaux say that this is actually an advantage because the centre of interest of a television picture is generally in the centre of the tube.

In its utilization of time for the transmission of picture information the system is very efficient. Very little time is wasted on flyback (only one per "frame" instead of several hundreds) and none at all on transmitting sync pulses. The only synchronization that is necessary is to keep the transmitter and receiver 15-kc/s sine waves (which are derived from the same source) in correct phase relationship with each other. This adjustment is done by a simple phase-shifting network. Incorrect phasing merely results in the received picture being turned round out of the horizontal. Another incidental advantage of having no sync pulses is that if an r.f. carrier is used for transmission it can be modulated completely by the picture waveform.

The circular shape of the complete picture makes it unsuitable for domestic television, but this does not matter so much in industrial television. In fact it might be considered something of an advantage, in so far as it gives better utilization of lenses, pick-up tubes and cathode ray tubes, most of which are circular in form.

* "Why Lines?" by F. P. Hughes. *Wireless World*, August 1954.

STYLI BY THE MILLION

Mass Production of Sapphire Points

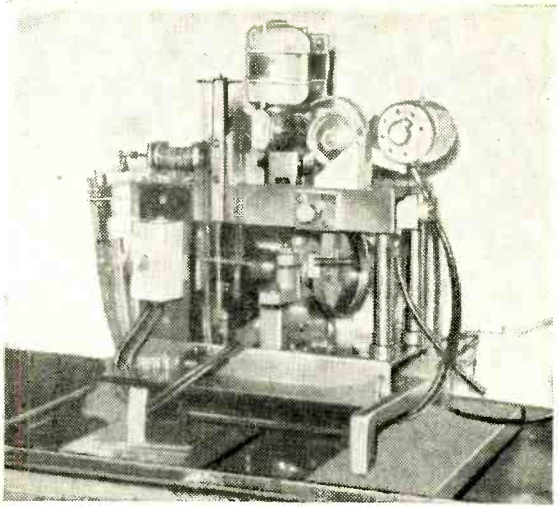
FOR a gramophone pickup stylus to function satisfactorily it must be shaped to close limits to conform with the groove section of the particular type of record with which it is to be used. The first sapphire styli were produced by the same basic techniques as those used by precious stone cutters, which accounted for their high price.

To meet the enormously increased demand and at the same time to bring down prices, Sapphire Bearings, Ltd., in collaboration with the Union Carbide Corporation of America, have developed radically new manufacturing methods in which quality is maintained, but costs are much reduced.

The slicing of the synthetic sapphire "boule" and the production of the "rondel" or cylindrical shank follow normal practice, but the formation of the conical point is carried out on a centreless grinder of

Left : Untouched photo-micrograph of stylus tip (standard finish).

Right : Diamond-wheel point grinding machine used in the production of "Windsor" sapphire styli.



special design in which a sintered diamond grinding wheel revolving at 22,000 r.p.m. takes the place of the more usual lap, which must be continually re-dressed with diamond powder by skilled operatives.

After the formation of the cone, which is taken right up to a sharp point, the styli are subjected to a "tumbling" process in batches of 10,000 to 20,000 in a diamond powder medium. Details of this process are not disclosed, but the result is a symmetrical spherical point which will pass the closest examination.

Inspection probably accounts for the major part of the cost of these styli, and every one is examined for flaws and to check that its dimensions fall within prescribed limits. Binocular microscopes of the latest design and projection shadowgraphs are used for this purpose. A further inspection is made after the styli have been mounted in their shanks or pickup movements (some of the leading pickup manufacturers entrust this work to the stylus makers).

The surface finish of the sapphire after "tumbling" is of a high order and satisfies all ordinary requirements. An even higher polish can be obtained by fusion of the surface in an oxy-acetylene flame, and this "super" finish may be expected to give a correspondingly lower surface noise on records whose grooves are in mint condition.

Both standard and flame-polished types of stylus are available under the trade name of "Windsor" and cost 2s 6d and 5s 6d each respectively.

In a new factory to be opened next year it is expected that production will be at the rate of 20 million a year.

Commercial Literature

Radar Plotting Aid; the "Locatorgraph." An illustrated booklet explaining how it can be used in various ways, with worked examples, available from Marconi Marine, Chelmsford, Essex, price 4s 6d.

Solderless Connections; a system involving many different types of crimped wire terminations, with special tools for attaching them, described in an illustrated brochure from Aircraft-Marine Products, 2100 Paxton Street, Harrisburg, Pa., U.S.A.

Spring Alloy for high-temperature working (up to about 800° C), impervious to rust and corrosion. Leaflet giving the properties of Nimonic 90 from Henry Wiggin & Company, Wiggin Street, Birmingham, 16.

Tape Recording Accessories; foot switch for dictating; telephone pick-up device (attached by suction cup); stethoscope earphones; single-earpiece headphones; a small crystal set mounted on a jack for reception of radio programmes. Leaflets from Truvox, 15 Lyon Road, Harrow, Middlesex.

Low-voltage Stabilizer, with a range of 1-15V d.c. and 0-25A. Regulation: a load current of 2.5A causes a voltage drop not exceeding 5mV. Stability: a ±10 per cent mains voltage change causes an output change of less than ±5 mV. Specification on a leaflet from Servomex Controls, Crowborough Hill, Jarvis Brook, Sussex.

Voltmeters, ammeters, wattmeters, including moving-coil, moving-iron and dynamometer types, mainly for use on industrial switchboards. Latest catalogue from Measuring Instruments (Pullin), Electric Works, Winchester Street, Acton, London, W.3.

Valve Retainers; booklet of tables giving the type of retainers needed for most valves in common use, from Electrothermal Engineering, 270 Neville Road, London, E.7. Distribution is restricted to equipment manufacturers.

Tape Recorders; transportable model in wooden cabinet, giving high-quality reproduction; a smaller portable model weighing 35 lb; a tape deck (used in both) with two speeds, 7½in and 4½in per second. Leaflets from Lee Products (Great Britain), Elpico House, Great Eastern Street, London, E.C.2.

R.F. High-voltage Generators for cathode-ray tube supplies and other purposes. Several models giving variable outputs over ranges between 5kV and 50kV. Output currents from 0.25mA to 1mA. An illustrated brochure from Teleonics (Communications), 196 Dawes Road, London, S.W.6.

Signal Strength Meter for television, consisting of r.f. amplifier, germanium diode and meter, with three ranges covering 0-10 mV altogether. Model supplied for each channel in Band I. Descriptive leaflet from Radio-Aids, 29 Market Street, Watford, Herts.

Communications Receiver, originally designed for Admiralty, with frequency range of 60kc/s to 31Mc/s divided into eight bands. Reception of a.m., c.w. and m.c.w. with either single or double superhet circuit, depending on frequency. Specification and description from Pye Telecommunications, Ditton Works, Newmarket Road, Cambridge.

Nickel-Copper Alloy "Monel" with strong resistance to corrosion. Data sheet giving physical and mechanical properties from Henry Wiggin & Company, Wiggin Street, Birmingham, 16.

R.F. Tuner, 3-valve 4-waveband superhet, for feeding high-quality amplifiers. Output 1 volt maximum at infinite impedance. Also two new amplifiers, one for use with tape recorders. Leaflets from Lee Products, Elpico House, Great Eastern Street, London, E.C.2.

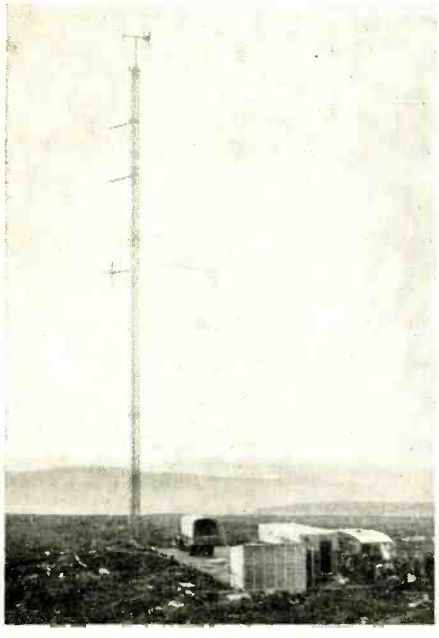
Electronic Manufacturing Facilities available in the Manchester area outlined in an illustrated booklet from the factory of F. C. Robinson & Partners at Councillor Lane, Cheadle, Cheshire.

Electronic Instruments for electrical, acoustic, radioactive, vibration, strain-gauge and electro-chemical measurements. An illustrated catalogue (in English) from the Danish company Brüel and Kjaer, available from the London office of Rocke International, 59 Union Street, London, S.E.1.

Component Storage Trays for assembly of electronic equipment in factories. Plastic mouldings designed suitably for interlocking, stacking and labelling. Leaflet from Precision Components (Barnet), 13, Byng Road, Barnet, Herts.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News



MOBILE television transmitter and temporary 150-ft mast at N. Hessary Tor, S. Devon

A Restrictive Practice?

VALVES and cathode-ray tubes are to come under the scrutiny of the Monopolies and Restrictive Practices Commission. The supply of these accessories is to be investigated by the Commission which has been asked to "report about both the facts of the matter and their bearing on the public interest."

Any person or organization wishing to offer evidence should write to the secretary of the Monopolies and Restrictive Practices Commission, 3, Cornwall Terrace, Regent's Park, London, N.W.1.

I.T.A. News

FREQUENCIES for the first three stations to be opened by the Independent Television Authority have now been announced. Birmingham will operate in Channel 8 (189.75 Mc/s vision, 186.25 Mc/s sound) and the transmitters for the London and Manchester areas in Channel 9 (194.75 Mc/s vision, 191.25 Mc/s sound). The frequencies of the London transmitter will be offset by 6.75 kc/s (vision) and 20 kc/s (sound).

Although Channels 8 and 9 were allocated to British stations in the Stockholm V.H.F. Broadcasting Plan the allocations were not made to transmitters in London, Manchester and Birmingham. It must, however, be remembered that the plan provides for the use of eight channels in Band III, only two of which will be available for television until such time as the present users of the band are accommodated elsewhere.

In addition to the appointment of P. A. T. Bevan as chief engineer (see Personalities) the I.T.A. has appointed Major-General D. A. L. Wade and Brigadier R. H. O. Coryton as assistants to the chief engineer. General Wade was, until recently, telecommunications attaché in Washington, and Brigadier Coryton chief signal officer, Northern Army Group.

National Radio Show

THE period chosen for this year's Earls Court exhibition is approximately the same as last year—August 24th to September 3rd. The Radio Industry Council, which organizes the show with the co-operation of its constituent associations covering the various sections of the industry, is again arranging for a preview for overseas visitors and invited guests on August 23rd.

Television Society Exhibition

IN addition to some 30 manufacturers and research organizations, exhibitors at the Television Society's Exhibition will include a number of members. The exhibition, which will be held in the gymnasium, University College, Gower Street, London, W.C.1, on January 6th, 7th and 8th, is concerned with television research rather than domestic reception and amongst the equipment to be seen will be standards conversion gear for international television exchanges.

Admission on the first day (6-9 p.m.) is limited to members and the Press. Tickets for the other two days (noon to 9 p.m. and 10 a.m. to 7 p.m., respectively) are obtainable free from the society, 164, Shaftesbury Avenue, London, W.C.2.

Ambulance Radio

ACCORDING to figures given by the Minister of Health in reply to a question in the House of Commons, 20 of the 63 county health departments use mobile radio in the operation of their ambulance services. Of the 83 county boroughs, 42 have installed mobile radio equipment. It might be added that this is in spite of the fact that ambulances come under the "private mobile radio" category and have to pay £3 per annum for each transmitter, whereas fire services and police pay only £2 per annum for each fixed station irrespective of the number of mobile transmitters operating in the network.

PERSONALITIES

Professor G. W. O. Howe, D.Sc., M.I.E.E., has been awarded the Fellowship of the American Institute of Radio Engineers "for his pioneering work in radio and his outstanding contributions to engineering education." Dr. Howe retired in 1946 from the James Watt chair of electrical engineering at Glasgow University, where he had been for 25 years, and was awarded an emeritus professorship. For fifteen

years prior to going to the university he was lecturer and assistant professor at Imperial College, London. Dr. Howe has been technical editor of our sister journal *Wireless Engineer* for nearly 30 years. Incidentally a 75-page index to his editorials in *Wireless Engineer* from January, 1926, to May, 1954, has been prepared by Dr. A. J. Small of Glasgow University.*

T. E. Goldup, C.B.E., M.I.E.E., has also been awarded the Fellowship of the I.R.E. "for his pioneering achievements in the design and development of thermionic tubes and his contributions to the technical and administrative counsels of the British radio industry." He joined the research staff of the Royal Navy Signal School, Portsmouth, in 1914, where from 1918 to 1923 he was senior experimental officer. He is now a director of Mullard's, which he joined in 1923 as an assistant in the valve laboratory.

Dr. A. G. Touch, M.A., D.Phil., the new director of electronics research and development at the Ministry of Supply, was a member of the Watson Watt radar team at Bawdsey research station from 1936 to 1940. For his contribution to the development of metre-wave AI and ASV he received an award from the Royal Commission on Awards to Inventors. Before joining the civil service he was at Clarendon Laboratory, Oxford. From 1941 to 1947 Dr. Touch was liaison officer with the British Joint Services Mission in Washington, where he was concerned with the development and production of airborne radio and radar equipment. For five years after his return from Washington he was superintendent, Armament and Instrument Experimental Unit, Martlesham Heath, Suffolk, and for the past two years has been deputy to the director, **Air Comdre. W. G. Pretty,** C.B.E., whom he is now succeeding. Air Comdre. Pretty was for two years in the Air Ministry directorate of signals, was deputy director (radar) at the Air Ministry and after a tour of duty as chief signals officer, Fighter Command, assumed the directorship at the Ministry of Supply, which he is now relinquishing. The new deputy director, electronics research and development (air) is **Air Comdre. C. A. Bell.**

John Clarricoats, G6CL, has completed 25 years as secretary of the Radio Society of Great Britain. To mark the occasion, the retiring president, A. O. Milne, made a presentation, for which over £150 was collected from members.

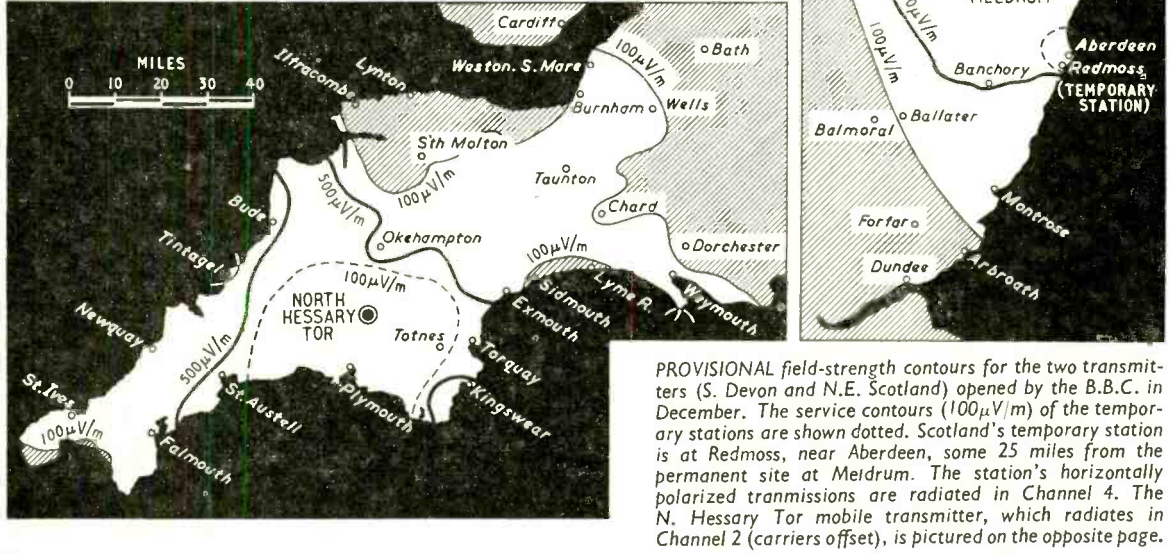
W. I. Flack, Assoc.I.E.E., who is well known as the designer of the View Master television receiver and Soundmaster tape recorder, is to concentrate on printed circuitry for the Telegraph Condenser Company.

* Obtainable from Dr. Small, price 5s.

P. A. T. Bevan, B.Sc., M.I.E.E., whose appointment as chief engineer of the Independent Television Authority was announced early in December, was for 20 years with the B.B.C. where he had latterly been a senior member of the Planning and Installation Department of the Engineering Division. He graduated in engineering at Cardiff University and was for three years a graduate apprentice at the B.T-H. Rugby works. At the B.B.C. he has been mainly concerned with the development of v.h.f. television and sound transmitters. Mr. Bevan is the author of a number of papers, for one of which he received the I. E. E. Duddell premium and has, since 1949, been a member of the editorial advisory board of *Wireless Engineer.*

C. R. Jephcott, A.M.I.E.E., has been appointed engineer-in-charge of the B.B.C.'s temporary television transmitting station at North Hessary Tor, South Devon. He joined the corporation in 1935 at the Droitwich station, where six years later he became a senior maintenance engineer. In 1946 he transferred to the short-wave transmitter at Skelton, Cumberland, where he has been a senior maintenance engineer until taking up his new appointment.

S. W. Wain has retired from the position of deputy engineer-in-charge of the Post Office radio station, Leafield, which he has held since 1942. During his 34 years at the Post Office he has also served at Bodmin, Rugby and Portishead stations. He is succeeded at Leafield by **E. G. H. Middleditch,** who has been in the Post Office since 1923. Mr. Middleditch went to the engineer-in-chief's office at headquarters in 1935 and during the war



PROVISIONAL field-strength contours for the two transmitters (S. Devon and N.E. Scotland) opened by the B.B.C. in December. The service contours (100μV/m) of the temporary stations are shown dotted. Scotland's temporary station is at Redmoss, near Aberdeen, some 25 miles from the permanent site at Meldrum. The station's horizontally polarized tranmissions are radiated in Channel 4. The N. Hessary Tor mobile transmitter, which radiates in Channel 2 (carriers offset), is pictured on the opposite page.

SIR ANTHONY EDEN, guest of honour at the Radio Industry Council annual dinner, is seen talking to Sir Kenneth Clark, chairman of I.T.A. On his right is Sir Ian Jacob, director-general, B.B.C.

was given the task of providing emergency radio-telephone installations and mobile multi-channel R/T stations for the War Office.

Clifford Sanctuary, who has gone to Canada to take charge of the engineering side of the recently formed Decca Radar (Canada) company, has been associated with radar since he joined the Bawdsey research station in 1939. Two years later he joined the R.A.F. and was concerned with the installation of CH radar stations and OBOE. He joined the Decca Navigator Company in 1946 and transferred to the research labs of Decca Radar in 1951.

A. J. Brunker, B.Sc.(Eng.), A.M.I.E.E., who before joining E. K. Cole, Ltd., in 1947, was deputy director (radio production) at the Ministry of Supply, has become the company's chief engineer. He has relinquished the position of general export manager but retains his directorship in the subsidiary company, Ekco Electronics.

Walter M. York, who, as an executive director of E. K. Cole, already controls Ekco publicity and the company's heating division, will, in addition, now direct the export of radio, television, plastics and ciné equipment.

F. H. McCrea has been elected chairman of the Dubilier Condenser Company in succession to the late W. H. Goodman, who formed the original Dubilier company in 1912. Mr. McCrea has just completed 25 years' service with the company and was appointed managing director in 1939, a position which he still holds.

G. Johnson, author of the article in this issue on a transistor d.c. amplifier, was concerned with the development of prototype gunnery radar at A.S.R.E. during the war, after which he was for a time senior inspecting officer at Ferranti's. In 1948 he became interested in electro-physiology and went to Hurstwood Park Hospital, Haywards Heath, to organize the new department of applied electro-physiology of which he is now in charge. He is honorary secretary of the Electrophysiological Technologists' Association and a council member of the EEG Society (electroencephalographic).

WHAT THEY SAY

Industry and P.O. Control.—"There is a strong door that shuts us out from discussions on frequency allocations"—G. Darnley Smith speaking at the Radio Industry Council dinner.

Are we so Boring?—"I do not want to weary the House with a quotation from *Wireless World* . . ."—C. R. Hobson, M.P., speaking in the House of Commons on November 23rd.

IN BRIEF

4,000,000 TV Licences.—Within the first few days of December the four-millionth television licence was issued. The number of television licences current in the United Kingdom at the end of November was 3,999,624, an increase of 157,956 during the month. The total number of receiving licences, including 250,256 for car receivers, was 13,794,195.

Television I.F.—The report on the choice of intermediate frequencies for television receivers prepared by the European Broadcasting Union, to which G. H. Russell referred in our July issue, is now available in English. The report, the full title of which is "The E.B.U. Enquiry Concerning the Choice of Intermediate Frequencies for Domestic Television Receivers and Related Questions" (Tech. 3062-E) can be obtained from the Union Européenne de Radiodiffusion, 4, rue de la Vallée, Brussels, Belgium, price 70 Belgian francs, including postage.

R.S.G.B. Membership.—A regrettable but expected drop in membership as a result of the necessary increase in subscription rates is recorded in the annual report of the Radio Society of Great Britain. Comparative figures given in the report show a 13 per cent decrease during the year ended June 30th, 1954. The respective figures for 1953 and 1954 are 11,190 and 9,735.

U.S. Colour TV.—Over 130 stations in the U.S.A. are now equipped to rebroadcast network colour transmissions and, according to data given in *Television Digest,* 40 of these will have three-colour film cameras by the end of January. A few stations are already equipped for live colour transmissions.

Solder Standard.—BS441:1954 "Rosin Cored Solder Wire, Activated and Non-Activated" is a revision of the standard "Cored-solder, Rosin Filled," published in 1932 and now includes methods of activating the rosin core. It costs 3s and is obtainable from British Standards Institution, 2, Park Street, London, W.1.

Component Testing.—Conditions and procedure for climatic and durability testing for components are given in BS2011:1954 "Basic Climatic and Durability Tests for Components for Radio and Allied Electronic Equipment." Based upon the Radio Industry Council specification RIC11 and the Services specification RCS11, the standard describes tests which will form the basis of the tests to be included in individual standards for specific components. Price 5s.

The **French Components Show** will be held at the Port de Versailles, Paris, from March 11th to 15th.

Germany's Radio Show, which, like its British counterpart, covers sound and vision reception and gramophone reproduction, will be held from August 26th to September 4th in Düsseldorf.

Luxembourg TV.—The operators of Radio Luxembourg have been granted the monopoly of television in the Duchy. Commercial programmes will be radiated by the 819-line station on 189.26 Mc/s vision and 194.75 Mc/s sound when the service starts early this year.

Monte Carlo TV.—Using the French definition of 819 lines the Monte Carlo television transmitter has a directional aerial array which concentrates energy along a narrow stretch of the Rivieria coast. Its sponsored programmes are receivable from San Remo, Italy, to St. Raphael, France.

E.B.U. Headquarters.—Having moved its receiving centre from the outer suburbs of Brussels to an interference-free site at Jurbise-Masnuy (see *W.W.*, September, 1953), the European Broadcasting Union has transferred its offices nearer the centre of the city. The new address is 4, rue de la Vallée, Brussels.

"Velocity of Radio Waves."—The velocity of light given in Dr. Smith-Rose's article (December, page 590) should, of course, have been 3×10^8 km/sec.

A course of 20 lectures on the applications of **Pulse Technique** in communications, radar and computor circuits will be given on Tuesdays, beginning January 11th, from 7.0-9.0 at the Kingston Technical College, Fassett Road, Kingston-upon-Thames. The fee is 3 guineas.

The presentation of technical information is naturally of particular interest to *Wireless World* and we, therefore, draw readers' attention to the course of five weekly lectures on the **Writing of Technical Reports** at the Borough Polytechnic, Borough Road, London, S.E.1. The lecturer is Geoffrey Parr, and the course, for which the fee is one guinea, begins on January 20th at 6.30.

The one-full-day-per-week course on Band II (f.m.) and Band III (television) reception, which ran from September to the end of the year at the **Northern Polytechnic,** Holloway, London, N.7, will be repeated on Mondays from 9.30 to 4.30, commencing January 10th. The fee for the three-months course is £2.

The recent presentation of awards to trainees in Cossor's electronic engineering **Apprenticeship Scheme** afforded an opportunity to record that 112 student apprentices have entered the scheme since its inception in 1947.

BUSINESS NOTES

Aveley Electric, Ltd., of 44, Tottenham Court Road, London, W.1 (Tel.: Langham 7097), have been formed to act as representatives and agents for Rohde and Schwarz, of Munich, manufacturers of communication and laboratory measuring equipment. Eventually the company plans to manufacture some of the instruments in the Rohde and Schwarz range and a factory is under construction in Aveley, Essex. The directors are R. F. Parker, B.Sc., J. I. Brown, A.M.Brit.I.R.E., and A. C. Judd, A.C.A.

Mobile radio equipment has been supplied by **Marconi's** to the North of Scotland Hydro-Electric Board to facilitate the repair and maintenance of the new power transmission line which runs between Fort Augustus and Speyside and is the highest in the U.K. The equipment has been installed in small buildings containing repair gear near the top of Corrieyairack Pass.

The **General Electric Company,** which, some months ago, installed mobile radio equipment for the rescue service of the N.W. Division of the National Coal Board, has now supplied similar installations for four other divisions.

It is announced by **Decca Radar** that over 3,500 ships, operated by more than 840 companies, navies and ministries throughout the world, have been equipped with Decca radar since the company started five years ago.

Learning a foreign language by "almost unconscious assimilation" with the aid of gramophone records is the principle of Assimil, which has been introduced into this country by **E.M.I. Institutes.** There are 20 double-sided records in the complete course, details of which are obtainable from 10, Pembridge Square, London, W.2.

A. K. Fans, Ltd., of 20, Upper Park Road, London, N.W.3 (Tel.: Primrose 5969), announce that A. W. Dean, who was with Marconi's, has joined the company and that they have taken over further factory space at 352, Goswell Road, London, E.C.1.

The complete television studio and equipment which **Pye** installed at the recent British Trade Fair in Baghdad is to be purchased by the Iraq government and re-erected on a site belonging to the country's broadcasting authority. It is anticipated that initially the station will be used for educational purposes.

Underwater television equipment is being supplied by Pye to the expedition which is endeavouring to locate the wreck of the *General Grant*, sunk off the Lord Auckland Islands, south of New Zealand, in 1866 with a cargo of 9½ tons of unrefined gold.

Medium- and short-wave transmitters, complete aerial systems and studio equipment are to be installed by **Redifon** at Piura for the Peruvian broadcasting organization Radio Nacional.

Cossor airfield control radar (Mark VI) has been installed at Zurich airport. A feature of this 450-kW surveillance radar equipment is the cancellation of permanent echoes, which is particularly important at Zurich where the Alps give heavy responses.

All-wave broadcast receiving equipment, gramophone amplifiers and loudspeakers are being supplied by **Pye Marine** for 20 trawlers being built at Lowestoft for the Soviet Union.

A $2.5M contract awarded to the **General Electric Company** for extensions to the telephone system of Haiti, in the Caribbean, includes the provision of v.h.f. radio relay equipment where the terrain makes the use of lines uneconomic.

Public address and intercom equipment has been installed by **Hadley Sound Equipments,** of Smethwick, at both the Renfrew (Glasgow) and Ringway (Manchester) airports.

Australian Agency.—The Sydney, N.S.W., firm of L. D. Beston (Aust.) Proprietary, Ltd., 387, Kent Street, would like to act as representatives of a U.K. manufacturer of television receiving aerials. Interested manufacturers should write directly to the company and are advised to send a copy of the correspondence to the U.K. Trade Commissioner, 39-49, Martin Place, Sydney, N.S.W.

Agency for a three-valve, all-dry, long- and medium-wave set made by a U.K. manufacturer not already represented in Ceylon is sought by Hentleys, Ltd., P.O. Box 670, Mackinnon Building, York Street, Colombo. Manufacturers should write direct to Hentleys but are invited to send copies of their correspondence to the U.K. Trade Commissioner, P.O. Box 745, Hong Kong Bank Building, Fort, Colombo.

NEW ADDRESSES

F. C. Robinson and Partners, manufacturers of electronic measuring and control equipment, have moved their head office and sales and service departments from Deansgate to 122, Seymour Grove, Old Trafford, Manchester, 16 (Tel.: Chorlton 5366). The factory is in Councillor Lane, Cheadle, Cheshire.

Furzehill Laboratories have transferred their head office and sales and designs departments to 57, Clarendon Road, Watford (Tel.: Gadebrook 4686). The production and purchasing departments are still at the works in Shenley Road, Boreham Wood, Herts (Tel.: Elstree 1137).

The Rectifier Division of **Standard Telephones and Cables** has moved from Boreham Wood, Herts, to a new factory in Edinburgh Way, Harlow, Essex (Tel.: Harlow 26811).

The London district office and service depot of the **Edison Swan Electric Company** is now at 10-12, Euston Buildings, N.W.1 (Tel.. Euston 6072). The company's head office will remain at 155, Charing Cross Road, W.C.2.

The Manchester office of **Elliott Brothers (London), Ltd.,** is now at 32, Deansgate, Manchester, 3 (Tel.: Blackfriars 7752).

A new branch office at 270, Corporation Street, Birmingham (Tel.: Central 6191), has been opened by the **Telegraph Construction and Maintenance Company.** The branch manager is J. H. Barham, Assoc.I.E.E.

Philips have opened new showrooms and a branch office at 47-49, Victoria Street, Bristol, Glos. (Tel.: Bristol 20307).

The address of the Middlesbrough district office of **British Insulated Callender's Construction Company** is now 55-57, Borough Road (Tel.: Middlesbrough 43644).

Gramophone and Microphone

THE pre-amplifier described in this article is intended primarily for use with the 10-watt amplifier described by the author in 1948,[1] and its h.t. supply of approximately 20 mA at 300 V may be obtained from this power amplifier with complete freedom from motor-boating troubles. If desired, however, the pre-amplifier may be built with its own power pack, and may then be employed for feeding any high-quality power amplifier requiring a sine-wave input not exceeding 4 V r.m.s., at high impedance, for full output.

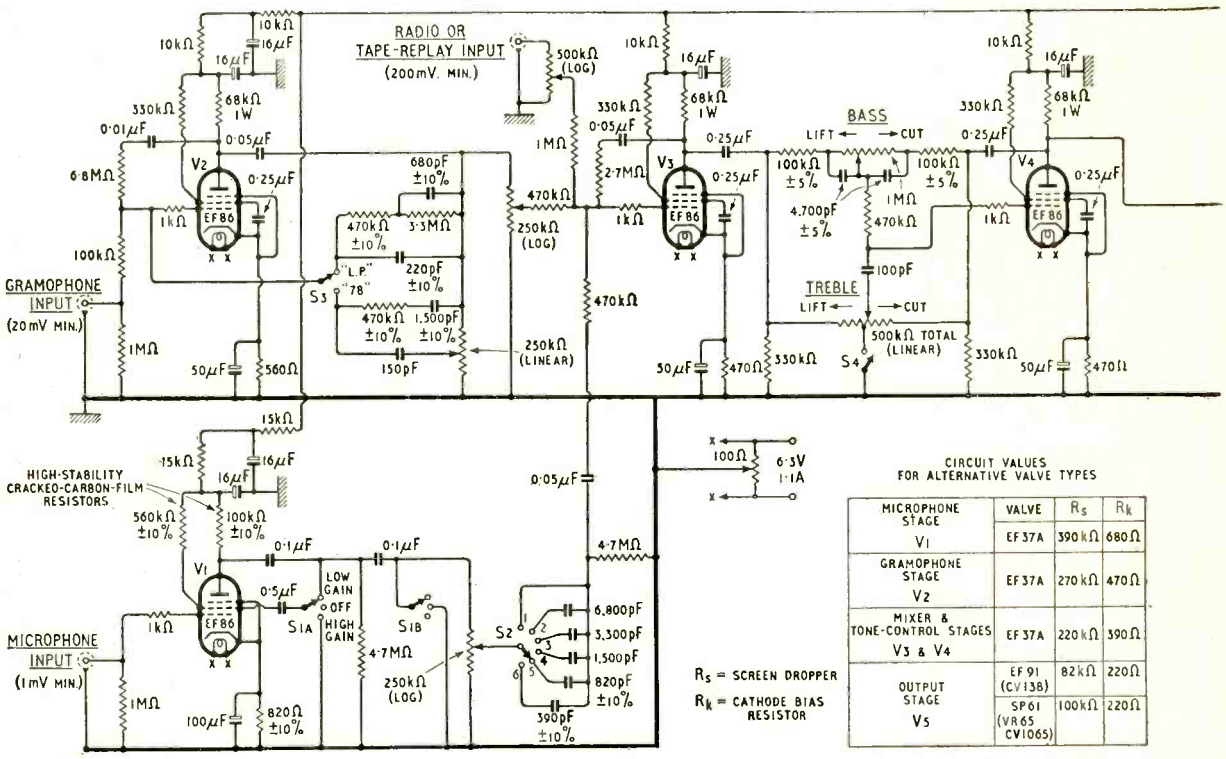
Separate input stages and gain controls are employed for the gramophone and microphone inputs, followed by a mixing circuit, making the pre-amplifier suitable for applications such as stage sound effects, recording, etc., where, for example, an effects record may be mixed in to provide a background to the spoken words of a play. If required, several microphone channels may be incorporated, whereas readers interested only in high-quality record reproduction may include only the gramophone channel.

The full output of 4 V r.m.s. may be obtained, with a total harmonic distortion not exceeding 0.1 per cent, for sine-wave signal inputs ranging from 1 mV to about 50 mV on the microphone channel, and from 20 mV to 1 volt on the gramophone channel. Full provision is made for recording-characteristic equalization, scratch filtering and microphone bass-cut, the writer's continuously adjustable tone-control circuit[2] being employed, in addition to the above, to provide adjustable compensation to suit room acoustics, loudspeaker characteristics, etc.

The equipment as described uses Noval-based miniature valves; but certain other valves may be employed if desired, and the slight changes in circuit values then necessary are indicated below Fig. 1. The Noval type appears to be becoming established as the preferred series in British commercial practice, combining excellent electrical characteristics with conveniently small size and satisfactorily robust construction.

Microphone Input Stage.—Experience with high-quality ribbon microphones has shown that, for general purposes, the maximum gain available on microphone channels should be sufficient to enable the following amplifier to be fully loaded when a sine-wave signal of about 1 mV r.m.s. is applied to the input valve grid. An EF86 low-hum, low-microphony pentode, under the operating conditions employed in the present equipment, gives a gain of approximately 90 without negative feedback, and its harmonic distortion is less than 0.1 per cent provided the input does not exceed about 10 mV r.m.s.

However, even a low-sensitivity high-quality microphone may sometimes give a signal in excess of 10 mV —for example, when placed near to a piano or an orchestra—so that the distortion introduced by such a pentode stage will then be greater than 0.1 per cent



CIRCUIT VALUES FOR ALTERNATIVE VALVE TYPES

MICROPHONE STAGE V1	VALVE	R_S	R_k
	EF37A	390kΩ	680Ω
GRAMOPHONE STAGE V2	EF37A	270kΩ	470Ω
MIXER & TONE-CONTROL STAGES V3 & V4	EF37A	220kΩ	390Ω
OUTPUT STAGE V5	EF91 (CV138)	82kΩ	220Ω
	SP61 (VR65 CV1065)	100kΩ	220Ω

Fig. 1. Complete circuit of pre-amplifier. All resistors ½ watt ±20%, except where otherwise specified. All capacitors (other than electrolytic) ±20% except where otherwise specified. Mullard valve type EF86 may be directly replaced by Osram Z729; other alternatives require circuit changes as shown in the inset table.

Pre-Amplifier

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

Versatile Design with Facilities for Mixing Several Inputs

unless the gain control is placed between the microphone and the grid. The disadvantage of having the gain control in this latter position is that the actual amplifier is operating at full gain all the time, resulting in unnecessarily high noise and hum levels under average conditions of use.

The problem is, therefore, to reduce the gain in such a way that low distortion is obtained without sacrificing signal-to-noise ratio, and the solution adopted in the present design is to place the gain-control potentiometer after the input stage and arrange that the valve may be switched to operate effectively as a triode instead of as a pentode when large signals are to be handled. Under triode conditions, an input of about 3 mV r.m.s. is required to give full output at the maximum-gain setting of the potentiometer, and the distortion does not exceed 0.1 per cent until the input reaches about 50 mV r.m.s. Thus, provided the switch is never used in the "pentode" position when sufficient gain can readily be obtained in the "triode" position, the distortion will never exceed 0.1 per cent for any value of input up to 50 mV—a value unlikely to be exceeded with a high-quality microphone.

The gain following the above input stage must be sufficient to give 4 V r.m.s. output from the pre-amplifier for a microphone stage output of 90 mV r.m.s.; with the mixing circuit employed, the noise level at the pre-amplifier output, with the input stages faded right down, is then approximately 70 db below 4 V r.m.s., which is highly satisfactory.

The above system has been adopted, instead of one of the feedback arrangements used in high-grade broadcasting equipment, for the following reasons:—

(a) Shunt-feedback methods,[3] if optimum signal-to-noise ratio is to be obtained, require the feedback circuit, microphone and input transformer to be designed to work in conjunction with one another, whereas in a versatile design, intended for amateur construction, it seems desirable to have an input circuit which will suit any available microphone with or without input transformer.

(b) Feedback obtained by inserting resistance in the cathode lead[4, 5] is liable to lead to unnecessarily high hum levels, unless a d.c. heater supply is used or other expensive precautions are taken.

(c) Circuits involving more than one stage[5, 6], special feedback transformers,[6] or ganged stud-type potentiometers,[4] are regarded as undesirably expensive for amateur use.

Though a single-knob gain-control system is certainly more convenient than the combination of potentiometer and switch used in the present design, it is thought that most amateurs will be prepared to sacrifice a small amount of simplicity of control in order to obtain a very high-grade performance economically.

In most circumstances the gain switch can be set, before commencing operations, to the position appropriate to the sensitivity of the microphone and the likely intensity of the sound, and it will not require altering during the performance. The gain-switching circuit has been so arranged, however, that no switch clicks are heard even if the switch is operated, as may occasionally be necessary, without first fading the input stage down. The switch (S1 in Fig. 1) must be of the make-before-break variety, to ensure that section S1B maintains a short circuit across the gain control during the whole of the time that section S1A is effecting the change-over from triode to pentode or vice versa.

On measuring the input capacitance of the microphone stage, including the input socket, values of approximately 30 pF and 70 pF were obtained under pentode and triode conditions respectively. The higher value under triode conditions is due to Miller effect, involving the screen-grid to control-grid capacitance. A capacitance of 70 pF, shunted across the secondary of a microphone transformer, will produce an appreciable effect on the high-frequency response only if the secondary impedance is well in excess of 50 kΩ; since such transformers are very rare, no trouble arising from input capacitance is likely to be experienced in practice.

A switch S2 is included (see Fig. 1) to enable various degrees of bass cut to be introduced on the microphone channel. This is a very desirable feature, par-

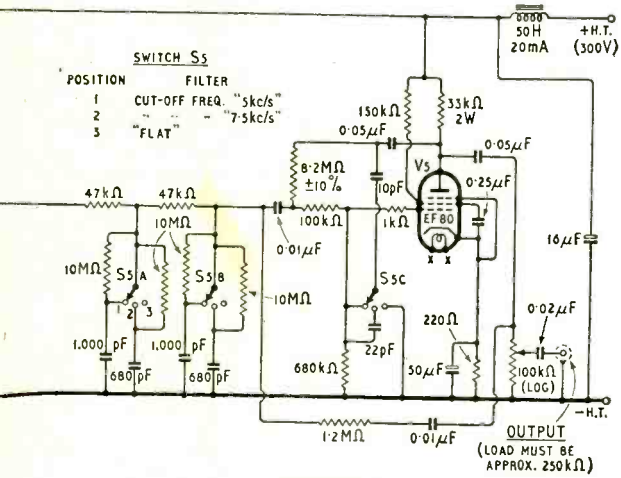


TABLE I

Number of contact on switch S2	Approximate frequency for 3 db attenuation.	Approximate distance from ideal ribbon microphone for perfect bass compensation.
1	—	—
2	50 c/s	3 ft
3	100 c/s	18 in
4	200 c/s	10 in
5	400 c/s	5 in
6	800 c/s	2.5 in

ticularly when using a ribbon microphone under fairly close-speaking conditions, since the curved wave-front reaching the microphone then causes a considerable increase in the relative output at low frequencies[7]. Table I on the preceding page gives, for each setting of the switch, the approximate frequency at which an attenuation of 3 db occurs, and the approximate distance from an ideal ribbon microphone at which the compensation for spherical wave propagation is theoretically perfect.

Gramophone Input Stage.—Equalization for recording characteristics[8] is obtained by means of negative-feedback networks associated with V2 in Fig. 1, it being assumed that the pickup employed gives a constant output for constant stylus velocity at all frequencies.*

In the "LP" position of the switch S3, the measured response curve of the gramophone stage is as shown in Fig. 2 (broken-line curve), and is suitable for equalizing microgroove records of both British and American origin. A little extra bass lift may sometimes be required, however, particularly with R.C.A. records, but this can readily be applied by means of the main tone control circuit. The "LP" setting may also be used for American 78 r.p.m. records.

The full-line curves in Fig. 2 are obtained on the "78" setting of S3; fixed bass equalization, which is accurately the inverse of the E.M.I. recording characteristic, is provided, and the treble equalization is adjustable by means of a potentiometer. With the potentiometer at approximately 40 per cent rotation from the maximum-treble end, assuming a linear element, the treble attenuation is nominally correct for equalizing the high-frequency pre-emphasis on Decca "ffrr" records. Other settings may be used to give the best audible results with records of various makes and conditions.

It will be seen that the "78" bass-equalization curve shown in Fig. 2 rises at a rate approaching 6 db/octave down to about 35 c/s, below which it changes over fairly rapidly to a similar rate of fall. This latter feature, which provides a useful measure of turntable rumble filtering, is achieved by including two a.c. couplings in the feedback loop used for bass equalization, instead of only one as is more usually the case[9]. The basic theory involved is the same as for the high-pass filter, and is considered later in this article. The practical design formulæ are given in Fig. 3, which also shows the circuit freed from irrelevant details such as grid bias, screen supply, etc.

A low-pass filter, to be described later, is included in the last stage of the pre-amplifier, and will frequently be employed as a scratch filter when using the equipment for reproducing gramophone records only. When mixing a gramophone recording with live speech from a microphone, however, it is often preferable not to limit the frequency range of the microphone contribution, so that the low-pass filter cannot then be employed; but since conditions are not very critical when the gramophone channel is used merely to provide a background effect, scratch filtering is likely to be necessary only with 78 r.p.m. records and can be provided adequately well by means of the adjustable treble-cut control associated with the gramophone input stage. By placing the low-pass filter at the output end of the pre-amplifier, instead

* The best moving-iron, moving-coil and ribbon pickups approximate closely to this ideal.

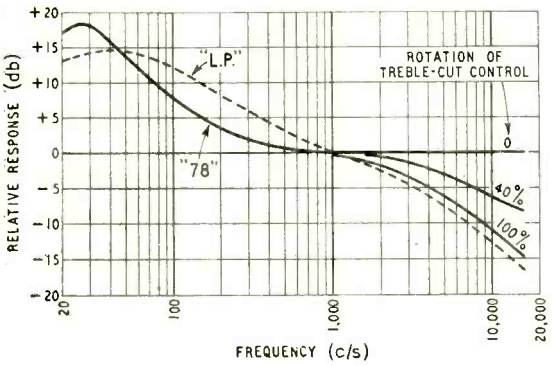
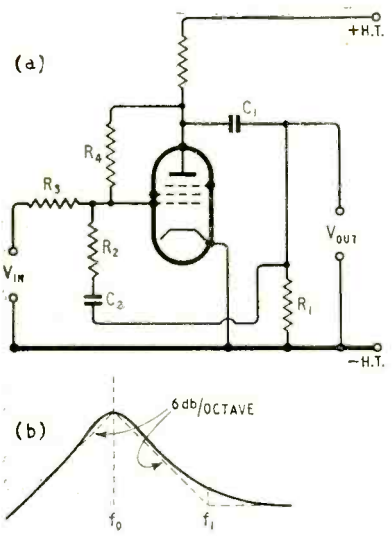


Fig. 2. Measured response curves for gramophone input stage (all components within 5% of values shown in Fig. 1).



Practical Design Procedure :—

(i) Choose arbitrary value for R_1 (at least 100kΩ)

(ii) Make R_2 several times R_1

(iii) Determine C_2 from :— $C_2 = \dfrac{1}{2\pi f_1 R_2}$

(iv) Determine C_1 from :— $C_1 = \dfrac{1}{2\pi R_1}\left(\dfrac{1}{Qf_0} - \dfrac{1}{f_1}\right)$

(v) Determine R_4 from :— $R_4 = R_2\left[\dfrac{Q^2(C_1R_1+C_2R_2)^2}{C_1R_1C_2R_2} - 1\right]$

(vi) Determine R_3 from :— $R_3 = \dfrac{R_2 R_4}{R_2+R_4} \div \left[\begin{array}{l}\text{Required value of} \\ V_{OUT}/V_{IN} \text{ at H.F.}\end{array}\right]$

Note :— The formulae apply accurately only when the actual valve gain is much higher than the value of $\dfrac{|V_{OUT}|}{|V_{IN}|}$ at f_3. In practice R_4 may be made higher than the calculated value, to compensate for finite valve gain.

Fig. 3. (a) Circuit used for gramophone bass equalization, omitting irrelevant details. (b) Frequency response obtained when Q=1.

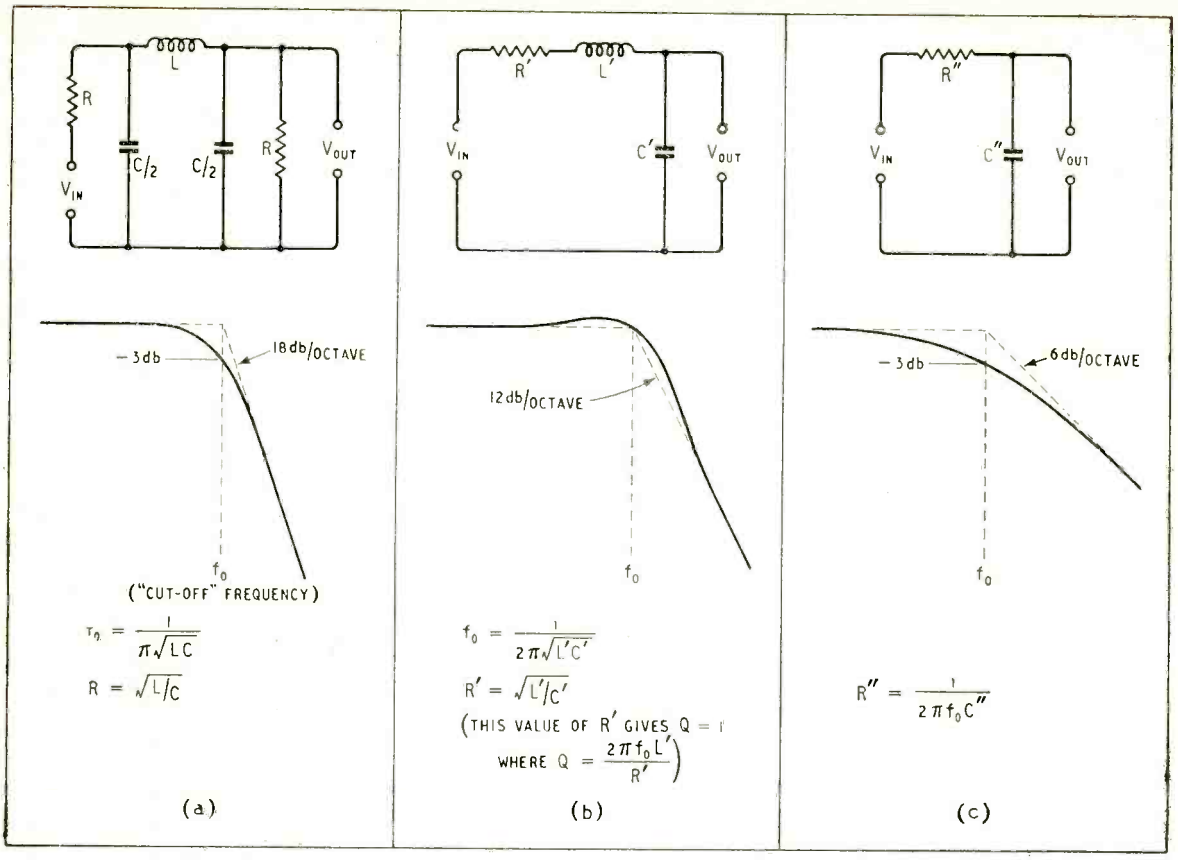


Fig. 4. The constant-k, π-section low-pass filter shown at (a) has the same response (to both sine-waves and transients) as that given by circuits (b) and (c) in cascade, assuming that (c) does not appreciably load (b).

of making it part of the gramophone stage, it becomes available for use on radio programmes, the radio input being fed to the mixer circuit in a similar manner to the microphone and gramophone inputs. A further consideration is that if a crystal pickup is used, the gramophone input stage may be omitted altogether, a suitable passive equalizing network[10] being connected between the pickup and the gramophone gain control;* the low-pass filter is, however, still available under these conditions. (An alternative method of using a crystal pickup, such as the Cosmocord GP20 "Hi-g," is to shunt the pickup with a series combination of two resistors, of values about 220 kΩ and 22 kΩ, the voltage drop across the 22 kΩ resistor being applied to the input of the gramophone stage shown in Fig. 1. The correct value of shunt resistance makes the crystal pickup have a response approximately the same as that of a moving-iron or moving-coil pickup.)

Mixer Stage.—An anode-follower or virtual-earth type of mixer[2] is employed, because it possesses the following desirable features:—

(a) The gain on one input channel is almost independent of the gain-control settings on the other input channels.

(b) The circuit is economical, enabling several inputs to be mixed with a single valve whilst also providing a useful amount of gain—just over four times in the present case.

(c) The non-linearity distortion is low, due to the negative feedback.

(d) The output impedance is low, also because of the negative feedback, making the circuit suitable for feeding the tone-control.

Tone-control Stage.—The tone-control circuit is almost exactly as previously published[2], but an EF86 valve is used in place of the high-slope valve originally specified, in order to secure reliable freedom from microphony and hum. The signal output from the tone-control valve, for a final output from the pre-amplifier of 4 V, is 400 mV; under these conditions, the non-linearity distortion introduced by the tone-control stage is much less than 0.1 per cent despite the low-slope valve employed.

With the switch S4 in the "open" position, the alternative treble-response curves, as shown dotted in Fig. 8 of the previous article[2], may be obtained. A resistor of 330 kΩ is connected to earth from each end of the treble-control potentiometer, to provide a d.c. return path from the grid to earth when S4 is opened—a requirement inadvertently overlooked when the original article was written, but soon pointed out by several readers! Whether this facility for obtaining the alternative response curves is included, is a matter for personal choice, and some constructors may prefer to omit it.

* The values of the gain control potentiometer and the mixer input resistor may be advantageously increased to 500 kΩ and 1 MΩ respectively.

Output Stage.—The output stage provides a voltage gain of approximately 10, and has associated with it feedback circuits giving high-pass and low-pass filter characteristics.

The high-pass filter, which has a fixed cut-off frequency of about 30 c/s, reduces tendencies for the main amplifier and/or loudspeaker to be overloaded by sub-audio frequency inputs caused by turntable rumble, or, on the microphone channel, floor vibration and the effects of wind on the microphone. This filter also substantially reduces the amount of h.t. decoupling necessary for obtaining complete freedom from motor-boating troubles when the pre-amplifier is fed from the main amplifier h.t. supply. Full bass lift may, in fact, be applied at maximum gain settings without causing instability, though this combination is unlikely to be needed in normal use.

The low-pass filter, as already mentioned, is primarily for reducing scratch and distortion on the gramophone channel, and cut-off frequencies of 5kc/s and 7.5kc/s may be selected by means of switch S5, a third position of which cuts the filter out.

It is sometimes said that filters using resistors and capacitors only, in suitable feedback circuits, give better transient response than can be obtained with passive filters which include inductors. In general, however, this notion is quite incorrect, and any filter employing feedback principles may, in fact, be shown to be equivalent, in both frequency response and transient response, to a particular passive filter using inductors. The feedback filters employed in the present equipment are equivalent to, or "simulate," simple constant-k filters[11] with one π (or T) section and resistive terminations, the rate of cut-off tending to 18 db/octave.

Considering first the low-pass filter, the basic circuit to be stimulated is that shown in Fig. 4 (a), and the first fact utilized in deriving the equivalent feedback circuit is that the response of the basic circuit is exactly the same as that of the two circuits shown in Fig. 4 (b) and (c) in cascade, provided that the component values are correctly chosen and that circuit (c) does not appreciably load circuit (b)*. It is the normal practice to make R in Fig. 4 (a) equal to $\sqrt{L/C}$; to simulate this condition, the circuit of Fig. 4 (b) must series-resonate at the nominal cut-off frequency of the filter, with a Q of unity at resonance, and circuit (c) must have a response which is 3 db down at the cut-off frequency. Thus, provided a feedback circuit can be found, which has the same kind of response as the Fig. 4 (b) circuit, it is then only necessary to add a "sample lag," as shown in Fig. 4 (c), to make it simulate the filter of Fig. 4 (a).

The main characteristics of the Fig. 4 (b) type of circuit are:—

(a) Level response at low frequencies.

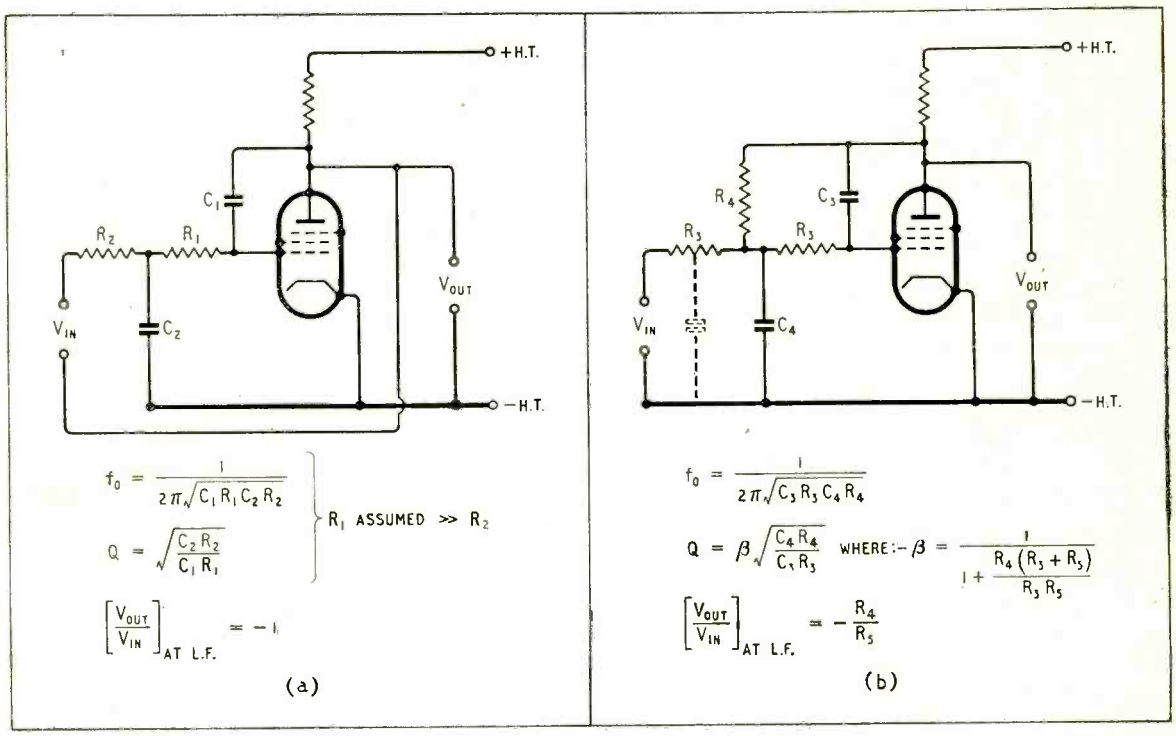
(b) A peak in the response near to the resonant frequency—unless the Q is very low.

(c) A rate of attenuation tending to 12 db/octave at frequencies well above resonance.

The above are also the main characteristics of a negative-feedback amplifier having two simple lags in the forward path, and it is actually found that the equation relating input and output voltages for such an amplifier is of exactly the same form as that for the Fig. 4 (b) circuit. Alternatively, one of the simple

* The latter condition may be satisfied by making circuit (c) of much higher impedance than circuit (b), or by interposing an isolating stage, such as a cathode follower, between the two circuits.

Fig. 5. Feedback circuits simulating the circuit of Fig. 4 (b). The formulæ apply accurately only when the actual valve gain is much higher than the gain given by the above circuits at low frequencies. The capacitor shown dotted above provides the additional lag required for simulating Fig. 4 (a) instead of Fig. 4 (b).



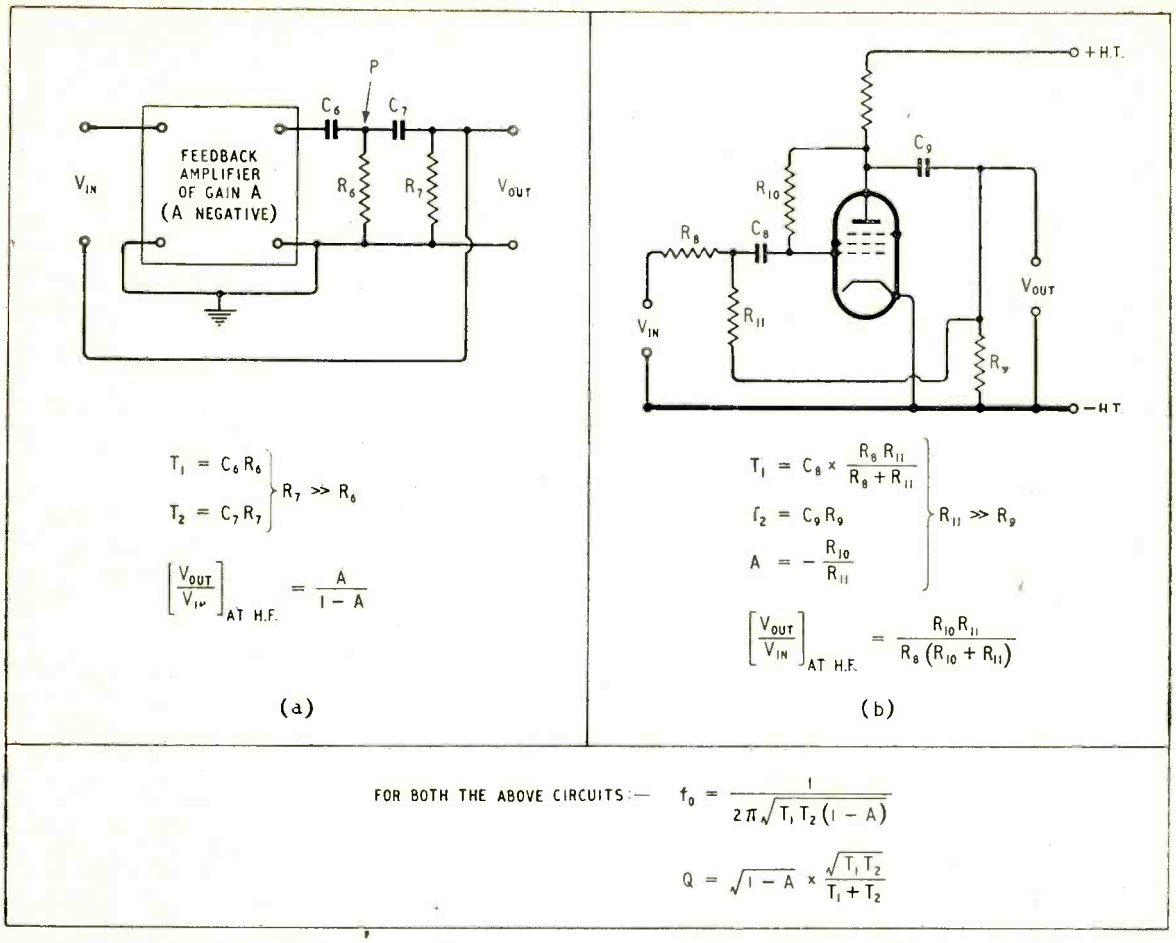


Fig. 6. Feedback circuits simulating Fig. 4 (b) with L′ and C′ interchanged. For simulating a constant-k, high-pass filter with $R=\sqrt{L/C}$ terminations, Q is made unity and a passive a.c. coupling, —3db at f_0, is added externally to the above circuits.

lags may be replaced by a Miller integrator,[12] leading to the circuit shown in Fig. 5 (a); this arrangement has the advantage that its performance is almost independent of the actual valve gain, provided the latter is high enough. The necessity for a "floating" signal-input source may be avoided by employing the modified circuit shown in Fig. 5 (b). The capacitor shown dotted in Fig. 5 (b) provides the additional lag required for simulating the circuit of Fig. 4 (a) rather than that of Fig. 4 (b),* and is placed before the valve (instead of after it) in order to enable the low output impedance of the feedback circuit to be utilized for feeding the cable connecting the pre-amplifier to the main amplifier—the cable capacitance may be as much as 200pF without materially affecting the performance.

On referring to the complete circuit diagram, Fig. 1, it will be seen that the low-pass filter circuit of Fig. 5 (b) is that employed in the actual equipment, though a little effort may be needed to disentangle the low-pass filter from the high-pass filter, the latter being achieved by feedback round the same valve!

In the high-pass filter, a feedback circuit is used to simulate a series tuned circuit like that shown in Fig. 4 (b) but with L′ and C′ interchanged. This is followed by a circuit as shown in Fig. 4 (c) but with C″ and R″ interchanged, the combination of these circuits simulating a constant-*k* high-pass filter with a rate of attenuation tending to 18 db/octave below cut-off. The basic system used for simulating the series tuned circuit is shown in Fig. 6 (a), and involves a feedback loop having two a.c. couplings in the for-

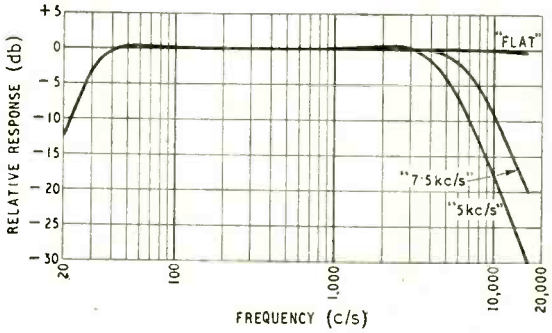


Fig. 7. Measured response curves for output stage in Fig. 1 (all components as marked, within ±5%).

* The above method of providing the additional lag actually results in slight departures from the simple theory, because the extra capacitor affects, to some extent the operation of the other lag, involving C4; but perfectly satisfactory results may be obtained in practice by suitable choice of component values. Ref. (13) gives an ingenious solution of this complication.

ward path, the forward gain being stabilized by non-frequency-dependent internal feedback. The arrangement is the same in principle as that used for bass equalization and rumble-reduction in the gramophone stage, except that in the gramophone application the output is taken from the point "P." The practical circuit evolved from Fig. 6 (a) is shown in Fig. 6 (b), in which irrelevant details have been omitted for clarity, and it will be seen that one of the time constants in the feedback loop comes before the valve and one after. Non-linearity distortion is considerably reduced by this means.

Fig. 7 gives the results of measurements on the complete output stage, with component values as shown in Fig. 1.

(To be concluded)

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[6] "Newly Developed Amplifiers for the Sound Programme Chain" by S. D. Berry, *B.B.C. Quarterly*, Summer 1954.

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[9] "High-Quality Amplifier: New Version" by D. T. N. Williamson, *Wireless World*, Nov. 1949.

[10] "Pickup Input Circuits" by R. L. West and S. Kelly, *Wireless World*, Nov. 1950.

[11] "Filters" by "Cathode Ray," *Wireless World*, Jan. and Feb. 1950.

[12] "The Miller Integrator" by B. H. Briggs, *Electronic Engineering*, Aug., Sept. and Oct. 1948.

[13] "Design of High-Pass, Low-Pass and Band-Pass Filters Using R-C Networks and D.C. Amplifiers with Feedback" by C. C. Schumard, *R.C.A. Review*, Dec. 1950.

Dates for Your *Wireless World* Diary

INDIVIDUAL announcements have already been made of the dates of many of this year's exhibitions, but for the convenience of readers we give below a list of the principal shows in 1955.

Television Society Exhibition University College, Gower St., London, W.C.1.	**Jan. 6-8**
Components Show (R.E.C.M.F.) Grosvenor House, Park Lane, London, W.1.	**April 19-21**
Physical Society Exhibition New Royal Horticultural Hall, Westminster, London, S.W.1.	**April 25 & 28**
Association of Public Address Engineers Exhibition Horseshoe Hotel, Tottenham Court Rd., London, W.1.	**April 27 & 28**
Northern Radio Show City Hall, Manchester.	**May 4-14**
British Sound Recording Association Exhibition Waldorf Hotel, Aldwych, London, W.C.2.	**May 21 & 22**
British Plastics Exhibition National Hall, Olympia, London, W.14.	**June 1-11**
National Radio Show Earls Court, Fulham, London, S.W.5.	**Aug. 24-Sept. 3**
Farnborough Air Show (S.B.A.C.) Farnborough, Hants.	**Sept. 5-11**

NEW ACOUSTICS LABORATORY

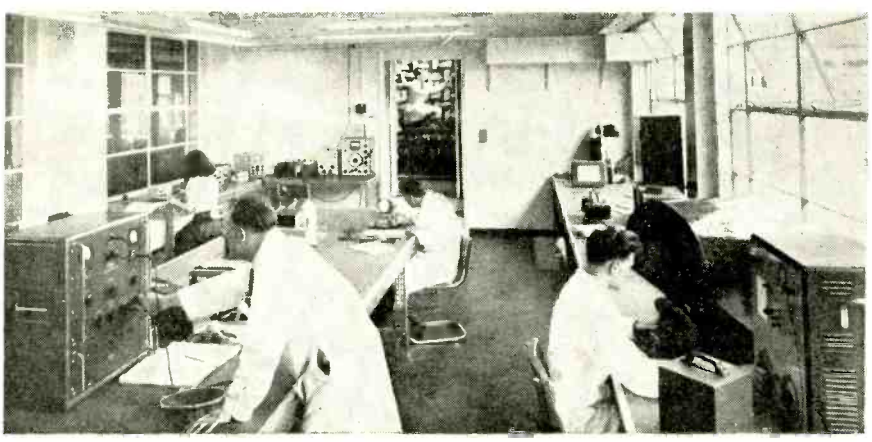
A NEW wing has been added to the laboratory of Goodmans Industries, Ltd., at Wembley for research and development in the production of loudspeakers, microphones and other electro-acoustic devices.

The main feature of the new extension is an echo-free room with a volume of 4,500 cu ft lined with glass fibre wedges 8in square at the base and 3ft long. The whole room floats on rubber supports and although a main line railway is only 100ft away, structurally borne vibrations are negligible. The unusually deep lagging presents problems in the design of the door, which must, of course, be similarly treated. These problems have been solved by mounting the door on vertical guides and raising it electrically into a tower on the roof of the building when access to the room is required.

In addition to normal frequency response curves, measurements of "hang-over" transients are also made by a tone pulse technique, and this has proved useful in investigating cabinet as well as loudspeaker performance.

Auxiliary equipment includes a high-speed level recorder (1,000 db/sec), electrical and acoustical standards and instruments for measurement of compliance and other mechanical parameters.

The services of the laboratory are available to set manufacturers for testing prototype designs and ensuring that harmonious acoustic relations exist between loudspeaker and cabinet.



Goodmans Industries acoustics laboratory, showing in the background the entrance to the echo-free chamber.

Education and Training

Can We be Satisfied with the Results?

By FRANCIS REECE

THE tremendous demand for radio engineers and technicians is reflected in the many advertisements which appear not only in the technical press, but also in the lay press. There has been no easing of the shortage of manpower over the past ten years, and it may be assumed that this is a serious handicap to a fast developing industry.

Why is there such a shortage when the importance of technical education is so widely appreciated and public interest in technology in this country is greater than ever before?

It is popular to criticize the lethargy of the younger generation. Be that as it may, employers cannot complain at the number of young men who are sufficiently attracted towards employment in the radio field to embark upon long and arduous courses of instruction. In fact, there has been a very large increase in the number of candidates taking the examinations of the City and Guilds of London Institute, the Institution of Electrical Engineers, and the British Institution of Radio Engineers.

Whilst, however, large numbers of students undertake courses of study, comparatively few successfully complete the courses. Every technical college reports that at the end of each academic year a number of students give up their courses either because of their waning interest or an inability to assimilate the work. One London technical college has reported, for example, that 50 students started on the first year of an Ordinary National Certificate course, but by the end of the third year only 25 actually attempted the final examination leading to the award of the certificate. Of that 25, only 5 went on to attempt the Higher National Certificate. Similar figures have been given in respect of courses in preparation for the City and Guilds Full Technological Certificate and other examinations.

These facts are of supreme importance in estimating the future number of engineers, as distinct from technicians, likely to enter the radio industry. The bulk of the engineers already employed and certainly the majority of future engineers, will come from the technical colleges with a Higher National Certificate or having directly passed the examinations of the I.E.E. or the Brit.I.R.E.

A Popular Misconception

It is a popular misconception that engineers have necessarily to be university graduates. The majority of the engineering staff of any firm or Government organization have not had the advantage of a university education. Indeed, the number of graduates securing degrees in the appropriate engineering faculties. could not possibly meet the present enormous demand for junior and senior development and research engineers. Moreover, the number of engineering degrees awarded in Great Britain has decreased in the last two years. Thus, in the main, industry must look to the technical colleges to provide the majority of men for whom there is at present such a demand.

It may be argued that much of the trouble lies in preliminary education. The minimum level of basic education laid down by the professional institutions is the Common Preliminary Examination conducted by the Engineering Joint Examination Board. This requires success in English, mathematics, elementary physics and a foreign language, and exemption is granted from it to the boy (or girl) who has obtained a pass in these subjects in the General Certificate of Education at the ordinary level.

Unfortunately, figures are not available to indicate how many grammar school boys enter the engineering profession, including the radio industry. Apart from this source many of the engineers of the future will receive their basic education in the secondary modern schools. It is, however, a deplorable fact that very few of these schools train their pupils for the General Certificate of Education even in two or three subjects.

Under the provision of the 1944 Education Act children not admitted to either grammar or secondary modern schools finish their education in the secondary technical schools. For the purpose of these notes such pupils need not enter into our reckoning, although doubtless many of them are ultimately engaged in engineering in an unskilled capacity or as craftsmen or mechanics. A few may have the tenacity to carry on with part-time studies to qualify for better positions.

Is Basic Education to Blame ?

The bulk of students taking the Ordinary National Certificate or similar courses at a technical college come now from the secondary modern schools and have not had the advantage of a grammar school education. It may well be that this lack of basic education accounts for the large wastage now being experienced in second and subsequent years of technical college courses.

The question may, therefore, be asked as to whether the eight years working of the new Education Act is in any way responsible for the very high percentage of failures in the C. and G., I.E.E., and Brit.I.R.E. examinations. Whatever the reasons, the fact is that since the war the number of young students attracted to the radio engineering career has steadily increased. In 1953, for example, the C. and G. had a record entry of over 30,000 candidates for their various examinations in telecommunications. Of this number only 394 succeeded in obtaining an Intermediate Certificate, 139 were awarded a Final Certificate, and 67 obtained the Full Technological Certificate in Telecommunications Engineering (Radio).

Success in the Full Technological Certificate exami-

nation in telecommunications only secures partial exemption from the appropriate professional examinations of the I.E.E. and the Brit.I.R.E. The younger engineer usually looks forward to qualifying for membership of one of these professional bodies. Some consideration must therefore be given to the experience of these institutions in assessing the technical qualifications of their prospective members, whether by direct examination or by granting exemption.

According to the last annual report of the Brit.I.R.E. the results of its own examination are very disappointing. Whilst the number of entries is now over 1,000 a year, fewer than 6% of the candidates pass the graduateship examination.

The I.E.E. runs a different scheme of examination but it is sufficient for our purpose to consider the results of its Section B, which includes the optional subject of radio communication. The I.E.E. does not distinguish between candidates taking radio communication and the electricity supply subjects in its summary of results, but in 1953 it had 722 candidates writing the Section B subjects, of which only 152 succeeded. Thus, although the percentage of success may vary between the three examining bodies mentioned, the over-all result must be disappointing to both the entrants and those who are looking for an increased entry to the engineering ranks of the radio industry.

Varying Standards of Instruction

It is true, of course, that apprentices, trainees and others may meet the requirements of their individual firms by obtaining National Certificates. In 1953 over 7,500 Higher and Ordinary National Certificates (Electrical Engineering) were awarded, but figures are not available to show how many of these certificates were in respect of radio or telecommunication subjects. The pass standard required for National Certificates seems to be a little lower than that required for success in external examinations, but an important additional requirement is that the candidate's course work is also taken into account. Furthermore, the radio content of a course for the H.N.C. varies according to the college. There are all too few colleges in Great Britain able to offer a course leading to a Higher National Certificate in radio subjects. Indeed, the I.E.E. issued a memorandum in 1950 which stated that only 20 such colleges were offering approved courses in radio and telecommunications engineering (including line communication).

Courses in preparation for National Certificates or the examinations of the C. and G., I.E.E. or Brit.I.R.E. are the first steps which must be taken for qualification as an engineer by a candidate not having the advantage of a university education. Only from these sources can the industry recruit the type of engineer who, graduating through the technician and junior ranks, can undertake responsibility for development and production. Such experience must be coupled with proper training for ultimate employment in senior positions.

A Select Committee has recently issued a report in regard to the manpower requirement of the Royal Air Force. The shortage is particularly acute in the electronic field. Thus the Services now add their claim upon the too few people available to industry.

Surely the first step towards solving this problem is for the Ministry of Education, the C. and G. and the engineering institutions concerned, to make a detailed investigation as to the reasons for the poor results in their examinations and the National Certificate scheme. If the answer is that the calibre of the candidates is too low because of the inadequacy of basic education, then the Ministry of Education has it in its power to alter the application of the 1944 Education Act. The present writer suggests, however, that the failure lies not so much with basic education as with the inadequacy of subsequent technical instruction. Various reports, including one issued by the Parliamentary and Scientific Committee, have suggested that there is a shortage of properly qualified lecturers and that the colleges are handicapped in not possessing suitable equipment. There has also been little progress with the proposal that lecturers should have better opportunity to secure industrial experience with corresponding release of industrial engineers to undertake part-time teaching.

A further factor in trying to produce better results is the need to overcome the reluctance of some colleges to provide courses specifically designed for the radio engineer. Many of the existing syllabuses were drafted for the training of the electrical engineer. The addition of one subject in radio in the final year of a course for the H.N.C. is not generally thought to be sufficient to meet the needs of a rapidly expanding industry.

The third possibility is to consider whether the examining bodies demand too high a standard. Everyone would welcome these various bodies reconciling their differences of opinion. If they did so the technical colleges would be greatly helped in the arrangement of their courses. Concerted and agreed opinion would also influence training at the grammar school level.

Pros and Cons of Specialization

The C. and G. has always been primarily concerned with the training of the mechanic and technician. In more recent years, however, it has developed these interests to a more advanced level for the radio and telecommunications engineer. To this extent they are encouraging specialization.

On the other hand the I.E.E. does not fully subscribe to any degree of specialization, as will be seen from a perusal of its examination syllabus. This, however, does not necessarily account for its slightly better percentage of examination successes when compared with those recorded by the C. and G. and the Brit.I.R.E. In general the I.E.E. insists on a broader education in general engineering, with emphasis upon practical laboratory work.

Rather naturally perhaps the Brit.I.R.E. appears to subscribe to the policy of specialization. The tendency is to attach more importance to physics than would normally be followed in an O.N.C. course; possibly the main criticism of the Brit.I.R.E. is that it encourages specialization within two years of starting a general engineering course. This insistence upon specialization in depth might therefore account for the small percentage of successes in its graduateship examination.

In only one respect does the National Certificate examination scheme and the examinations of the two institutions agree—that of insisting upon some system of approved courses requiring actual attendance and the provision of suitable laboratory work. In the case of the C. and G. there is no insistence on the satisfactory completion of an approved course. The candi-

date alone decides when he will take the examination and the temptation to "have a go" may account for many of the failures. The Brit.I.R.E. appears to have realized that this factor contributes to the low percentages of success and is now insisting that candidates for the examination must provide evidence of supervised course work.

There is much discussion on the proper way of using an engineer once he has been recruited. The unskilled worker, the mechanic, and the technician are all needed by the industry. The future development, and the grasping of opportunities at hand in the radio industry, will be lost unless the engineer is recruited at the right age and with the requisite basic education.

It is not the function of this article to discuss the opportunities which are available to the properly trained young engineer. It is true that unfavourable comparison is very often made with the returns available elsewhere to unskilled labour. Nevertheless the interest of a comparatively new and growing art continues to attract large numbers of young men. The fact that they fail to achieve their goal must reflect on the education and training that they receive.

Education and training will continue to be a subject in which industry must take an increasing part. As employers, however, they are not alone in this responsibility for the same story of shortage of radio and electronic engineers is to be found in the Civil Service, the Navy, the Army, and the Air Force. Even the B.B.C., with its own internal system of training, is continually advertising vacancies for radio engineers.

Last year the Radio Industry Council published a most useful pamphlet "Careers in Radio and Electronics" dealing with the need and the opportunities for the young engineer in the radio industry. The booklet was a further indication of industry's realization that it has a very important part to play in the training of the engineer of the future. Certainly, the opportunities available within the industry for "sandwich" courses and other methods of part-time study, coupled with experience, are a great advance upon the facilities available to the pre-war student.

The R.I.C. estimated that up to 3,000 boys a year can be absorbed by the industry. No account was taken, however, of the demand for radio engineers outside the industry, and the developments already mentioned, including the Services' requirement, probably means that at least double this number is required every year if all demands are to be reasonably satisfied. All the more reason, therefore, to ensure that available material is properly trained and not wasted. The first essential is to retain the interest of the student in the early years of his technical training. Unless this problem is tackled, the tendency must be for the younger man to take advantage of the opportunities in other fields, to the subsequent detriment of future development in the radio industry.

Can we, therefore, be satisfied with the results achieved by our present method of technical education?

PUBLICATION DATE

***Wireless World* will in future appear on the fourth Tuesday of the Month preceding that for which it is dated. The February issue will therefore be published on 25th January.**

Radio Officers' Training

Colleges Providing Courses

THE particulars included in the lists of further education establishments published in our September and October issues last year were provided by the Ministry of Education and included only those colleges, etc., which come under the direct control of the Ministry. They do not, therefore, include the privately operated wireless schools throughout the country which provide training for prospective radio officers. The following establishments in the United Kingdom are licensed by the P.M.G. to use transmitting equipment for instruction purposes.

Bridlington
North Eastern School of Wireless Telegraphy, Radio House, Shaftesbury Road, Bridlington, Yorks.

Grimsby
Grimsby Nautical School, Orwell Street, Grimsby, Lincs.

Hull
Municipal Technical College, Park Street, Hull, Yorks.

Leamington Spa
Midland Wireless School, 2, Myton Croft, Myton Road, Leamington, Warwicks.

Liverpool
Riversdale Technical College, Riversdale Road, Liverpool, 19.
Wireless College, 6, Princes Road, Liverpool, 8.

London
British School of Telegraphy, 179, Clapham Road, London, S.W.9
Wireless School, Radio House, 21, Manor Gardens, Holloway, London, N.7.
London Telegraph Training College, Morse House, 20, Penywern Road, Earls Court, London, S.W.5.
Norwood Technical College, Knight's Hill, W. Norwood, London, S.E.27.

Manchester
Wireless Telegraph College, 25, John Dalton Street, Manchester.
College of International Marine Radiotelegraphic Communication, Overseas House, Brook's Bar, Manchester, 16.

Plymouth
Plymouth and Devonport Technical College, Tavistock Road, Plymouth, Devon.

Preston
Northern Counties Wireless School, 91, Lancaster Road, Preston, Lancs.

Southampton
The University, Southampton.
Air Service Training School of Radio and Radar, Hamble, Hants.

South Shields
Marine School, Ocean Road, South Shields, Co. Durham.

SCOTLAND

Aberdeen
Marine Radio College, 56, Union Street, Aberdeen.

Edinburgh
Edinburgh Wireless College, 17, Gayfield Square, Edinburgh, 1, Midlothian.
Leith Nautical College, Leith, Edinburgh, 6, Midlothian.

Glasgow
Glasgow Wireless College, 26, Newton Place, Glasgow, C.3, Lanarks.

Greenock
Watt Memorial School, Dalrymple Street, Greenock, Renfrews.

WALES

Cardiff
Cardiff Wireless College, 1, Stuart Street, Docks, Cardiff, Glam.

Colwyn Bay
Wireless College, East Parade, Colwyn Bay, Denbighshire.

NORTHERN IRELAND

Belfast
Marine Radio College, Orlington House, 2, Eglantine Avenue, Lisburn Road, Belfast.

"Special Quality" Valves:

Improvements in Electrical Characteristics as Well as in Reliability

By E. G. ROWE,* M.Sc., A.C.G.I., D.I.C., P. WELCH* and W. W. WRIGHT,* B.Sc., A.Inst.P.

IN our company, we started work on reliable valves in early 1949 because of complaints about valve failures in an automatic pilot equipment. We then expanded our efforts in order to help our Radio Division to produce equipment which would successfully pass flight trials. The real impetus, however, was provided by the Services, who later in the same year placed large-scale development contracts for the design of reliable valves to be plug-in replacements for types on the Preferred List.

Our work showed that whilst human errors in manufacture played a part in producing failures, the basic valve designs needed attention. The major problem was that most valves had loose structures which gave rise to noise and characteristic instability, whilst some had structures of such dimensions that low frequency resonances were inevitable. Fig. 1 shows the proportions of noise output contributed by the various valve components.

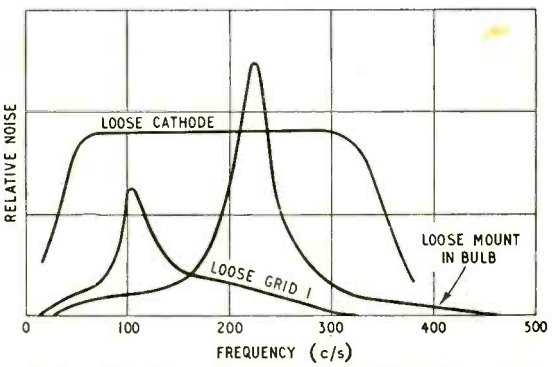


Fig. 1. Contribution of various parts of the valve structure to noise output.

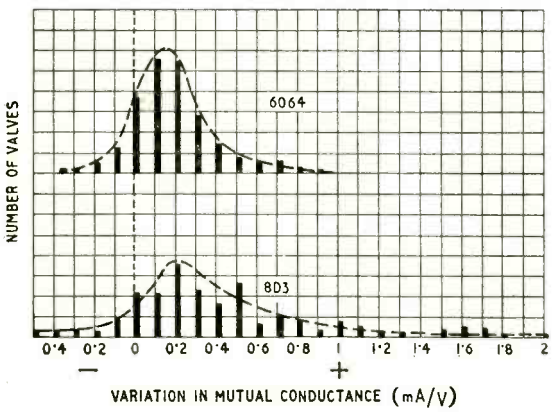


Fig. 2. Comparison of mutual inductance spread between type 8D3 and its special-quality equivalent, 6064, in 500 hours static life test.

Some manufacturers tended to take panic measures on the principle that if more struts were added to the valve structures then they would be bound to be more reliable, but our view has always been that a more scientific approach would pay dividends, even though it might take longer in actual time. Our philosophy was that before a valve design was considered suitable for production it had to be analysed for noise, and a resonance search test equipment designed by Dr. H. Moss proved invaluable for this purpose. Its disadvantage was that valves had to be made up first and then tested, but since then we have devised empirical formulae to forecast in advance whether the individual components would produce objectionable resonances. Thus this particular piece of test gear has now become a routine checking instrument only.

Cathode Poisoning

The most serious cause of valve failures, other than short life catastrophes, was found to be the evolution of gas, resulting in cathode poisoning. The cause of this was traced to frictional movement between the mica insulators and the valve envelope and components, and the elimination of this has been the most important contribution to valve longevity under conditions of vibration and shock.

The techniques used to overcome such troubles, and the results obtained, have already been described in *Wireless World*†. Work done on these mechanical improvements has also shown some very gratifying results with respect to the electrical characteristics. Not only has it been possible to produce redesigns which are electrically interchangeable with the existing types, but added advantages have been obtained in that there is a significant reduction in characteristic spread, a lower drift of characteristics in early life, reduced electrical noise and improved microphony performance. Fig. 2 shows a typical improvement in mutual conductance spread and Fig. 3 relates to the low frequency noise distribution.

In addition, it has been established that many of the theories held regarding valve instability are second-order effects compared with the advantages resulting from mechanically strengthening the valve structure. As an example, it has been possible to produce double triodes for d.c. amplifier work and Fig. 4 shows the improvement achieved on the type 6158.

The successful elimination of early life catastrophic

* Brimar Engineering Division, Standard Telephones & Cables.
This article makes use of some of the information and diagrams in a paper "Thermionic Valves of Improved Quality for Government and Industrial Purposes," to be published in *Proc. I.E.E.*

† "Trustworthy Valves," by E. G. Rowe. *Wireless World*, March, 1952.

failures under vibration is shown in Fig. 5, which compares the 8D3 with the 6064 and also demonstrates the improvement which can be achieved by selective testing of ordinary commercial valves.

With normal static life testing we have used a method popular in the U.S.A. and based on a 500-hour life test. At the end of the run the average life of the group of valves is assessed by using the formula:

$$\text{Average life percentage at } x \text{ hours} = \frac{\text{Sum of life hours for all valves under test}}{x \text{ hours and number of valves started}} \times 100$$

American specifications for the minimum acceptable life performance give a figure of 80 per cent for normal commercial valves and 95 per cent for the reliable types, while R.C.A. quote 97 per cent for their Red Series. Our figures on three of our "Trustworthy" types are 99.82 per cent, 99 per cent and 100 per cent respectively.

Having said something about the design of reliable valves, let us now look at the manufacturing problems.

An average valve has seven glass-to-metal seals and 35 welds, with over 800 separate and distinct manufacturing steps to convert the raw material into the finished product. The production engineer has the task of manufacturing mass-production quantities of such complex articles with the minimum variation of mechanical, chemical and human tolerances. The problems of reliability resolve themselves into greater efforts to control the materials, the processes and the operators' variability.

There are two schools of thought regarding the place in which special quality valves should be made. One advises an entirely separate location from the ordinary types, but much can be said in favour of their manufacture in the centre of the main assembly groups, so that with strong supervisory control the effect of the lessons learned will have a large psychological effect on the whole factory. This point is doubly important when it is realized that in the event of another war very large numbers of special quality valves will be demanded.

To obtain the high quality demanded it is necessary to have continuity of production over long periods and the corollary to this is that the diversity of valve types shall be limited as much as possible.

Mass-Production Outlook

Initially the assembly of "Trustworthy" valves was done on a time-work basis with no incentive towards speed. However, it was found that this was so alien to the mass-production outlook in valve manufacturing that a change was made to operate teams controlled by a quality control system working on each assembly position. It has now been possible to introduce an incentive scheme based on quality and quantity, and a study of the results has demonstrated that when an operator is given a simple sequence of jig-aided operations the work begins to flow at her natural rate with maximum efficiency.

The achievement of failure rates as low as 2 per cent per 1,000 hours is not dependent solely upon structural design and the control of the manufacturing

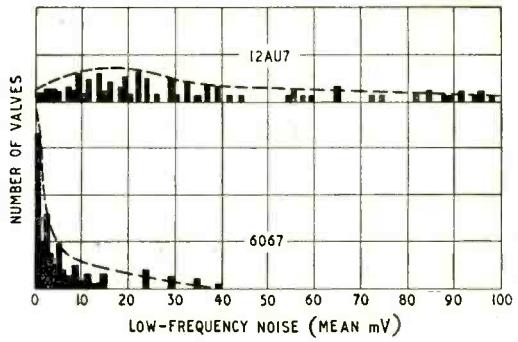


Fig. 3. Comparison of low-frequency noise output distributions for type 12AU7 and its special-quality equivalent, 6067.

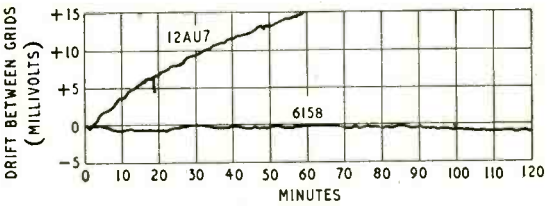


Fig. 4. Comparison of drift performance between type 12AU7 and special-quality type 6158 (equivalent to 13D3).

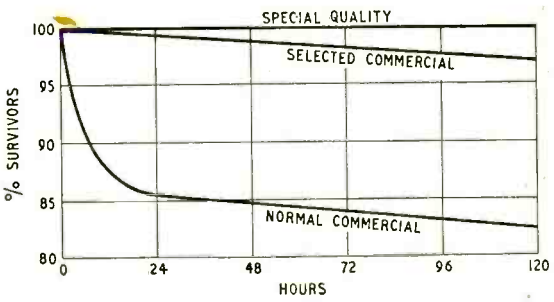


Fig. 5. Comparison between special quality, selected commercial and normal commercial valves for survival under vibration (470 c/s at 3.5g for a period of 120 hours).

unit. Good design and manufacturing controls combine to ensure that the manufacturing variations will be small and that there will be a few random faults or errors, but they cannot guarantee their complete elimination. It is imperative, therefore, that a form of valve testing shall be adopted which takes into account both "manufacturing variations" and "manufacturing errors." The development of suitable testing procedures is very important, as it is easy to evolve a series of unwieldy tests which can make large-scale production impracticable.

So much for the problems involved in making reliable valves—but the matter does not end there. The contribution required from those who use valves is a very large and vital one. It is the very versatility of the valve which gives so much scope to the circuit designer's ingenuity.

It may not be appreciated that the rate of failures of specific valves in different equipments can vary by a factor of 10. This can best be minimized by co-operative effort between the designers and the valve

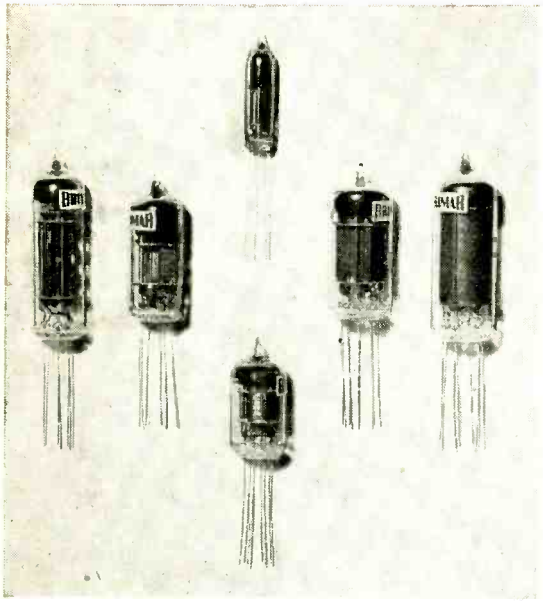


Fig. 6. Typical examples of flying-lead valves.

makers. The valve manufacturer makes the request to all designers that they should take full advantage of his intimate knowledge of the idiosyncrasies of valves. Valves are defined by specifications, but these can only cover the applications known and visualized at the time the valve was introduced. Close collaboration can ensure that all valves which meet the test specification will perform satisfactorily in service and will enable the valve maker to carry out adequate checks to cover any use of special characteristics. By this means a compromise is reached whereby the most suitable valve for the job is used, from the point of view characteristics and continued availability, and the best-known circuitry is utilized to accomplish its purpose.

Avoiding Glass Fractures

Now for the equipment manufacturer. Reliability can depend on more mundane matters than circuitry and valve characteristics. The valve is a glass article and should be treated as such. Glass is severely weakened by the minutest of scratches, and jumbling valves together in a box, for example, will produce scratching by the nickel pins. Modern valves such as miniatures have a complex multiple glass-to-metal seal, and leaks result from strains caused by mechanical incompatibility with the valve-holders. It is therefore important that wiring jigs shall be inserted into all holders before chassis wiring takes place, and as the valve pins are easily distorted on handling, all valves should be pin-straightened in a proper jig, and not with pliers, immediately before insertion into holders.

In circuit testing the valve should not be tapped harder than is necessary to check for noise. The tendency to use a screwdriver for this purpose is unfortunate.

It may be thought that some of these comments are irrelevant, but experience has shown that such practices are common and contribute materially to setting up conditions which cause delayed fractures some time after the installation of the equipment. The recent publication of a Code of Practice, CP.1005, on the correct usage of valves, should be learnt by heart by all designers, and is every bit as important in our sphere as the new Highway Code is intended to be to the road user.

It is obvious that electronic equipment in the future is likely to become more and more complex, and it is important that steps are taken to see that circuit complexity and unreliability do not become synonymous. The equipment designer must create and engineer his apparatus so that it becomes just a "black box" as far as the user is concerned. As an example, the telephone is a simple device to the user, yet we are all aware of the complexity of automatic telephone equipment. It is therefore increasingly important that equipment is designed conjointly with *all* component manufacturers and with adequate thought given to problems that will confront the user.

Now, what about the valve outlook—present, past and future?

Valves for the immediate future are taken care of by an adequate number of reliable miniature types. The past can best be dealt with by applying the testing techniques established for reliable valves to the domestic manufacture of the older types of valves, thereby eliminating the early life catastrophic failures due to unsatisfactory workmanship.

Further improvements in valve reliability must be at the expense of the present type of valveholder. Incompatibility between this and the valve pin positioning can cause failures in excess of the target achieved by the valves alone, and it is logical to adopt wired-in techniques which, in addition to reducing failures, can permit greater exploitation of the valve characteristics. There is a great need for bright circuit engineers to cast aside the chains of present circuit-technique thinking. They should regard these wired-in valves as new tools to be used on their own merits and in circuitry designed to use them to their full capabilities, so that the whole ratio of ironmongery to electronic circuitry is drastically changed. Some typical wired-in types are illustrated in Fig. 6.

As valve makers we dislike intensely the suggestion of unreliability which is cast at the electronics industry. One rarely hears such comments in the civil and mechanical engineering fields, but we are confident that we are on the brink of an era when electronics will have grown up and will have no more of this slur.

NEWS FROM THE CLUBS

Kingston-on-Thames.—The Osram 912 amplifier and G.E.C. metal-cone loudspeaker will be demonstrated at the meeting of the Kingston and District Amateur Radio Society at 7.45 on January 13th at Penryn House, Penryn Road, Kingston-on-Thames. Sec.: R. S. Babbs, 28, Grove Lane, Kingston-on-Thames, Surrey.

Cleckheaton.—The meeting of the Spen Valley and District Radio and Television Society on January 12th at 7.30 in the Temperance Hall, Cleckheaton, will be devoted to films. On the 25th members will meet the Bradford Radio Society in a quiz at Cambridge House, Bradford, Yorks. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds, Yorks.

Coventry.—At the meeting of the Coventry Amateur Radio Society at 7.30 on January 3rd at 9, Queens Road, Coventry, T. R. Theakston will speak on "Mathematics." Sec.: K. G. Lines, G3FOH, 142, Shorncliffe Road, Coventry, Warwicks.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by correspondents

"*Inexpensive 10-Watt Amplifier*"

IN his criticism in your November issue of the Baxandall type of amplifier your correspondent John Brighton underrates the benefits of negative feedback when applied to tetrodes and pentodes working into loudspeaker loads.

An increase in load impedance, such as occurs at high and low frequencies, will cause the "violent increase in third-harmonic distortion" mentioned only if the signal voltage is maintained constant, and occurs on account of the increased anode-voltage swing. When negative feedback is applied, even in small amount, the grid-voltage swing is automatically adjusted to maintain the output voltage reasonably constant against load variations, and the condition which would cause the sudden increase in third harmonic distortion is prevented from arising. It is a fallacy to say that negative feedback can only reduce distortion to the same extent as the gain; where the feedback prevents an overload, as in this case, the reduction can be much greater for the cause of the distortion is, in fact, removed.

Apart from this consideration, of course, the quoted typical figure of 40 db for feedback would apply only for the correct load condition. An increase in load also causes a corresponding increase in loop gain, and on this account alone the picture would be brighter than that painted by Mr. Brighton.

Chislehurst, Kent. D. J. R. MARTIN.

YOUR correspondent, John Brighton, in your November issue, raises again the hypothetical objection to the use of tetrodes in the output stage of a "quality" amplifier, but what, might we ask, does this alleged "violent" increase in third harmonic distortion really amount to in practice? Precious little!

The real reason why the Baxandall amplifier has not become popular is more likely to be owing to the fact that it requires 4 volts r.m.s. to give full output, which in many cases is inconveniently insensitive. A big point in its favour, however, is that it is a very "sanitary" design, meaning that its author's specification of performance can be achieved with ease. Despite protestations to the contrary, I do not think that this is quite so true of the Williamson. Constructors would be very well advised always to check performances with square waves as Baxandall suggests, and prepare themselves for some shocks!

Enfield, Middx. J. K. WEBB.

JOHN BRIGHTON, in his letter published in the November issue, suggests that tetrodes are less desirable than triodes for use in the output stage of a high-quality loudspeaker amplifier employing negative feedback, because of increased third-harmonic distortion when the load impedance becomes reactive and/or higher in value than the nominally correct value.

The following experimental results have been obtained recently, on an amplifier which is the same as that described in my article in *Wireless World*, January, 1948, except for the use of a smaller and cheaper output transformer with a silicon-steel core.

TABLE

Load Resistance (ohms)	11	13	15	17	20	25	30	∞
Third Harmonic Distortion (per cent)	0.172	0.089	0.070	0.061	0.056	0.053	0.052	0.042

With a 15-ohm load resistor connected to the output, a 500-c/s sine-wave input, of negligible third-harmonic content, was adjusted to give a mean power output of 10 watts; i.e., an output voltage of 12.2 volts r.m.s. With the input voltage kept constant, the value of the load resistor was then varied, and the effect on the third-harmonic distortion was as shown in the table.

An air-cored inductor, having a reactance of approximately 15 ohms at 500 c/s, was then connected across the amplifier output, and it was found that the third-harmonic distortion, at a level of 12.2 volts, was considerably less than with a 15-ohm resistive load. Reduced distortion was also obtained with a 16-μF capacitance load.

The above results thus show that, with this amplifier, the distortion is not critically dependent on either the value or the phase angle of the load, and that an increase in load impedance actually causes a reduction in distortion. What, then, is wrong with Mr. Brighton's argument?

In the absence of feedback, it is perfectly true that an increase in the load impedance of a tetrode amplifier, with constant signal input, causes an increase in third-harmonic distortion.* It should be noted, however, that there is also an increase in output voltage and an increase in gain.

When a large amount of voltage negative feedback is applied to a tetrode amplifier, on the other hand, an increase in load impedance causes almost no increase in output voltage, the feedback automatically reducing the signal applied to the grids of the output valves by the appropriate amount. Since this reduction in grid swing is accompanied by an increase in the forward gain of the feedback loop (i.e., more decibels of feedback are brought into play), it is hardly surprising that the third-harmonic distortion falls off as the load impedance is increased.

It would thus appear that Mr. Brighton has overlooked the beneficial effects of reduced grid swing and increased loop gain which automatically occur when there is a rise in the load impedance of a feedback amplifier using tetrodes.

Malvern. P. J. BAXANDALL.

* See, for example, Fig. 13.30, p 570, "Radio Designer's Handbook," Fourth Edition.

"*Quality on V.H.F.*"

I AM surprised and disappointed to learn from H. Bishop's rejoinder (December issue) to your editorial that it is not the B.B.C.'s intention at least to try to transmit as many programmes as possible that justify high quality, with a full 15-kc/s frequency response. The B.B.C. apparently intends to use ordinary Post Office music circuits for all its transmissions. These, I believe, are equalized only up to 8,500 c/s, and hence constitute a poor feeder for quality transmitters.

Mr. Bishop states that the better quality is brought about by the improved signal/noise ratio. I take it that the P.O. music circuis are better than the f.m. transmitters in this respect. However, surely the main advantage to be gained from a better signal/noise ratio is the wider dynamic range attainable. Even this, I suppose, will not be realized, as the programmes will be common to both f.m. and medium-wave transmitters, and the manual compression necessary for the latter is done at the studios. It is also unfortunate that this compression is more noticeable on f.m. as the now discernible concert hall atmosphere and microphone hiss rise and fall. The outlook certainly looks black for music lovers and quality enthusiasts, of which there must now be a great

and quickly increasing number in the country—witness the expanding sales of "hi-fi" equipment and L.P.s; also the popularity of Mr. Briggs' lectures.

Surely a circuit equalized up to 15 kc/s could be provided from the local studios to the transmitters at a cost small compared to the cost of the transmitters themselves. A 15-kc/s line could also be provided to much-used concert halls—a small "hi-fi" network. After all, it is done for television, and up to 3 Mc/s, too, probably at a far greater cost than for 15 kc/s circuits.

Let us hope that, in years to come, a high-quality national network will enable, for example, Londoners to hear an Usher Hall concert with 15-kc/s bandwidth. However, why not start now with a few local circuits—why spoil the ship for a ha'p'orth of tar?

London, N.10. A. F. HARRISON.

Television Quality

I WOULD like to draw attention to the picture degradation that is evident in the regular B.B.C. television news and newsreel.

Bearing in mind the high standard of reproduction set by the previous newsreel, I feel that there can be little justification for the noticeably low picture quality, the snowstorm effect of innumerable scratches, spots and lines brought about by imperfect camera and development processes, and the unnecessarily large and often thrice-repeated cueing marks which could be easily replaced by other less obtrusive methods of cueing.

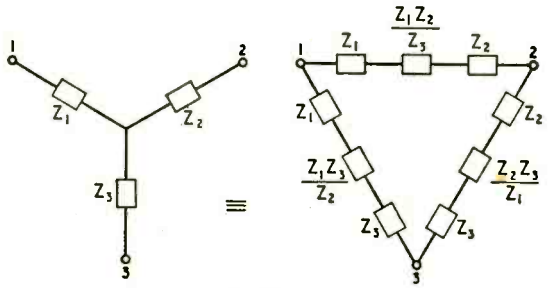
Perhaps quality is partly determined by the small gauge film techniques involved in producing a daily news film service and partly by the transcription equipment. It might be argued that no better equipment is available at present, but as far as the film is concerned there can be no excuse.

Instead of carrying on with the present feature, the B.B.C. might well consider reverting to the style and quality of the earlier newsreel until such time as they are in the position to operate with equipment and film processing techniques free from avoidable degradations.

London, S.W.4. G. T. CLACK.

"*Some Electrical Theorems*"

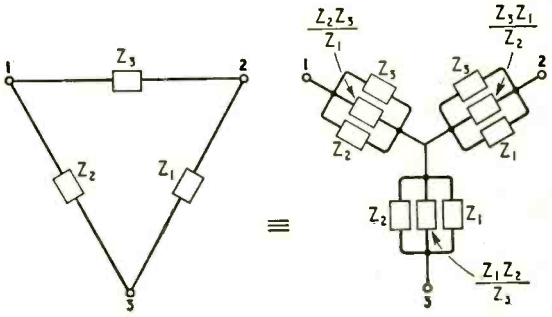
THE publication of this article by W. Tusting in the November issue of *Wireless World* recalls to mind a communication by Professor Williams* on a diagrammatic expression of the star-delta transformation.



Y−Δ, AS IN REFERENCE BELOW

It may be of interest that this expression can be simplified a little further if a change is made in labelling the impedances of a delta for which an equivalent star is required. The diagrammatic expression is then as shown in the accompanying diagrams.

The labelling of the delta will be recognized as corresponding to the commonly used method of identifying the sides and angles of a triangle.



Δ−Y, WITH CHANGE OF LABELLING

Portland, Dorset. H. V. HARLEY.

Mathematics

DO you not think, Sir, that the general tone of some of your articles tends to *increase* the non-mathematical reader's fear of mathematics? I have noticed repeatedly that "the mathematician" is regarded as some strange creature with a curious twist of mind quite beyond normal comprehension. For example, "Cathode Ray" spoke of the filter expert who disposed of the non-expert with a cosh, as though it were something dreadfully obtruse and difficult, whereas in fact the use of mathematics renders the subject easier, not harder, if one takes the trouble to learn it. And it is only a matter of taking trouble; one does not need to be in any way extraordinary.

I see that Thomas Roddam has heard mutterings in the undergrowth about his use of maths. (This is hardly surprising, since a non-mathematical reader doesn't know what a polynominal is anyway, and isn't encouraged when he notes that it is a Tchebycheff variety!) Surely this is all the more reason for trying to debunk the supposed difficulty of maths, not to encourage such an attitude. It is with great pleasure, therefore, that one notes W. Tusting's attempt (November issue) to popularize the use of the better-known circuit theorems. But *have* they got "high sounding" names? Or is it just imaginary difficulty with the theorems themselves which makes the titles seem a supercilious affectation on the part of "the mathematicians"? I fear it is the latter!

Harefield, Middx. F. V. BALE.

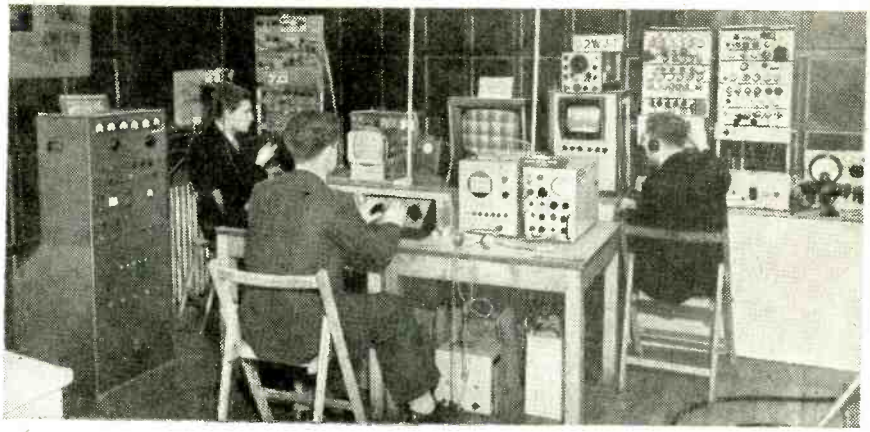
"*Neon Timers*"

IN your December issue B. T. Gilling advocates the use for photographic work of a timer which gives a constant interval irrespective of fluctuations in mains voltage. Surely this is not worth any bother and, in fact, the timer is better without it.

The visual light output of a normal filament mains lamp is proportional to approximately the fourth power of the mains voltage. The effect on normal blue-sensitive bromide paper presumably varies with an even higher power. An ideal photographic timer would, therefore, reduce the interval by, say, 6 per cent for each 1 per cent increase in mains voltage. To do this it would be necessary to have the capacitor charging voltage only a few per cent higher than the neon striking voltage. This is probably impracticable, as the interval would also vary rapidly with small changes in component values, etc., but at least it is clear that for photographic work a stabilized h.t. supply actually makes the overall performance worse as well as making the unit more expensive. For black-and-white work a normal timer is sufficient and for colour work the enlarger bulb must be run from a constant voltage source; the same can be used for the timer.

Bristol, 6. N. J. WADSWORTH.

* E. Williams; "Star Delta Theorem", *Wireless Engineer*, August, 1951, p. 258.



Amateur television station G2WJ/T as installed at the exhibition. On the extreme left is the 436-Mc/s transmitter, while the rest of the equipment consists of video control gear. Two cameras (not shown) were used for televising personalities, talks and demonstrations.

R.S.G.B. Exhibition

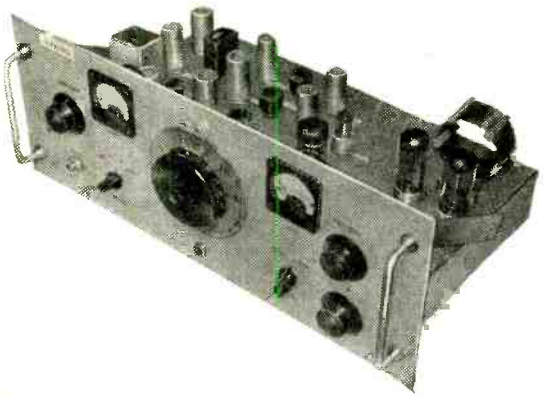
Amateur and Commercial Equipment at the Eighth Annual Show

SINGLE-SIDEBAND techniques were again very much in evidence at the recent show organized by the Radio Society of Great Britain, and their bandwidth-saving properties came in for special mention by Harry Faulkner, C.M.G., who opened the exhibition. Mr. Faulkner, as a former Deputy Engineer-in-Chief of the Post Office, once had a great deal to do with international frequency allocations and he said that anything concerned with saving space in the ether came very close to his heart.

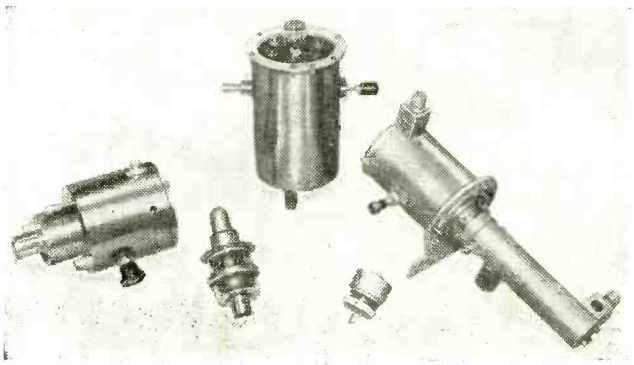
Two main methods of achieving single-sideband telephony transmission were actually represented. In one, known as the "filter" system, the audio signal is first modulated on to a low-frequency r.f. voltage and the unwanted sidebands resulting from the process are removed by a filter. (The "carrier" is suppressed by the use of a balanced modulator.) The remaining sidebands are then mixed with a high-frequency r.f. oscillation to produce the desired output frequency. In the other method, which seems to be more generally popular, the audio signal is first of all split into two components with a phase difference of 90° between them. An r.f. oscillation is similarly divided into two components and these are modulated respectively by the two a.f. signals and finally combined. The carrier again is suppressed by the use of balanced modulators, while the phases of the resulting sidebands are such that in the combined output one sideband is balanced out and the other is augmented. This method requires fewer stages but is perhaps more difficult to adjust.

One of the practical difficulties of the last-mentioned "phasing" method is in obtaining two a.f. outputs displaced 90° in phase, but one exhibitor was showing some small units designed for this purpose which are manufactured (on an amateur basis) and made available to other amateurs who feel unable to cope with the problem themselves.

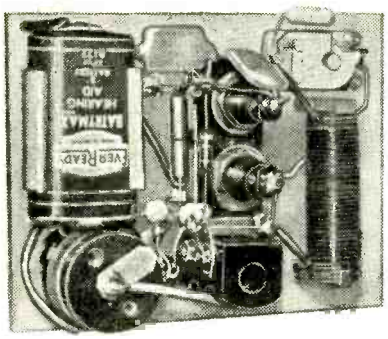
Another branch of amateur work praised by Mr. Faulkner was the active experimentation which has been going on for some time in the 70-cm band. He said that as the professional radio people seemed rather reluctant to move into Band IV the amateurs would now be able to lead the way once again, as they did in the old days. There was, in fact, a good



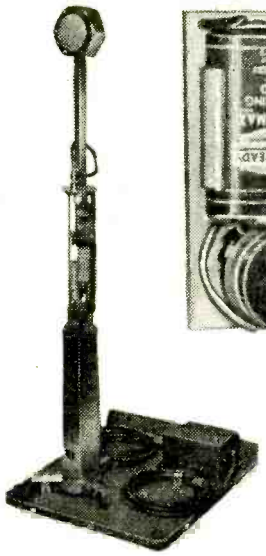
Representative single-sideband transmitter for operation on 3.8 Mc/s and 14 Mc/s.



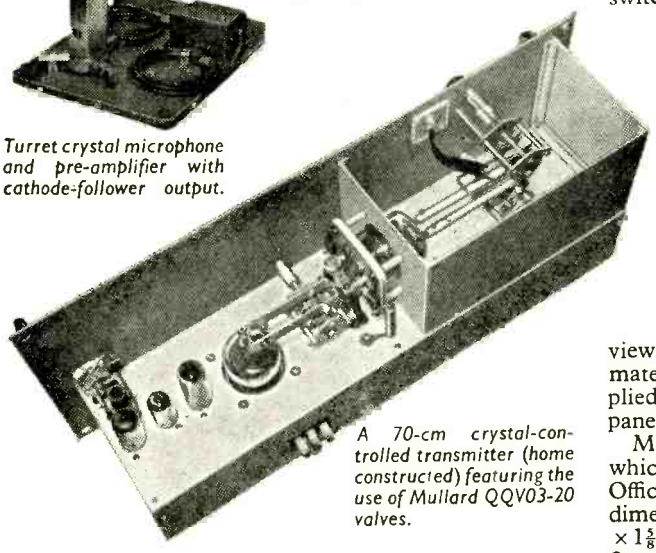
Right: Examples of workmanship in "plumbing" for operation on 70 centimetres.



Midget transistor transmitter operating on 7 Mc/s and powered by a hearing-aid battery.



Turret crystal microphone and pre-amplifier with cathode-follower output.



A 70-cm crystal-controlled transmitter (home constructed) featuring the use of Mullard QQV03-20 valves.

deal of 70-cm transmitting and receiving equipment on show with some very fine examples of workmanship in "plumbing" and tuned-line techniques.

Mr. Faulkner was, however, referring more particularly to the amateur television transmissions in the 70-cm band. These were represented at the exhibition by a complete amateur television station with two cameras and a transmitter working on 436 Mc/s. The r.f. output (20 watts peak white) was being absorbed in a dummy load, and from this a probe supplied an input to a 70-cm convertor, which represented the receiving side. The 45-Mc/s output from the convertor was then "piped" to various standard television receivers distributed about the hall. Apart from the cameras, the video side of the transmitting equipment included the usual sync-pulse and waveform generators, a 3-camera mixer unit, a monoscope unit and c.r.t. monitors for checking the video waveform and the outgoing picture. The transmission standards were 202½ lines non-interlaced.

Transistor transmitters are apparently becoming quite popular. The transistors at present available, however, are somewhat limited in their operating frequencies, and most of the transmitters on show were for working on either 1.8 Mc/s or 3.5 Mc/s. In one notable exception, however, the designer had succeeded in making the transistor oscillate at 7 Mc/s. The tiny transmitter (shown on the Brimar stand) was crystal controlled and it used a new point transistor made by Brimar, Type TP2, which officially has a maximum operating frequency of 2 Mc/s. Other new transistors shown by Brimar were the TP1 point type, for switching applications up to 100 kc/s, and the TJ1, TJ2 and TJ3 junction types for audio applications.

Brimar also had some interesting new miniature valves suitable for Band IV receiving circuits. The 6AM4 is an earthed-grid triode on the B9A base suitable for amplification or mixing, while the 6AF4 is a B7G triode intended for use as an oscillator. Both will operate at frequencies up to 1,000 Mc/s. Suitable circuits for these valves have already been described in *Wireless World*.*

Apart from the home-constructed transmitters there were two new commercial equipments on view, Both were fairly compact table models, with band switching from about 3 to 30 Mc/s. The Labgear model gave a nominal output of 150 watts while the Panda equipment was for the lower power of 35 watts. Amongst the new "prefabricated" transmitting units shown by the Minimitter Company was an aerial matching unit, which permits the separate tuning of open-wire feeders, and a 35 ft steel mast which is hinged in the middle to allow adjustments to be made to the aerial on top.

A comprehensive range of cabinets shown by Philpott's Metalworks included a portable instrument case for amateurs who like to give their home-constructed test gear a finished and professional appearance. The one on view, with a black crackle finish, measured approximately $8\frac{1}{2} \times 6\frac{1}{2} \times 4\frac{1}{2}$in, but other sizes can be supplied. Miniature racks, complete with chassis and panels, were also displayed.

Magnetic Devices were showing a useful new relay which is almost identical in operation with the Post Office Type 3,000 relay but is somewhat smaller. The dimensions (above chassis) are 2½in high × 1in wide × 1⅝in deep. A dust-proof can is provided. When fitted with a 10-kΩ coil the pull-in current is approximately 4 milliamps. An associated firm, Cathodeon Crystals, featured their quartz crystal units, which can now be supplied to order in as short a time as one week.

* "Valves for Bands III, IV and V," by D. N. Corfield. *Wireless World*, June, 1954, p. 272.

FIRMS SHOWING

Amos (Electronics), 45-49, High Street, Bletchley, Bucks.
Automatic Coil Winder and Electrical Equipment Co., Winder House, Douglas Street, London, S.W.1.
Cosmocord, 700, Great Cambridge Road, Enfield, Middlesex.
English Electric Valve Co., Waterhouse Lane, Chelmsford, Essex.
Enthoven Solders, Enthoven House, 89, Upper Thames Street, London, E.C.4.
General Electric Co., Magnet House, Kingsway, London, W.C.2.
Grundig (Great Britain), Kidbrooke Park Road, London, S.E.3.
Labgear (Cambridge), Willow Place, Cambridge.
Magnetic Devices, Exning Road, Newmarket, Cambs.
Minimitter Company, 37, Dollis Hill Avenue, Cricklewood, London, N.W.2.
Panda Radio Company, 58, School Lane, Rochdale, Lancs.
Philpott's Metalworks, Chapman Street, Loughborough.
Pye Telecommunications, Ditton Works, Newmarket Road, Cambridge.
Standard Telephones & Cables (Brimar), Footscray, Sidcup, Kent.
Taylor Electrical Instruments, Montrose Avenue, Slough, Bucks.

ELECTRONIC POSITIONING

Digital Methods for Automatic Control of Machine Tools

THE idea of controlling machine tools by electronic mechanisms may not seem very startling to the average radio or electronics man, but it is creating quite a stir in the engineering world. Various systems are being tried out, some more advanced than others, but they all have the same ultimate end in view: to replace the human operator, working his lathe or drill or milling machine, by an electronic apparatus controlled by a continuous input of information from some kind of storage medium, such as a punched card or magnetic tape.

The scheme is really intended for manufacturing relatively small quantities of precision machined parts where the use of normal mass-production techniques would be somewhat inefficient. Exponents of the idea say that it will be more accurate than using human operators (because electronic mechanisms don't get tired) and that the machine tools will be used more efficiently: the machining operation is carried straight through at maximum speed and the control apparatus does not have to stop periodically to scratch its head, so to speak.

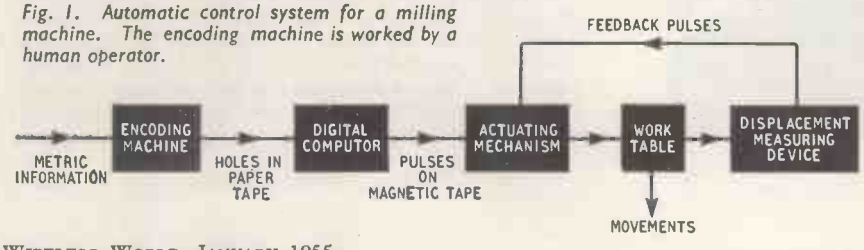
A fairly advanced system is shown schematically in Fig. 1. This has been devised by Ferranti's (at Edinburgh) for the automatic control of a milling machine, the work-table under the cutting tool being moved in accordance with information fed in from a magnetic tape. The whole system is based on the principle of specifying the contours of the part to be machined by a series of points, each having x and y co-ordinates from a given reference point. The x and y values are then used to move the work-table in two directions. This does not mean, however, that a human "programmer" has laboriously to put all this information on to the magnetic tape point by point. A digital computor is brought into play here, for most contours can be represented by mathematical expressions and it is only necessary to instruct the computor to calculate a straight line or a semi-circle or a parabola, as the case may be. Thus all that the human "programmer" has to do is to feed in information about the points of change on the contours (for example, where a straight line starts to bend round into a circle) and then the computor does the rest.

Electronically controlled drilling machine. The required position of the work-table is set up initially on the control desk (right).

The real heart of the system, however (and the real subject of this article), is the mechanism by which the work-table is continuously positioned under the cutting tool. For precision machined parts this positioning has to be done to an accuracy of one ten-thousandth of an inch. The straightforward method of simply turning a calibrated lead-screw is therefore not good enough. With backlash in the work-table mechanism, one could never be sure that the work was actually being moved in accordance with the control information going into the lead-screw. The ideal method would be to measure the work itself as it was being cut and control the work-table movements accordingly. This, however, is somewhat difficult to do. In practice the best solution is to measure the movements of the work-table and use this information for controlling the positioning process.

The feedback type of mechanism by which this is achieved can be seen at the right-hand side of Fig. 1. The control system actually works on a digital, or step-by-step, principle because this enables it to be made as accurate as desired, according to the number of digits used. Thus a measurement or movement of 2.3075 inches can be represented more accurately in digits of one ten-thousandth of an inch than in digits of one thousandth of an inch, which would give either 2.307 or 2.308. Actually digits of one ten-thousandth of an inch are used. The actuating mechanism receives a train

Fig. 1. Automatic control system for a milling machine. The encoding machine is worked by a human operator.



of "command" pulses from the magnetic tape, each representing one digit. These cause the work-table to move and as a result the displacement measuring device produces a train of similar pulses representing ten-thousandths, which are fed back to the actuating mechanism. On the receipt of each "command" pulse the work-table moves in the required direction until a feedback pulse cancels the "command" pulse, when the movement stops. Thus the work-table can only move through the measured ten-thousandth of an inch and no further movement is possible until another "command" pulse arrives.

A similar digital servo system is used by Ferranti for positioning the work-table of a drilling machine (shown in the title picture). Here, however, there is no automatic control from magnetic tape. A human operator sets up the x and y co-ordinates of the hole to be drilled on a series of control knobs, then the machine proceeds to move the work-table until the required point is directly under the drilling bit. The work-table is driven by electric motors and, as before, its movement in each direction is measured by a device which produces a train of pulses, each pulse representing a displacement of one ten-thousandth of an inch. These pulses are counted by a decade counter until they have cancelled the number (in ten-thousandths) already set up on the control knobs by the operator. The "error signal" is then reduced to zero and the driving motors stop. There are five control knobs for setting up each dimension (x and y), the first for inches, the second for tenths, the third for hundredths and so on. Thus, if the operator sets the x dimension to, say, 5.7394 inches, this is the same as 57,394 ten-thousandths, and the decade counter has to count that number of digits before the cancellation occurs and the motor stops.

The electronic circuit which counts the pulses and finally cancels the original number makes use of the well-known Dekatron tube. For each dimension, x or y, there are five of these tubes in cascade, one for each decimal place of the number. The required number is set up on the five tubes by applying a negative voltage to a particular cathode on each one (this is done by the control knobs) so that the glow is initiated at this point. The arrival of pulses from the displacement measuring device then causes the glow to move, not in the normal clockwise forward direction, but backwards towards zero. In other words the incoming pulses are subtracted from the original number set up by the operator. This subtractive operation can be achieved quite simply because of the reversible properties of the Dekatron. It is only necessary to reverse the connections to the guide electrodes to cause the glow to be transferred in an anti-clockwise direction. Thus, when the incoming pulses have finally brought the original number down to zero the glow in the last tube transfers to the "zero" cathode and this produces an output signal which stops the work-table driving motor.

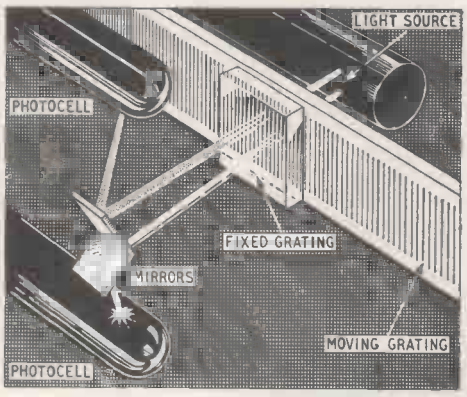


Fig. 2. Diffraction-grating system for measuring displacement and giving an output in digital pulse form.

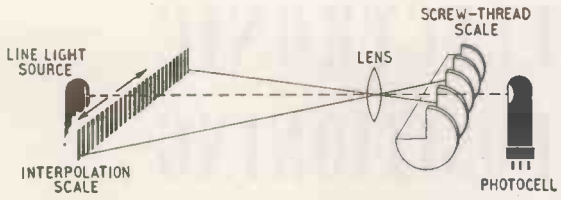


Fig. 3. Displacement measuring device using an accurately machined coarse scale and optical interpolation system.

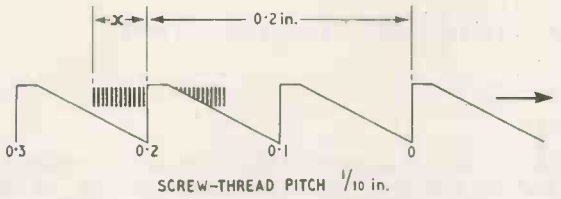


Fig. 4. Typical position of the interpolation-scale image of Fig. 3 in relation to the teeth of the coarse scale.

One of the most difficult problems from the practical engineering point of view is in producing a displacement measuring device capable of detecting a movement as small as a ten-thousandth of an inch. The two Ferranti machines use an optical system based on the interference pattern produced by two finely ruled gratings. Fig. 2 shows the general principle. A length of grating is fixed to the moving part of the work-table while another short length is fixed to the stationary part. The long grating therefore slides across the short one with the two surfaces almost in contact, and the pair are suitably aligned to produce an interference effect. A parallel beam of light is projected through the arrangement and when there is relative movement the interference effect modulates the intensity of the beam. One complete cycle of variation in intensity occurs for a movement equal to the pitch of the gratings, and from this it is possible to obtain two discrete electrical pulses per grating line. The gratings are ruled with 5,000 lines to the inch*, so that one pulse is produced for every ten-thousandth of an inch. By arranging two photocells as shown, so that the phase of the light variation is different in each, a two-phase electrical system is formed, and the phase rotation of this reveals in which direction the work-table is moving.

A rather different system of measuring displacement in digital form has been developed by Mullard. Measurements are made by referring to a standard marked off at intervals of a tenth of an inch with high accuracy. Such a standard can be produced in a tool-room by skilled craftsmen. An optical interpolation system is used for intermediate measurements, and the

* "The Production of Diffraction Gratings" by L. A. Sayce, *Endeavour*, October, 1953.

interpolating scale is easy to make photographically.

The standard takes the form of a long rod cut with a screw thread of sawtooth form, the pitch being one-tenth of an inch. Part of the rod is cut away to reveal a cross-section of the thread as shown in Fig. 3. The vertical edges are then individually ground and lapped to form scale graduations 0.1in apart with an absolute positional accuracy of 0.00005in. The rod is fixed to the moving part of the machine and is made of hardened steel with the same coefficient of expansion as that of the machine.

The principle of the optical interpolation is shown in Fig. 3. An interpolating scale four inches long has 1,000 equidistant vertical opaque bars 0.002in wide, alternating with transparent bars of equal width. A lens forms an image of this grid across the teeth of the screw-thread, and a reduction factor of 40 is used to make the image fit exactly between two teeth.

Fig. 4 shows a typical relative position of the two scales. The optical image is fixed in space while the screw-thread scale is moving past it to the right. Regarding the left-hand edge of the image as a fixed reference point, the total displacement of the first edge of the screw-thread scale (marked "0") is two tenths of an inch plus the fraction of a tenth x. The number of interpolation bars in x is the number of ten-thousandths of an inch in the fraction. To count these ten-thousandths electronically, the transparent bars in the scale are illuminated one by one by a line of light which moves behind it (Fig. 3). A photocell placed close behind the screw-thread scale then receives a succession of light pulses. As the sloping edge of the sawtooth is encountered by the moving light the pulses are reduced in amplitude until they finally disappear. Their sudden reappearance at the 0.2-in edge is the signal for them to be counted. This proceeds until the light reaches the left-hand end of the scale, when the total count is the fraction x of 1,000.

The scale is scanned repetitively by the line of light and the fraction x is determined afresh at each scan. In this way the system provides an output at regular intervals stating the position of the moving part of the machine. At the end of a scan the position is compared by means of a reversible counter with that set up initially by a human operator on six 10-position dials. The difference is then held and displayed on a meter until the end of the next scan, when a fresh value of the difference is available. The relative position is given within a definite limit, one ten-thousandth of an inch, since only whole numbers of interpolation scale bars are counted. However, the distance in which the count changes by one unit is less than 0.0001in, and the moving part of the machine can be set to these discrete positions with an even greater accuracy.

The reversible counter actually subtracts the measured dimension from the pre-determined dimension, and the difference displayed on the meter indicates whether the measured dimension is too long or too short and gives a rough indication of the magnitude of the error.

Both this Mullard machine and the Ferranti drill require a human operator to set up the controls in the first place—though, of course, no special skill is needed for such an operation. This could, however, be avoided by using a punched card system to supply the input information. The Ferranti drill would then be fully automatic and the Mullard machine could be made so by using the error signal (normally fed to the meter) to control motors which would drive the moving part of the machine until the error was reduced to zero.

THE DUST PROBLEM

A New Device for Cleaning Gramophone Records

By CECIL E. WATTS

GRAMOPHONE records when examined under a microscope all have one thing in common; dust can be observed in nearly every inch of groove. As the reproducing stylus must surmount most of those particles small enough to rest in the angle of the groove, it is certain the groove loses control of the stylus many times a second, with a corresponding loss in accurate tracing. It may be reasoned that microscopic dust is mainly airborne and is light enough to be pushed aside. This is no doubt true of the larger masses; the smaller particles, such as those shown in the groove in Fig. 1, must obviously be trapped by the contour of the stylus. This fact, plus the increased surface noise, extra wear and tear of stylus and groove wall, clogging of stylus tip, etc., provide sufficient reason for more than casual attention to the dust problem, which becomes increasingly important as the quality of the reproducing system is improved.

The use of a plush or other pad, with or without cleaning fluids, has been the recommended treatment to date. If this operation is performed in bright sunlight a close examination usually shows the groove to be anything but clean, and certainly by the time the record is played it is again well charged.

Elementary logic points to the "instant of playing"

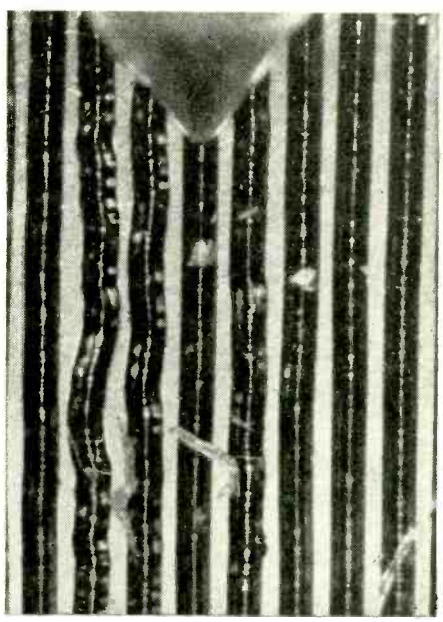
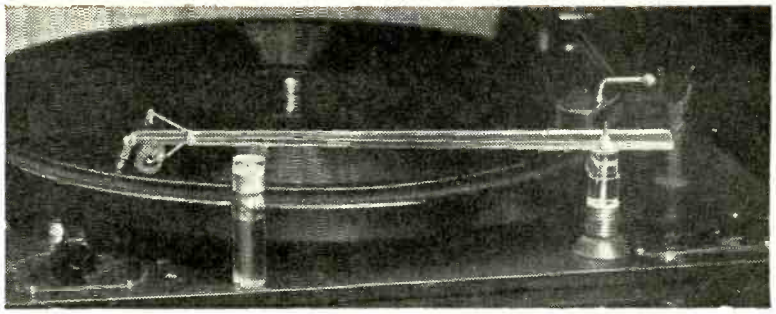


Fig. 1. Photomicrograph of record grooves before cleaning.

as being the ideal moment to clean the record; in practice with an interval of a fraction of one revolution of the turntable between cleaning and playing. No doubt the various types of brush attachable to the pickup arm which have been designed in the past have been produced with this object in mind. Any such fitment applied to the modern ultra-lightweight pickup is, unfortunately, more than likely to affect its performance.

A separate arm seems essential to carry such a cleaning device, and these thoughts have been embodied in the "Dust Bug," a device which has in fact a lightweight plastic arm terminating in a small brush of nylon bristles, each of which is pointed so that the bottom of the groove may be thoroughly explored. The bristles also serve to track the arm across the record. A cylindrical plush pad (the "bug") is situated immediately behind the brush and collects the loosened particles.

The device is placed at the commencement of a record just before the pickup is lowered and cleans the record as it is played. A wipe with the dispenser cork of the cleaning fluid bottle cleans and charges the pad

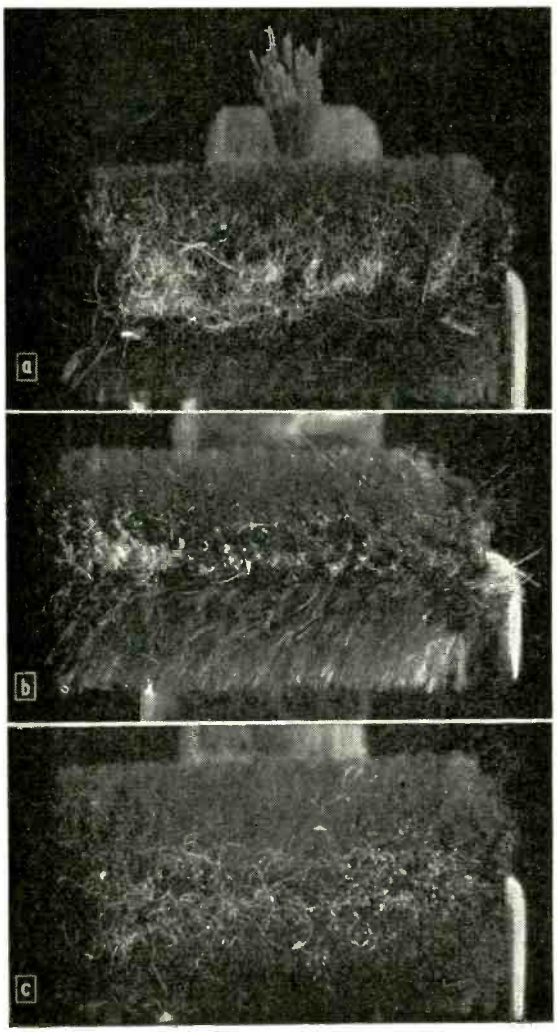


Automatic record cleaning accessory ("Dust Bug") with suction mounting for fixing to the motor board.

with the minute amount of fluid required to dissipate any electrostatic charge induced by the friction of the reproducing stylus or by previous polishing.

Most record cleaning fluids seem to serve equally well, the one favoured being a moderate concentration of ethylene glycol in distilled water, this being a trusted favourite for use in direct disc recording. One advantage of this form of cleaning is that the quantity of any anti-static or cleaning fluid is so minute that it is extremely unlikely that any trace remains in the groove even after prolonged use. This is well illustrated in Fig. 2 which depicts the last few seconds of "Petrouchka" (Decca LXT 2502) where the final "high C" on the trumpet disappears into the tape and other background noise.

Fig. 3 has been included to emphasize the necessity for using the cleaner each time a record is played.



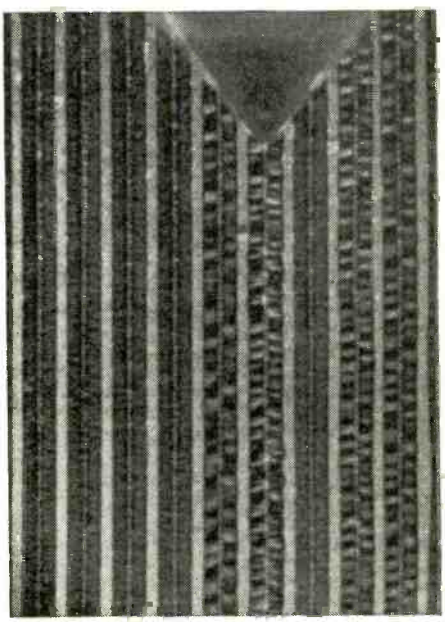


Fig. 2. Any residues remaining after cleaning are considerably less than the background noise modulation as seen in the four grooves on the left.

Left: Fig. 3. Dust particles, etc., collected by the plush pad (a) after the first use of the cleaner on a 12-inch l.p. record, (b) after a second playing immediately following the first, and (c) a third playing of the same record after being stored for a day in the maker's envelope.

ALL YOU NEED TO KNOW ABOUT RADIO

By "CATHODE RAY"

Technical Terms Used in the Underworld of Wireless

THIS particular season of the year is so full of things that there is grave danger of the necessities of life being crowded out by the luxuries. This page, for example, might receive less attention than usual, by reason of the prolonged concentration ordinarily demanded by it. As a concession to the flesh, therefore, I am this month bestowing a complete treatise on radio. It is so light that it can be assimilated even after the pudding, and yet so comprehensive that it is a good defence against the loss of dignity that is entailed by party games of the general knowledge sort. Originally presented free with the Christmas 1934 issue, it is now completely revised and enlarged.

Experience has shown that the whole of anything is equal to the sum of its parts. Know each part, and you know the whole. Samson himself might have struggled in vain to snap a bundle of firewood, but a child can take a stick at a time and break it. The reason why radio is found to be so difficult is that the student takes the whole bundle in his hand and expects to build Rome in a day. But when the loaf has been daintily sliced into separate grains of sand it soon (to put it metaphorically) makes a mighty ocean.

Each mysterious part of radio will now be clearly defined. This knowledge has hitherto been confined to a few experts; now, it is all revealed in language that everybody can understand. N.B.—*You are warned that it is not considered suitable for children.*

Band Pass. You don't suppose the musicians pay to get in, do you?

Band Spread. An effect closely associated with **Self Capacity** (q.v.).

Beat Frequency. Confidential information for avoiding a **Lightning Arrester.**

B.F. Source. According to Eton, Harrow. (And vice versa.)

Buffer Stage. Usually the last but one in the series. For a description, refer to W. Shakespeare (*As You Like It*, Act 2, Scene 7).

Cavity Resonance. A cause of unwanted whistles, often existing at the **Buffer Stage.**

Condenser. High official of the B.B.C., whose duty is to fit the programmes in at all costs. His work is often in vain, and may be either fixed or moving. See also **Padding Condenser.**

Detector. Post Office official equipped with clever apparatus that responds to absence of licence.

Dissipation. See **Featherweight Pick-up, Night Effect, Watt.**

Earth. All natural wireless sets must be planted with the roots firmly underground, and well watered. A flower-pot is not recommended; it might be neglected during holidays. Portable sets are grown under a frame and need no earth.

Eliminator. Chemical preparation for combating parasitic oscillation. See **Skin Effect.**

Featherweight Pick-up. A form of **Dissipation** (q.v.).

Feedback. A concomitant of **Instability** (q.v.); also noticed just after Christmas and at other irregular seasons. The **Pre-selector** is particularly subject to it.

Gain Control. See **OHMS Law.**

Hand Capacity. A high-frequency phenomenon especially noticeable on leaving a hotel, whether equipped with wireless or not. It is believed that some form of direction-finder is used in the acceptor circuit, for screening seldom avails to prevent one from being run to earth.

Harmonic Distortion. Well-known characteristic of music pupils and modern composers. In severe cases is known as **Random Noise.**

High Tension. A state which is liable to exist as a result of **Key Clicks** (q.v.).

Homing System. A device for cases of **Instability** (q.v.). In its more fully developed forms it can be used to suppress **Key Clicks** (q.v.).

Indoor Aerial. A device for foiling the **Detector.**

Insertion Loss. Money put in a fruit machine.

Instability. A variety of **Night Effect** (q.v.).

Key Clicks. Unwanted noises due to **Instability.**

Lightning Arrester. See **Beat Frequency.**

Microphonic Noises. Technical term for broadcast programmes.

Miller Effect. See **Dust Core** (if you can!).

Mutual Conductance, Tight Coupling, etc. These expressions are too romantic in character to be discussed in a prose publication. The subject is more suitable for an ode.

Night Effect. There are several varieties: one of them is usually most noticeable at the **Output Stage;** it is characterized by **Instability,** and, in severe cases, the seeing of two or more programmes at once. See also **Homing System, Key Clicks, Dissipation.** Another variety, which is common at a later stage, is also known as **Variable-Mu.** Still another (liable to be confused with the latter) is **Threshold Howl** (q.v.).

Noise Suppression. See **Output Stage, Threshold Howl.**

Non-linear Conductor. One that takes excessive stage gain.

OHMS Law. A law relating to Income Tax (or Remote **Gain Control**).

Output Stage. Generally coincides in time with severe outbreaks of **Night Effect;** usually about 10.30 p.m. **Noise Suppression** may have to be fitted at this stage.

Padding Condenser. A negative condenser employed when a programme runs short.

Phase-change. Often observed at the detector or lightning arrester stage, or when a communication is received relating to **OHMS Law.**

Pre-selector. Scientific term for acquisitive junior member of a family. The pre-selector stage is reached at the age of about two years.

Primary Cell. One designed for first offenders.

Random Noise. See **Harmonic Distortion.**

Reaction. A common result of **Dissipation.** A pick-up may be needed.

Self Capacity. Characteristic typical of the **Pre-selector.**

Shunted Meter. Device for avoiding electric charge.

Skin Effect. Also known as parasitic oscillation.

Speech Choke. Would be very valuable, but is not permitted in this country, since it conflicts with the tradition of "freedom of speech."

Superhet. A very powerful type of receiver that brings in every station, and most of them twice. From the American *super*=very, and *het*=hot (e.g., "all het up").

Tape Recorder. A tailor's assistant, who repeats everything back.

Thermal Agitation. Characteristic exhibited by a cat on hot bricks. See also **Variable-Mu.**

Threshold Howl. A form of interference peculiar to the weeks leading to Christmas. Is almost invariably followed by **Hand Capacity.**

Tracking. Operation of the **Detector.**

Trimmer. Another name for **Condenser** (q.v.).

Twin Feeder. The sort of thing one expects to see on "Inventors' Club."

Variable-Mu. A form of interference of feline origin. See **Night effect, Thermal Agitation.**

Watt. A character who, in his youth, performed useful services in the kitchen, such as preventing kettle lids from flying off, so that his name became symbolic of energy. In later life, however, he seems to have fallen into evil ways, to judge from frequent references to Watt's Dissipation.

Wavechange Switch. Despite the popularity of so-called continuous (or permanent) waves, this appliance meets with some application in the art of coiffure. Closely associated with step-up transformation.

Zero Beat. Absence of corporal punishment.

By now you will, I am sure, need no further evidence that radio is a sordid and degrading occupation. Perhaps you would care to make it the subject of a New Year Resolution?

MAKING A GOOD RECORDING

Importance of Microphone Technique

ENCOURAGED by the high standard of quality which is readily obtainable from commercial gramophone records these days, many people have bought disc or tape recorders to make their own musical recordings, either for self-criticism or for the delectation of friends. After spending not inconsiderable sums on the best available equipment it is a common experience to find the first results disappointing.

In nearly every case the trouble can be traced to unsuitable acoustical surroundings or to faulty microphone technique, and can be remedied only by practice and experience. This point was emphasized by G. Elliott in a recent lecture on "The Art of Balance and Control in Recording Studios" to the British Sound Recording Association in London. Mr. Elliott, who has many outstanding recordings to his credit, including the "tugboat" effects record (Mercury Sound Recordings) said that while there was as yet no perfect microphone there were many very good ones, each with characteristic merits and shortcomings which could be deployed to make the most of any given situation.

Microphones were the tools of the recording "engineer"—microphones and his own ears, which could best be trained by listening to all and sundry sounds, first directly and then through a simple reproducing channel consisting of microphone(s), amplifier and a monitoring loudspeaker. Where possible the same loudspeaker should always be used in the same acoustical environment, and it was significant that broadcasting and recording organizations concerned with the interchange of recorded material had recently initiated moves for the standardization of monitoring conditions.

Mr. Elliott described several typical recording problems and illustrated with tape recordings the synthesis of a good recording of an orchestra from the outputs of a number of microphones, distributed among the players and in the body of the hall. It was evident that a single microphone failed to give that elusive quality of "presence," so much esteemed by gramophiles.

An interesting point which emerged from Mr. Elliott's talk was the increasing importance given by composers and arrangers of light music to "balance and control." It was now becoming the practice to include in the score specific instructions for emphasis, and even the introduction of artificial reverberation over part of an individual musical phrase. The results are undoubtedly stimulating and the means by which they are obtained were, in the examples played by Mr. Elliott, completely hidden by the "art which conceals art."

Extended-range L.F. Sine Wave Oscillator. The author asks us to correct a printer's error in the second line of this article (page 596, December, 1954, issue); the range of 20-20,000 c/s should be regarded now as *in*sufficient for exhaustive testing of high-fidelity amplifiers. He also points out that the 1-MΩ grid leak of the last valve should be returned to earth and not to cathode as shown.

TRANSISTOR D.C. AMPLIFIER

Stable Push-Pull Circuit for Low Level Operation

By G. JOHNSON*

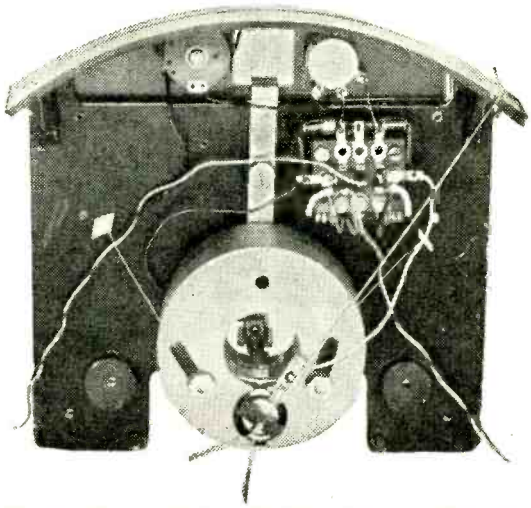
AN instrument constructed in the laboratory using a barrier-layer photocell in a photometer arrangement proved to be too insensitive for certain uses and an attempt was made to improve it by adding a d.c. amplifier between the photocell and the meter. It was desirable to make the instrument portable and independent of the mains, and the transistor appeared to offer advantages in these directions. Since the completed amplifier measures 3in × 1½in × 2in, including the power pack of two 1.5-V cells, and could be made smaller if desired, it fulfils both these requirements.

The main difficulty with d.c. transistor amplification is the extreme sensitivity to temperature variations. The collector current is approximately doubled for every 10°C rise in temperature. In this amplifier the problem was overcome by using a completely symmetrical push-pull circuit and arranging that any change in ambient temperature would equally affect both transistors.

Two Mullard OC71 *p-n-p* junction transistors are used in a simple earthed-emitter circuit with the 0-50μA meter connected between the collectors and the photocell with its attenuator connected between the bases. The voltage at the collectors is equalized by the load-balancing potentiometer, which acts as a set-zero control. The transistor temperatures are equalized by enclosing them in adjacent holes drilled in a small block of aluminium.

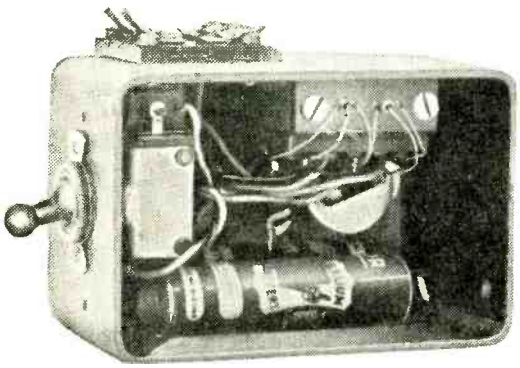
The power is derived from two Vidor V.0107 Kalium cells which are of the same dimensions as the U7 pencil battery but are capable of providing up to 3,000 hours use at the average current drain of 200μA required in this amplifier. With this length of life it was at first thought unnecessary to include a battery switch, but this is essential for the purpose of setting the mechanical zero of the microammeter, which has been found to vary quite as much as the zero variations due to the d.c. amplifier itself.

The measured overall gain is approximately 30, giving the 7-inch meter a sensitivity of better than 0-2μA full scale. The overall noise produces a fluctuation on the needle which does not exceed plus or minus half a scale division, i.e., better than ±0.01μA. This very low figure is due to the fact that most of

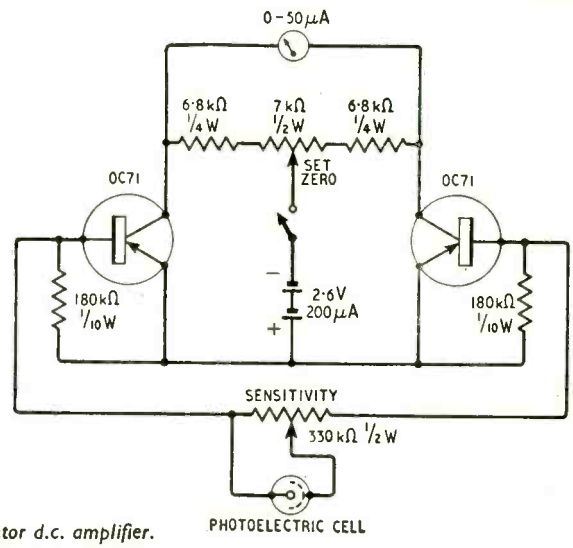


The amplifier mounted on the base plate of a 7-in scale edgewise-reading meter. Batteries are on the back of the meter case. The control potentiometers can be seen immediately below the scale and their shafts protrude through the case on either side of the mechanical set zero.

* Biophysics Department, Hurstwood Park Hospital.



Underside view of amplifier. The transistor leads can be seen emerging from holes in a Paxolin cover over the aluminium block. Controls are on the top of the case.



Right: Circuit of the transistor d.c. amplifier.

the transistor noise is of too high a frequency for the meter needle to respond.

Following the satisfactory results obtained with this amplifier a second one was constructed, the potentiometers, amplifier, chassis, and batteries being mounted inside the case of a similar 0-50μA meter with the controls accessible underneath the edgewise scale. This has proved to be a very useful general-purpose meter, taking the place of the cumbersome mirror galvanometer and having a very much shorter time-constant. The instrument works equally well as a centre-zero galvanometer since the set-zero control can be used to bring the needle to any point on the scale for zero input to the amplifier.

INTERNATIONAL STANDARDIZATION

Summary of I.E.C. Discussions on Components

By G. DAVID REYNOLDS,* Ph.D., M.Sc., M.I.E.E.

As already recorded, the International Electrotechnical Commission held its Golden Jubilee meeting in Philadelphia in September. As in all international bodies the work of the I.E.C. is conducted by comparatively small committees representative of the countries participating. One of the sub-committees (12-3) deals exclusively with the standardization of radio and electronic components. This component committee has been working since 1950 on the international recommendations for standardizing methods of testing radio components and excellent progress has been made in spite of the fact that the full committee meets for only about eight days in each year. The radio industry and the Service establishments in this country had done a great deal of work, separately and jointly, on this subject before 1950 and this helped considerably in the rapid progress made internationally.

The meetings are not too formal and the committee works as a body of engineers with a common end in view and with a minimum of "politics." This year, at Philadelphia, thirteen nations took part and the co-operation and mutual understanding shown was even better than in past years. The British delegation to the components committee, of which I have been a member since 1950, is officially sponsored by the British Standards Institution and is paid for by the various associations in the radio industry.

In these notes a few items have been selected from the great mass of detailed discussion on every aspect of testing of capacitors and composition resistors at the Philadelphia meeting. They give some idea of the problems and difficulties met in reaching international agreement.

Capacitor and Resistor Standards

Draft standards for paper, ceramic, electrolytic and mica capacitors, for the colour coding of ceramic capacitors, and for carbon resistors, were discussed and brought near to completion. Work is now beginning on standards for high-stability composition resistors and carbon potentiometers and on the standardization of some of the principal dimensions of the components themselves.

The ceramic capacitor standard covers Type I capacitors, with moderate power factor and reasonably linear temperature coefficients. A standard series of values for the temperature coefficient has been agreed, and there are tolerances ranging from ± 15 parts per million per degree centigrade for special purposes, to $\pm 1{,}000$ p.p.m./°C for general use. The capacitance values follow the E-series of preferred numbers (BS 2488), which is already used for carbon resistors.

The colour coding of ceramic capacitors has presented a very serious problem. There are at present several codes in existence with slight variations between them, and attempts to arrive at a standard code have proved very difficult. The code must cover temperature coefficient (one band or, sometimes, two), value (three bands using resistor code, with values in pF), and tolerance (one band). The principal difficulty is that there are only ten colours normally used while there are more than ten temperature coefficient groups, with their various tolerances, to put into the code. The latest I.E.C. proposal is for a five-band code except for the $+100 \pm 30$ p.p.m./°C, and the -3300 ± 2500 p.p.m./°C coefficients which will need six bands. The code also covers two qualities of high-dielectric constant material (Type II).

The preparation of a series of standard values for electrolytic capacitors has also proved extremely difficult. In most European countries the "powers of two" series—2, 4, 8, 16, 32, 64—is used up to 64μF, but for higher values and for low voltages round values such as 10, 20, 25, 50, 60, 100, 150, 200, 250 are quite common.

For mechanical dimensions and tolerances in general, the R10 series of numbers adopted by the International Standardization Organization is widely used (BS 2045). Each term is obtained by multiplying the previous term by the tenth root of ten. The values are rounded to 1, 1.3, 1.6, 2.0, 2.5, 3.2, 4.0, 5.0, 6.3, 8.0, 10, etc. (Incidentally, the well-known resistor series is based on the twelfth root of ten.) At one stage it was suggested that the R10/3 series be used for electrolytic capacitors—i.e., every third item of the R10 series, making the values 1, 2, 4, 8, 16, 32, 130, 250, 500, 1,000—but this has not proved popular. The latest drastic proposal is 1, 2, 5, 10, 20, 50, etc., but this may not be the last word.

The agreement of standard voltages for electrolytic capacitors has proved equally difficult, and to meet the needs of all the representatives present a very long series has finally been adopted.

* Murphy Radio, Ltd.

Frame Flyback Suppression

Requirements and Circuitry

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

IT is now a common practice to include frame flyback suppression circuits in television receivers. It has become common only in the last year or so, however, and many, if not most, existing sets do not contain them at all. The reason for this lies in the fact that the television signal itself is supposed to suppress any visible effect of the frame flyback. During the flyback period the signal is at or below black level and so the scanning spot is supposed to be extinguished and, therefore, invisible.

In practice, however, it is by no means rare for the flyback lines to show up on dark parts of the picture. It is often said that this occurs because the d.c. component of the signal is not fully retained in the receiver, but this is certainly not the only cause. If one starts initially with the receiver correctly adjusted on a picture of average mean brightness, the adjustment being such that good tone gradation is secured in the dark parts as well as the light parts, there should be no trace of the frame flyback even on quite black parts of the picture. If that condition is obtained and the mean brightness of the picture becomes less, the flyback lines will show if the d.c. component is not retained fully. A readjustment of the brightness control will then restore the proper conditions.

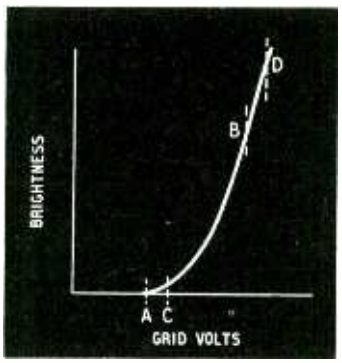


Fig. 1. Typical c.r. tube characteristic. With the bias set at A and the signal sweeping over AB there is little detail in dark regions. Better results are secured by biasing to C but only a relative black is then obtained.

It does frequently happen, however, that with a picture of average mean brightness it is not possible to secure a complete absence of the frame flyback lines and at the same time to obtain good rendering of tonal values in dark parts of the picture. When brightness is adjusted so that the flyback lines just become invisible on a black part of the picture it is found that there is no tone gradation in dark regions. When brightness is adjusted for the best picture quality, the flyback lines show in the dark parts.

One possible, but not very likely, cause of this is the presence of an unwanted brightening pulse on the cathode-ray tube. In the frame timebase and deflection circuits pulses exist during the flyback period; in particular, there is a positive pulse of several hundred volts amplitude on the anode of the frame output valve. If, by stray coupling, this could reach the grid of the tube with an amplitude of only a volt or so it would have an appreciable effect. At the grid of the video stage it would have much more effect because of the gain of this stage.

Such effects are not very likely, however, because the grid of the c.r. tube is normally by-passed to chassis by a large capacitance and the video stage is usually well screened.

The unwanted appearance of the flyback lines is usually brought about by the curvature of the valve and tube characteristics. In an ideal system, the brightness of any point on the screen of the c.r. tube would be proportional to the brightness of the corresponding point in the scene being televised. The transmission system as a whole would be linear.

The tube characteristic, however, is not linear. It is rather like that of a valve and there is a considerable amount of curvature towards cut-off. A typical characteristic has the form sketched in Fig. 1. If the tube is biased so that black level corresponds to point A changes of signal near black level cause only small changes of brightness, whereas the same changes of signal near white level (point B) cause much larger changes of brightness.

If the linearity of the system is perfect except for the tube characteristic, therefore, tone gradations in dark parts of the picture are less well reproduced than they are in the light parts. A considerable improvement can be secured by reducing the tube bias so that black level comes at the point C. Black and white now correspond to C and D and the difference between the slopes of the curve at these points is much less. As a result, a better tonal range in the black region is secured.

However, "black" is no longer a complete cessation of light output from the tube. It is really a dark grey, but it does appear black by contrast with the bright parts of the picture.

It might be thought that the flyback, being at black level, would not be visible even under these conditions. However, it is and the reason is because the flyback trace is superimposed on the picture. In a black region of the picture, and especially towards the bottom of the picture, the screen is still emitting some light when the spot retraces it for the flyback and re-excites the screen. In such a region of the picture the screen is excited twice per scanning cycle where the flyback crosses it but only once per cycle elsewhere. Only when black corresponds to zero light output from the tube does this effect cease to occur.

It is, therefore, inevitable that the flyback lines shall be visible as long as the flyback signal is at

black level and black level is not a true black but only a relative back. In these days of bright pictures and the use of a good deal of ambient lighting, it is not often that a true black is permissible if a soot and whitewash effect is to be avoided. It becomes desirable, therefore, to suppress the signal on the tube during flyback by applying a pulse which drives the tube beyond cut-off.

Before going on to discuss the form of circuitry employed, it may be as well to deal with an objection that may be raised to the foregoing argument about the effect of the tube characteristic. Curvature of the tube characteristic means, in other terminology, that its "gamma" is not unity; it is actually about 2.2. In the transmitter, iconoscope-type tubes have a gamma of about 0.5 and so the camera tube and the receiving tube are complementary and produce an overall gamma of about unity. With other tubes gamma correction is employed.

It should happen, therefore, that the video signal is pre-distorted at the transmitter to correct for the curvature of the characteristic of the receiving tube. It thus appears that the argument based upon this curvature is a false one.

Video Stage

However, a similar curvature takes place in the video stage. Even if the transmitter pre-distortion corrects precisely for the tube curvature, therefore, the argument still holds for the curvature of the video stage. In practice, too, the pre-distortion cannot be precisely right for every receiving tube.

It is interesting to notice at this point that the effect of the video stage is quite different in modern receivers employing cathode feed to the tube than it was in early ones in which the video signal was fed to the grid. The video-stage characteristic is of the form sketched in Fig. 2 and when the signal is fed to the grid of the tube the valve is biased to point A, the video signal sweeping always negative with respect to A. The output then becomes more positive as the input becomes more negative for increasing brightness. The sync pulses and the dark regions of the video signal fall on the linear part of the valve curve and it is the white parts that come on to the curved portion. The result of video-stage curvature is thus to reduce the tonal range in the white parts of the picture.

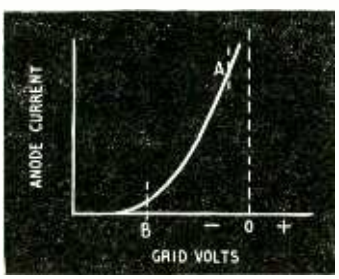


Fig. 2. Typical video stage characteristic. With grid feed to the c.r. tube the valve is biased at A; with cathode feed the bias is at at B.

When the video signal is applied in the modern way to the cathode of the c.r. tube, however, the video signal must be of the opposite polarity. The video valve must be biased to point B in Fig. 2, so that as the input increases positively for increasing brightness, the output must change negatively to carry the tube cathode negatively. As a result, it is now the sync pulses and dark parts of the picture signal that fall upon the curved part of the characteristic and the white parts that come in the linear region.

Video-stage curvature is not, of course, a necessary thing. It can be avoided by using a big enough valve and supplying it with enough current. Also, various correction circuits are possible. All these things cost money, however, and apart from the flyback lines the curvature does not have a very large effect upon the picture quality.

Suppression Pulse

Because of these effects, therefore, it has become the practice to apply a suppression pulse to the c.r. tube, the pulse being derived from the frame timebase. The ideal pulse would be a rectangular one of the same duration as the actual flyback of the spot. The amplitude of pulse required is not critical; it must be sufficient to extinguish the spot during flyback but not so great that it can cause any damage to the tube.

Tube makers generally set a limit of about 200 V to the maximum negative grid-cathode voltage. At least one-half of this must be allowed for the brightness control and so it is probably undesirable that the pulse should exceed 50 V in amplitude. The minimum value for suppressing the spot is probably around 5 V. There is thus a good deal of latitude in the choice of amplitude. This is just as well because the ideal rectangular pulse is usually difficult to obtain.

The pulse can be applied to the control grid of the tube if it is negative-going, or to the cathode if it is positive-going. As the signal is applied to the cathode in most sets, applying a suppression pulse to the cathode as well involves mixing the two. It is simpler to apply the pulse to the grid if a negative pulse is as easily obtained as a positive.

The usual commercial practice is to take a pulse which appears naturally in some part of the frame timebase and to apply it to the tube through a simple RC shaping circuit. The resulting waveform is very far from the ideal one but, as the requirements are not stringent, a satisfactory result is secured.

On the anode of the frame output valve there appears a waveform of the kind shown in Fig. 3(a). It comprises a negative-going saw-tooth during the scan period and a positive-going pulse during the flyback. The total amplitude is rarely less than 100 V and is usually several hundred volts. The rise of voltage at the end of the scan is very rapid indeed

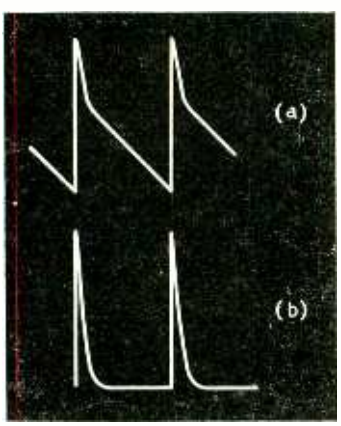


Fig. 3. The waveform on the anode of the frame output valve is sketched at (a) and the result of differentiating it at (b).

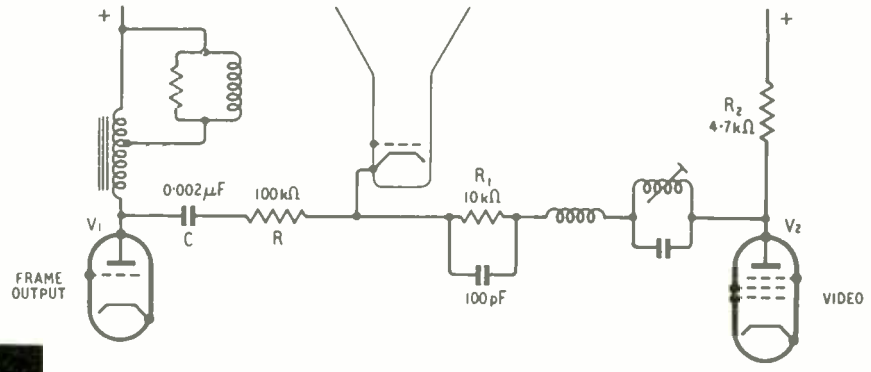


Fig. 4. Circuit diagram of the video stage and frame output circuit of a typical receiver. The video signal from V_2 is fed to the cathode of the tube. The frame waveform on V_2 is fed to the tube through C and R which differentiate it; in addition R with the video components R_1 and R_2 form a potential divider to reduce the amplitude.

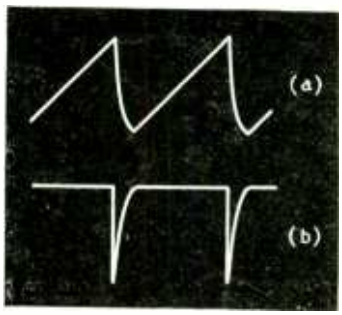


Fig. 5. The waveform across the charging capacitor of a timebase is shown at (a) and the result of differentiating it at (b).

and the subsequent fall during the flyback period is relatively slow and follows a more-or-less exponential law.

An RC coupling of differentiating type will remove the saw-tooth and leave a pulse wave as shown in Fig. 3(b). Such a wave can be applied to the cathode of the c.r. tube. The time constant of the coupling is commonly around 0.2 msec and the suppression circuit is no more than a 0.002-μF capacitor in series with a 100-kΩ resistor connected between the tube cathode and the anode of the frame output valve.

The video circuits connected to the cathode affect the performance, of course, and because of their moderate impedance the pulse is considerably attenuated. The impedance is commonly around 5 kΩ and the attenuation is therefore some 20:1. A typical circuit of this type is sketched in Fig. 4.

Another common method is to differentiate the waveform across the timebase charging capacitor and apply it to the grid of the tube. The waveform is roughly like the one of Fig. 5(a) and differentiating it changes it to the form (b) which is much the same as that of Fig. 3(b), but inverted. All that this involves in many cases is a resistor in series with the lead from the grid of the tube to the brightness control and a capacitor between the tube grid and the charging capacitor of the timebase.

Pulse Duration

In most sets, the flyback is governed mainly, if not entirely, by the output circuit of the frame timebase. The flyback of the saw-tooth generator itself can be quicker than the flyback in the output circuit. When this is the case it is unlikely to be satisfactory to take the suppression pulse from the saw-tooth generator. The pulse will be too short and will only suppress a part of the flyback.

Generally speaking, it is safer to take the pulse from the output circuit itself, for it is then necessarily related to the flyback on the tube. However, when the usual form of feedback circuit is used in the output stage the output flyback is fed back too and reacts on the input to modify the flyback there. As a result, there is a relation between the input and output flyback times and it can be quite satisfactory to take the pulse from the input; that is, from the charging capacitor.

The shape of the pulse obtained by simple means is far from ideal. The maximum amplitude is unnecessarily large and the quick initial return and slow end to the pulse mean that it is difficult to secure full flyback suppression at the top of the picture without darkening the picture itself at the top. In practice, it seems easier to get a satisfactory performance than one would expect on theoretical grounds.

In a test with the *Wireless World* Television Receiver, Model 2, a 100-kΩ resistor was inserted in series with the grid lead of the tube and the grid connected through a 0.001-μF capacitor to the "hot" end of the frame deflector coils. The output transformer is normally connected to be phase-reversing so a negative pulse is secured. The pulse amplitude is about 10 V only but is adequate for quite good suppression.

Transmitted Suppression Pulse

In recent months, the need for flyback suppression has been reduced by a change which has been introduced in the television waveform. This change amounts to the introduction of a small flyback suppression pulse in the video signal itself as transmitted. Before the alteration, the signal level immediately before and after the line sync pulses (the front and back porches) and on the tips of the inverse frame pulses was black, corresponding to 30 per cent of peak white signal. The present level is unchanged at 30 per cent but is now blacker than black, for the true black level of the picture itself has been altered to 35 per cent of peak white.

If the picture signal itself swings through 30 V between black and white the total video amplitude used to be $30/0.7=43$ V, of which 13 V was sync-pulse amplitude. Now it must be $30/0.65=46$ V of which 13.8 V is the sync-pulse amplitude and 2.2 V is the amplitude of the "suppression pulse."

The change is one which is helpful in preventing the flyback lines from showing whatever may be the actual cause of their tendency to appear. The pulse amplitude, however, is hardly sufficient to ensure the absence of the lines in all circumstances and it can hardly be increased in the transmission. Its presence does not remove the desirability of suppression circuits in the receiver, therefore, but it does make their design somewhat easier.

Transatlantic Telephone Cable

BOLD PROJECT CALLING FOR UNCONVENTIONAL AMPLIFIER DESIGN

IN one of the books on which our youthful enthusiasm for electrical communication was fed there appeared a confident statement that, despite the great progress made in ocean telegraph cables, a transatlantic *telephone* cable was (for reasons stated) forever beyond the bounds of possibility. So it was an interesting experience to be sitting in the I.E.E. lecture theatre listening to details of a transatlantic telephone cable, laying of which is to begin next summer*. And this cable is to provide not just one telephone circuit, but 36 simultaneously.

Admittedly it is not yet an accomplished fact. To the conservative engineer, brought up on generous factors of safety, it may appear bold to the point of foolhardiness to put some £12,500,000 into a scheme that includes a sub-ocean link more than 10 times longer and much deeper than any yet in use, and in which the failure of any one of 312 valves or of thousands of associated components at the bottom of the sea will cut off all 36 lines at once, with no spare in reserve.

To the ordinary radio man with emphatic views on accessibility for servicing, the idea of sinking all those amplifiers at 40-mile intervals across the bed of the Atlantic, under anything up to 2½ miles depth of water, must appear more like a nightmare than a serious engineering project. To say that it was asking for trouble would seem to be a sublime understatement. Other aspects of the matter spring to mind: how does one supply the valves with the necessary power? And how, when something goes wrong, does one locate the fault? Yet notwithstanding its rather unpractical appearance, the whole thing has been gone into and accepted by the best British and American brains, the contract between the American telephone companies and the British Post Office was signed more than a year ago, and preparations for carrying out the work are far advanced.

Why offer such hostages to fortune, instead of extending the radio telephone system that has served the transatlantic route for 27 years? The answer to that, at least, can readily be appreciated by the radio man. There are in fact two transatlantic radio telephone systems: the original long-wave circuit between transmitters at Rugby and Rocky Point, and the short-wave system providing at present 16 circuits. Not only are there no spare frequency channels left for extending the service, but interference is making things increasingly difficult on the existing channels. Unlike broadcasting, v.h.f. channels are not available to fall back on, because their range is too limited. Even the present short-wave frequencies are not entirely suitable, because they are at the mercy of ionospheric disturbances which suspend communication in an unpredictable manner, so that quite often the inadequate long-wave link is the only one effectively serviceable.

Attenuation

The difficulty about a submarine cable is its attenuation, or loss of signal power with distance. Even with an open-air wire line there are limits to the distance before signals are reduced below noise level. A cable necessarily has solid dielectric, so the loss is greater. It increases with frequency, so the longer the cable the lower the maximum frequency that can be effectively transmitted. The first transatlantic cable was limited to something of the order of 1 c/s, so obviously only telegraphy was possible, and very slow telegraphy at that. New materials and techniques, especially Permalloy for continuous inductive loading, have enabled the bandwidth to be raised, in the very latest and best examples, to about 100 c/s. This is still far short of what is needed for a single speech channel, even if compressed by the device known as the Vocoder.

Ordinary underground telephone cables have an attenuation of the order of 1 db per mile at audio frequencies. At that figure, a 20-mile run reduces the power of the signal by 99

* Information from the lecture, "A Transatlantic Telephone Cable" by M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey, has provided the basis for this article.

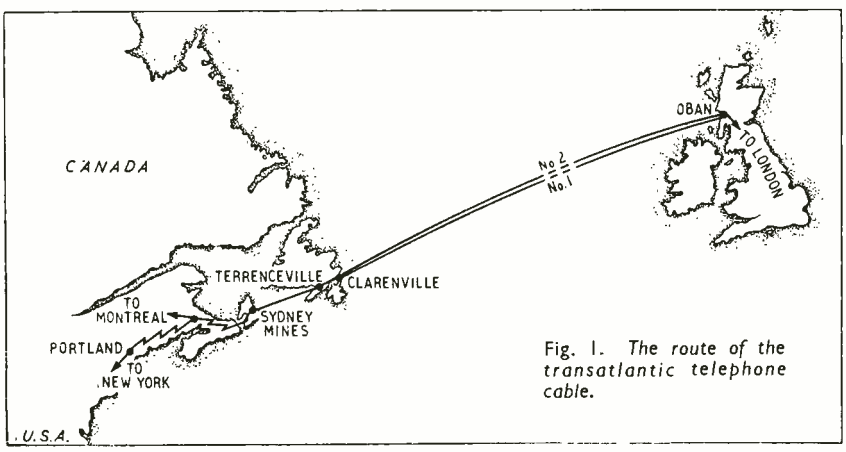


Fig. 1. *The route of the transatlantic telephone cable.*

per cent. This is not more than can easily be made up by a simple amplifier at the receiving end. But a 200-mile line having the same rate of attenuation would reduce the signal power to one hundred-trillionth; a loss that could *not* be made good, for although an amplifier with a power gain of 10^{20} could no doubt be made it would be futile, since it would be overloaded with its own noise, let alone any picked up by the line. Judge, then, of the impossibility of a transatlantic distance, which would reduce the signal power in the ratio 10^{-200}, to say nothing of the distortion caused by unequal velocity with frequency.

Long-distance telephony of any kind is only made possible by inserting amplifiers—called by telephone engineers *repeaters*—at intervals along the route. Thus although the loss caused by a 200-mile line is too much to make up in one go at the end, there is not the slightest difficulty in keeping it up to strength if amplification is applied every 20 miles, or even 40 miles. But where the telephone line is at the bottom of the sea for such (or greater) distances, the difficulties are only too obvious. The idea of having floating battery-driven repeater stations moored at intervals across the Atlantic was looked into and, not surprisingly, abandoned as impracticable.

Submerged Repeaters

The first submerged repeater put into telephone service anywhere in the world is one belonging to the British Post Office laid between Anglesey and the Isle of Man in 1943. There are now 31 G.P.O. repeaters underneath the seas around the British Isles, and more are being installed. But all this experience does not necessarily provide a basis for a transatlantic system, for not only are these European cables much shorter but they are laid in relatively shallow water. Nevertheless, a 300-mile cable between Scotland and Scandinavia was designed and constructed deliberately with Atlantic requirements in view, for experience, and 16 repeaters of the same type are to be used in the 340-mile section of the transatlantic system linking Newfoundland with Nova Scotia (Clarenville to Sydney Mines; see Fig. 1).

Meanwhile the Americans, who for geographical reasons are not much interested in shallow-water routes of moderate distance, had been studying the problem of a sub-Atlantic repeater *ab initio*, and have evolved a rather different type. In 1950, two cables (115 and 125 miles long) using five submerged repeaters of this type at depths from 120 feet to just over a mile were laid between Key West and Havana, and they have worked ever since without failure or deterioration. Fifty-two such repeaters are to be included in each of the two cables to be laid over the 2,000-mile route between Newfoundland (Clarenville) and Scotland (Oban).

A long-distance telephone cable providing only one communication circuit would not be an economic proposition. Multi-core cables, as used for local telephone circuits, are quite out of the question for submarine cables. Instead, a simple coaxial line is used, having sufficient frequency band width to take a

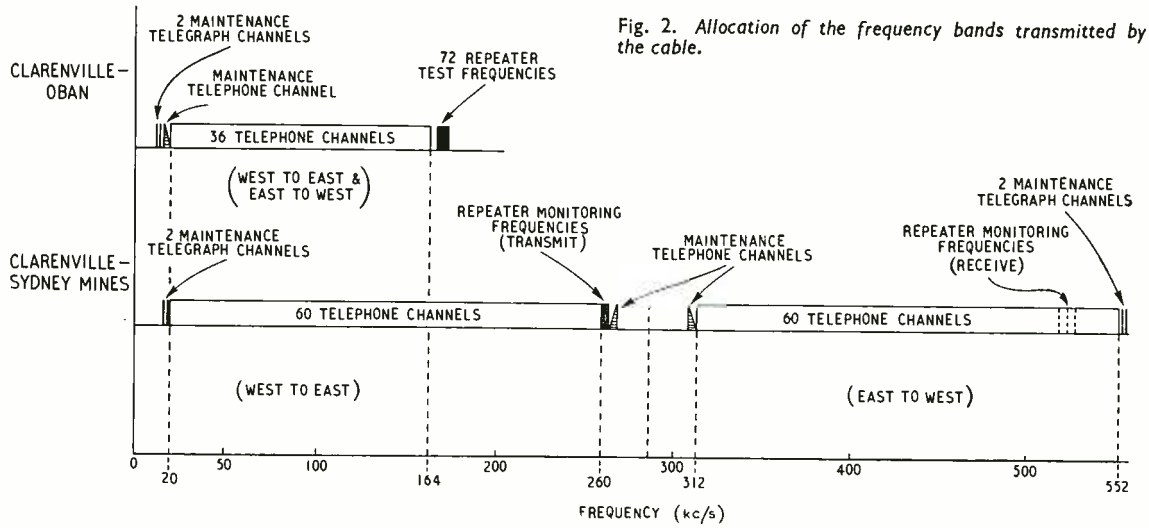


Fig. 2. *Allocation of the frequency bands transmitted by the cable.*

number of separate speech channels. Single-sideband frequency changers are used to shift the 3,000-c/s wide speech band to higher frequency channels for transmission. So the transatlantic telephone cable problem is in fact much harder than it was when envisaged a generation or so ago and declared impossible, because it is required to transmit frequencies many times higher—and therefore many times more severely attenuated—than the highest speech frequencies. Hence the need for repeaters at fairly frequent intervals.

The net working bandwidth of the cable to be used for the main transatlantic link (Oban to Clarenville) extends from 20 to 164 kc/s, divided into 36 speech channels at 4 kc/s intervals (Fig. 2). Frequencies below 20 kc/s are to be used for one telephone channel and two telegraph channels for maintenance purposes, and 167-174 kc/s for certain test frequencies to be explained later. The second cable is not a spare; it is required for communication in the reverse direction. In the shorter Clarenville to Sydney Mines section the repeaters are much larger and enable that part of the cable (which is of the same type for both sections) to be used over a frequency band more than three times greater. This leaves room for no fewer than 60 speech channels in *both* directions, so only one cable is needed. Some of the extra channels

will be used for service between Newfoundland and the rest of Canada; the remainder will be spare.

The cable itself (Fig. 3) is built around a central copper conductor slightly thicker than 10 s.w.g., overwound with copper tape. The dielectric is Polythene —a valuable British contribution to cable technique— and the outer conductor is made up of six copper tapes, overwound with copper worm-resisting tape. Over this again is Telconax for screening, and steel armour wiring sandwiched between jute servings; overall diameter 1.21in. Near the shore ends, additional armour is used for extra protection.

Repeater Construction

Experience in laying cables had shown that unless great care was taken they were liable to be damaged, especially by kinking. Two things that conduced to kinking were irregularities in the cable itself and interruptions in the laying process. For both these reasons the Americans decided to design the repeaters to be used for the main crossing as nearly uniform with the rest of the cable as possible; in particular, that they should be sufficiently flexible to pass through the cable-laying gear without interruption. The repeater finally evolved takes the form of a

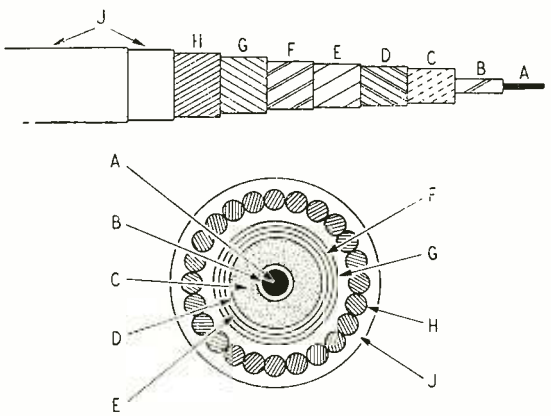


Fig. 3. *Cross-sectional and constructional views of the deep-water type of coaxial cable. A. Centre conductor: 0.1318in dia copper. B. Three 0.0145in copper surround tapes. C. Polythene to 0.620in diameter. D. Six 0.016in copper return tapes. E. 0.003in overlapped copper anti-teredo-worm tape. F. Gapped Telconax tape. G. One serving of cutched jute. H. Twenty-four 0.086in diameter high-tensile steel armour wires. J. Two impregnated-jute servings.*

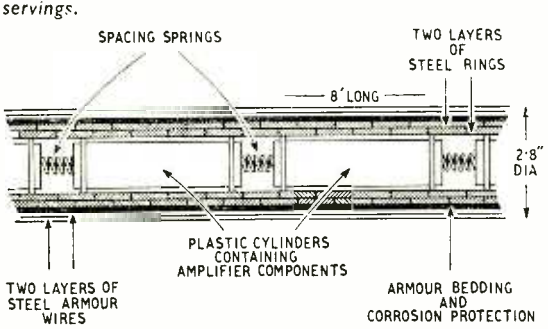


Fig. 4. *Longitudinal section showing construction of American-type flexible repeater built into the main trans-atlantic run of the cable.*

flexible bulge in the cable, 8ft long and 2.8in diameter, tapering down to the normal cable diameter over a distance of 20ft at each end. To design and produce a repeater in such a narrow space, with protection against ingress of moisture or collapse under sea water pressure up to 3 tons per sq in, yet at the same time to be flexible; to fulfil a stringent specification of gain from 23 db at 12 kc/s to 65 db at 108 kc/s; to be fed and tested from the shore; and to maintain its performance within close limits, without access for not less than about 20 years—that was a problem indeed.

The construction is certainly unconventional (Fig. 4). The valves and components constituting the amplifier are divided into 15 separate parcels, each contained in a cylinder 5in long and about 1¼in internal diameter. These cylinders, made of a plastic material similar to Perspex, are coupled together with short springs to form a system resembling a string of sausages. They are protected against the external pressure by two layers of overlapping steel cylinders each ¼in long, over which is a layer of copper and then the usual armouring wires and jute. An elaborate system of seals is provided to prevent water penetrating the joints between this repeater housing and the cable proper. The tensile strength of the cable, which must be very considerable to stand the weight of several miles of itself from ship to sea bed, plus the laying stresses, has to be maintained throughout the repeater sections. Sufficient flexibility has been achieved to enable the repeaters to bend to a 3ft radius. To minimize risk of damage to the cables it is intended to lay the whole of the deep-water part of each (about 1,500 miles) in one operation. This length of cable weighs about 5,000 tons, and the only ship capable of doing the job is the British H.M.T.S. *Monarch*. It is hoped that the necessary twelve consecutive days of favourable North Atlantic weather will occur next summer, and again for laying the second cable the year after.

Amplifier Circuitry

Fig. 5 shows the circuit diagram of the American repeater. It is a 3-stage amplifier using pentodes of a type that is old enough to have been on continuous test for 13 years, and in which reliability, long life, and low anode voltage took precedence over high mutual conductance. The heaters are rated at 0.25 A 20 V d.c., so the three in series require 60 V, which is also the anode voltage. Initially, however, they are to be under-run as shown. The power is fed along the signal wire; consequently transformers are needed to keep it out of the amplifier circuits, and chokes to keep the signals out of the power circuits (which in Fig. 5 are drawn in heavy line). A necessity in an amplifier to cover a frequency band of more than 144 kc/s without intermodulation, and at the same time to maintain a stable gain for years without adjustment, is negative feedback. It is applied through a frequency-discriminating network to give the desired gain/frequency characteristic.

Two interesting details can be seen in the diagram. One is the quartz-crystal resonator shunted across the feedback circuit. Its effect virtually is to remove feedback at its resonant frequency. Each repeater has its crystal tuned to a different frequency, in the 167-174 test band already mentioned. At that frequency its gain is much greater than at other frequencies, and, moreover, is much more dependable on valve characteristics. By measuring the transmission

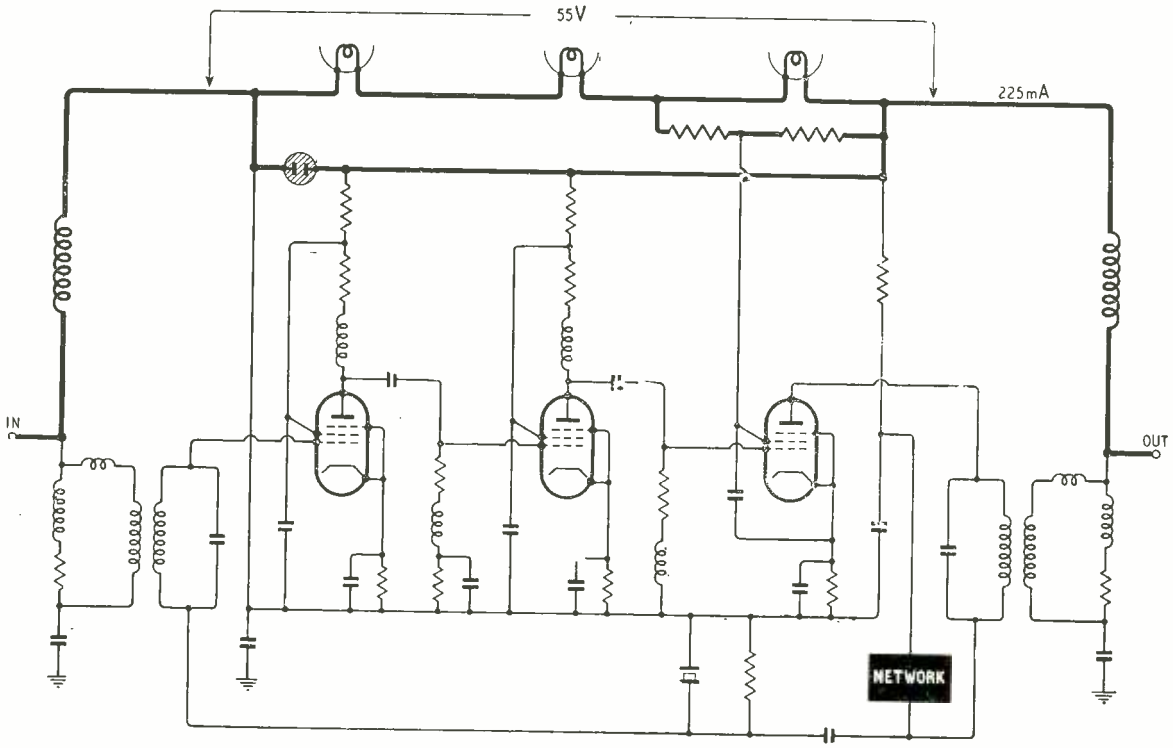


Fig. 5. *Amplifier circuit diagram of the American-type repeater. The power circuit is distinguished by heavy line and for clarity the heaters are shown separately above the valves to which they belong.*

of the cable at the 52 different frequencies in the test band to which the crystals resonate it is possible to locate any repeater that is falling below standard. Not only so but each high-gain peak at crystal resonance causes an increase in amplifier noise at that frequency, which can be detected by a sharply-tuned receiver on shore; it is, therefore, a quick and simple matter to locate any repeater that has failed. One has only to note the test frequency at which the noise peak is missing. It might be supposed that an open-circuited heater would interrupt the power feed for the whole cable, rendering this test impossible; but the second interesting detail is the gas-discharge tube shunted across the heater chain of each amplifier. The normal voltage across its electrodes is insufficient to strike it, but if any heater chain becomes open-circuited the voltage rises and the diode conducts, re-establishing continuity. Since the amplifier would then, of course, be out of action, the noise peak at its particular frequency would be missing and the fault would thereby be located.

Besides the 55-V drop across the three heaters, there is another 20-V drop in the 40 miles of cable between one repeater and the next, so the total drop for the whole cable with its 52 repeaters is nearly 4,000 V. Half of this voltage is provided by a constant-current generator between one end of the cable and sea, and the other half by another generator of oppo-

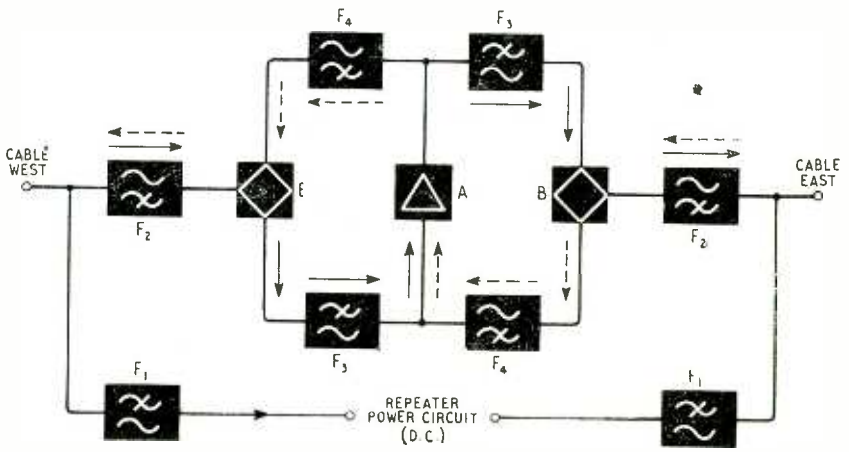


Fig. 6—*Block diagram of British-type repeater for the Newfoundland to Nova Scotia section of the cable. Filters F_1 and F_2 separate the power and signal currents, and filters F_3 and F_4 separate the East to West (high frequency) signals from the West to East (low frequency). BB are balanced bridges, and A is a pair of parallel-connected amplifiers.*

site polarity, at the other end. No part of the cable, therefore, is at more than 2,000 V to sea.

Because a single fault in any part of any of the repeaters would affect all the telephone circuits at once, perhaps fatally, and repair by cable ship is a lengthy, expensive and hazardous business, the most extraordinary care is taken in selection and assembly of all components. The repeaters are manufactured by specially selected workers in air-conditioned rooms and surgical type of clothing.

The circuit diagram of the amplifier in the British type of repeater used in the Nova Scotia to Newfoundland section of the system is very similar to Fig. 5, but in other respects the design of repeater is quite different. Following the techniques successfully used by the G.P.O. on a smaller scale in Europe, no attempt has been made to confine the outlines of the repeater to a slight and gradual bulge capable of passing through the normal cable-laying machinery. It takes the form of a rigid cylinder 9ft long and $10\frac{1}{2}$in diameter. Since this provides about ten times the internal volume of the flexible repeater, there is room not only for both "ways" and more channels but also a duplicate amplifier to improve the reliability. Moreover the components are not subject to such cramping dimensional restrictions. Fig. 3 shows that all the East to West channels are higher in frequency than the West to East; it is, therefore, possible to separate the two lots of channels *en bloc* by means of high-pass and low-pass filters as in Fig. 6, so enabling one amplifier (actually two amplifiers in parallel) to be used for both lots, rather in the manner of a bridge-connected rectifier unit. Another contribution to achievement of the wide frequency band is the use of modern high-performance valves ($g_m = 6$ mA/V). A cure for the apparent gradual deterioration in mutual conductance, which is caused by the formation of a resistive barrier at the cathode,* has been found by the G.P.O. —the use of platinum cathode cores—and it is hoped that this will ensure that the valves will have stable characteristics over a very long life.

Testing of the British-type repeaters is by means of tones in the 260-264 kc/s band. Each repeater receives its own test tone and has a frequency-doubler that brings its frequency into the band that is amplified in the reverse direction. A signal at that frequency is consequently returned to the starting point, to provide a measure of the transmission level. Pulse-testing equipment is also provided for measuring the overload point in each repeater and thereby ascertaining whether both amplifiers are still working.

Mechanically, the cable is cut at the repeater points and the armouring firmly anchored at each end of the repeater housing. The apparatus compartment, which occupies about half the length, is firmly sealed at both ends, and filled with dry nitrogen to inhibit corrosion. An ingenious modification of the cable-laying machinery has been devised to pass the repeaters through without obstruction. Because of the wide frequency band covered, these repeaters are to be laid at shorter intervals of about 20 miles; 16 of them are, therefore, required along the single cable between Clarenville and Sydney Mines.

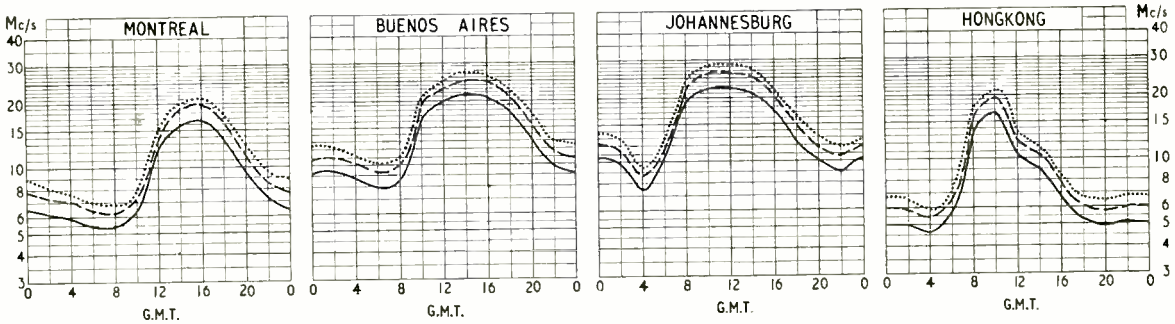
It will be interesting to see how the British and American ideas about submerged repeaters compare in practice over a period.

The authors of the I.E.E. lecture are already looking forward to a transistorized cable to supersede the present system. The number of repeaters, and consequently the frequency band that can be transmitted, is at present limited by the safe voltage that can be applied to the cable for supplying power to the valves. With its small size and modest power requirements the transistor has obvious attractions in this field. The authors look still farther forward to a transatlantic television cable as an eventual possibility. If sufficient financial provision could be seen, it is unlikely that technical difficulties would long remain unvanquished.

* "Valve Cathode Life," by C. C. Eaglesfield; *Wireless World*, Dec., 1951, p. 505.

SHORT-WAVE CONDITIONS

Predictions for January



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 January.

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

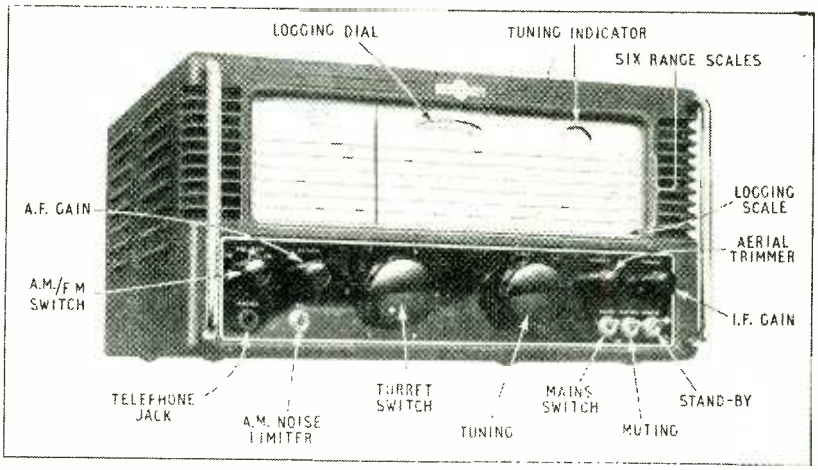
..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

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

A.M./F.M. Communications Receiver

Review of Eddystone Model 770R, Covering 19 to 165 Mc/s



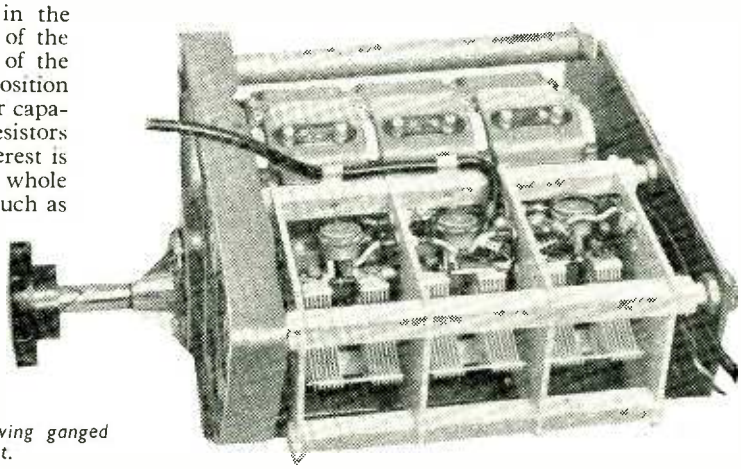
NINETEEN valves, of which all but two are miniature, and three germanium crystal diodes are used in the new Eddystone Model 770R wide range, v.h.f. communications receiver. The types of these valves, their circuit positions and functions will be found in the valve table. This set is believed to be the only British-made receiver now available giving continuous tuning over such a wide v.h.f. range as 19 to 165 Mc/s. There are six ranges and the extent of each, together with some of the services likely to be found in the various bands, are outlined in the frequency tables on the following page.

The 770R has an i.f. of 5.2 Mc/s and provides for the reception of a.m. and f.m. telephony and c.w. telegraphy. No marked departures from well-tried techniques are attempted, but considerable ingenuity is evident in the planning of the circuit and range-changing mechanism of the front-end, comprising the r.f., mixer and oscillator stages. This is, of course, the real heart of a receiver of this kind and its general performance depends almost entirely on the design of this part of the set. Its very satisfactory behaviour on all ranges, but especially on the 114-to-165-Mc/s one, is a tribute to the design of the front-end unit.

The r.f., mixer and oscillator stages in the 770R are a single unit, and a good idea of the general arrangement can be seen in one of the illustrations. The set employs a six-position rotary-coil turret, three ganged split-stator capacitors, valve-holders and sundry small resistors and capacitors. The main feature of interest is that virtually no r.f. wiring is used in the whole unit; the positioning of the main items, such as coil turret, tuning capacitors and valveholders, is such that their interconnecting points fall so close together that the soldering tags alone form the wiring. Moreover, little real wiring is employed inside the coil turret itself. As shown in the

VALVE TABLE

Circuit Position	Type	Function
V1	6AK5 EF95 (CV850)	Pentode r.f. amplifier.
V2	6AK5 EF95 (CV850)	Mixer.
V3	6AK5 EF95 (CV850)	Oscillator.
V4-V7	6BA6 (CV454)	I.F. Amplifier
V8	6AU6 (CV2524)	F.M. limiter.
V9	6AL5 (CV140)	F.M. discriminator.
V10	6AL5 (CV140)	Noise limiter and a.g.c.
V11	6AU6 (CV2524)	"S" meter valve on a.m. Tuning indicator on f.m.
V12	6BA6 (CV454)	Beat frequency oscillator (BFO)
V13	6AU6 (CV2524)	Noise amplifier (muting).
V14	12AU7 (CV491)	Muting stage.
V15	12AU7 (CV491)	A.F. amplifier and phase inverter.
V16-17	6AM5 (CV136)	Push-pull output stage.
V18	VR150 30 (CV216)	Voltage stabilizer.
V19	5Z4G (CV1851)	Full-wave h.t. rectifier.
CD1	Germanium	A.M. detector.
CD2-3	Germanium	Noise detectors (muting)



Right : Front-end unit of Eddystone 770R showing ganged capacitors, valveholders and (in rear) coil turret.

illustration of two of the turret coil assemblies, the higher-frequency coils are self-supporting and are soldered direct to the inside extensions of the external contact studs. Any trimmers included have the shortest possible leads to their respective points.

Turret Mechanism

The actuating mechanism of a coil turret for v.h.f. use is a vitally important feature of its design, as it is most essential that at all times the turret comes to rest in exactly the same position on any one range. A fractional displacement would either add to or subtract from the total inductance in the circuit and cause changes in tuning of sufficient magnitude to render the range scales, if calibrated directly in frequency as they are in the 770R, quite useless. Moreover, as facilities are provided for accurately logging the tuning positions of stations, any unreliability in the turret positioning would become immediately apparent when a previously logged station's position is sought after changing ranges. Apart from small initial variations in tuning caused by oscillator drift (which cannot be entirely avoided by voltage stabilization alone), no abrupt changes in the tuning position of a station was noticed by going from range to range and back to the original. We looked for these effects most searchingly on the highest frequency range and, finding none, conclude that the coil turret mechanism is above reproach in this respect.

The tuning system of the 770R is the same basic type as used in other Eddystone communications receivers. It provides an overall reduction of 140 to 1, embodies a flywheel to counteract frictional drag of the gears, and gives a smooth and free action. It is heavy enough to carry the pointer some distance along the scales by spinning the knob sharply. The weight is

FREQUENCY TABLE

Range	Frequency coverage (excluding overlaps)	Remarks
1	114 to 165 Mc/s	Aircraft, amateurs.
2	78 to 114 Mc/s	F.M. broadcast, land mobile, aero navaids.
3	54 to 78 Mc/s	Television, aero navaids.
4	39 to 54 Mc/s	Television, U.S. amateurs.
5	27 to 39 Mc/s	Amateurs, aero navaids, meteorological aids.
6	19 to 27 Mc/s	Broadcast, amateur, marine.

nicely chosen and does not give the impression of taking charge of the tuning, as sometimes seems to occur when the flywheel is too heavy. The pointer is a long pendant one and embraces seven 12-in long horizontal scales, six of which are calibrated linearly in frequency; the seventh is the logging scale marked 0-2,500 and having 25 divisions. Each division represents one complete revolution of a subsidiary logging dial which is visible through an aperture in the top centre of the main dial. This dial has a 360-degree scale and is engraved 0-100. In effect it expands every scale to the equivalent of 32 ft. Quite small changes in frequency can thus be observed on the logging dial.

A.M./F.M. Arrangements

Owing to the rather high i.f. used (5.2 Mc/s) four i.f. stages have been included to satisfy the requirements of high sensitivity coupled with a wide band-

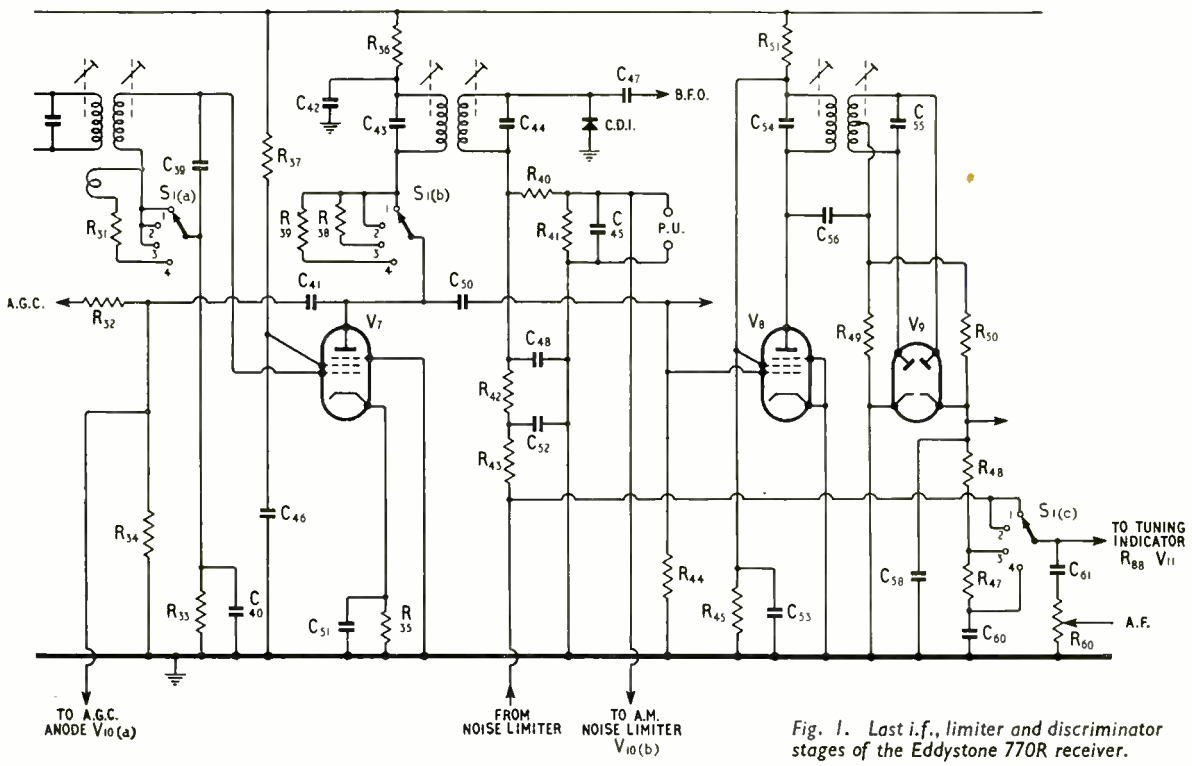


Fig. 1. Last i.f., limiter and discriminator stages of the Eddystone 770R receiver.

width for f.m. reception. For f.m. there is in addition a limiter and a Foster-Seeley discriminator. For a.m. reception there are no fewer than 10 tuned circuits and a crystal diode detector. Some interesting features (see Fig. 1) can be found in that part of the circuit, which includes the last i.f. stage V7 limiter V8 and discriminator V9. The switches S_{1a} to S_{1e} are part of a larger switching system, which might be called the "services switch," as it changes over from a.m. to f.m., adjusts bandwidth to suit each type of service and in the "CW" position switches on a BFO. S_{1a} and S_{1b} are for bandwidth adjustment of the i.f. amplifier at this point, the markings on S_{1a} indicating the four positions of the switching system; (1) CW, (2) AM, (3) NFM and (4) FM. NFM is narrow-band f.m. and is used for certain types of transmission for which the frequency deviation need not exceed ± 15 kc/s compared to the ± 75 kc/s of wide-band f.m.

In the top right-hand corner of the main dial is a small aperture disclosing a tuning indicator. It serves a twofold purpose; it functions as a single-strength meter for c.w. and a.m. transmissions, registering on the carrier level, and is used as a tuning indicator for f.m. It has a red-line centre zero on which the pointer is aligned for correct tuning on f.m. and a 0-9 "S"-scale for a.m. It is sometimes said that an f.m. signal can be tuned in correctly by adjusting for minimum background noise, but this region is generally far too broad for satisfactory tuning. The meter indicator of the 770R is very sensitive to small changes in tuning and enables the desired accuracy to be achieved in a simple manner.

Details of the circuit associated with this indicator are given in Fig. 2, which includes the switch S_{1d} for changing over the indicator's functions from tuning indicator to "S" meter as required. It forms part of the main S_1 switching system. The remainder of the circuit is reasonably straightforward.

A push-pull output stage is used, preceded by a phase-splitter and a.f. amplifier. Negative feedback is employed. An output transformer provides matching for an external loudspeaker of 2.5 to 3 ohms; a loudspeaker is not included in the set. Provision is made for headphones and—unusual in a set of this kind—for a gramophone pickup.

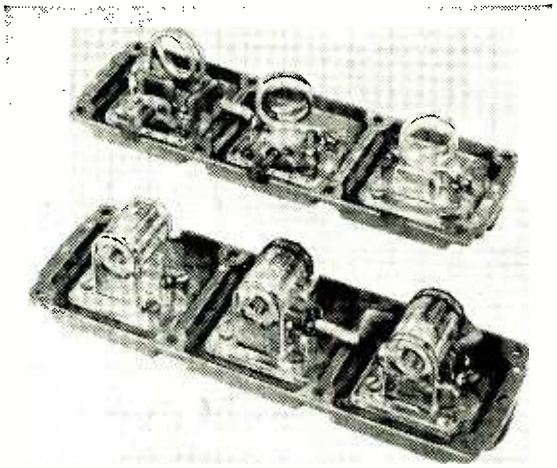
One other circuit detail, which, however, is common to most communications receivers, is a stand-by switch. It de-sensitizes the set in the stand-by position and also closes a pair of spare contacts to be used, if required, to control a nearby or remote transmitter via a relay.

Performance

The impression given by the set is that it has about as much sensitivity as can usefully be employed. The selectivity in the CW and AM positions is adequate for all v.h.f. requirements; and it must be judged on this basis. It leaves a little to be desired on the 19- to 27-Mc/s band, but these frequencies may be regarded as rather outside the normal scope of this receiver.

During our tests we dodged from range to range, noting station tuning positions and often coming back to them time and again; it was a form of monitoring and covered the whole v.h.f. range of the receiver. The set seems ideally suited for this type of work which could form one of its principal rôles.

The noise limiter suppresses ignition interference on a.m. transmissions quite effectively, but seems to cut rather deeply into the upper frequency response. Indeed, it forms a useful way of suppressing most of the set noise when the full gain is employed and especially so when the BFO is used, which, as seems inevitable, adds considerably to the general background noise. However, this is not peculiar to the 770R.



Two of the coil units removed from the turret.

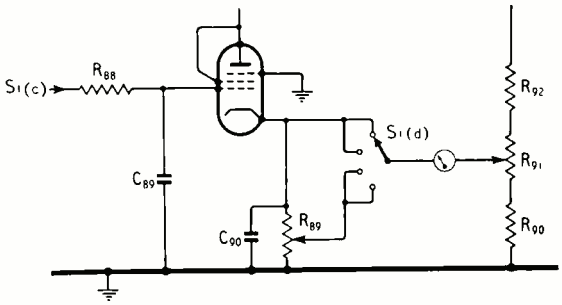


Fig. 2. The f.m. tuning indicator and a.m. "S" meter are combined in one stage.

The following extracts from the maker's specification serve to give some idea of the receiver's qualities.

Sensitivity.—Better than 5 μV on all ranges for a 15-db signal/noise ratio and 50 mW output.

Selectivity.—CW and AM; 40 db down, 50 kc/s off resonance. Narrow band FM; 40 db, 80 kc/s away from resonance. Wide-band FM; 40 db down, 175 kc/s off resonance.

Noise Factor.—Not greater than 14 on Range 1, decreasing to less than 5 on Ranges 5 and 6.

Image Ratio.—Better than 20 db at 165 Mc/s and correspondingly greater at the lower frequencies.

Frequency Stability.—Drift less than 0.001 of 1 per cent C, and less than 0.001 of 1 per cent for a 5-per cent change in mains voltage.

As the receiver covers the 21-, 28- and 145-Mc/s amateur bands it might have some appeal in this direction provided the price does not prove too great an obstacle.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.

Circuit Symbols

Differences Between American and British Standards

By "SYMBOL SIMON"

THE June, 1954, issue of *Proc.I.R.E.* contains a list of graphical symbols—covering *all* electrical needs—which have been agreed with the American Standards Association.

In this country, the "heavy" and "light" engineering fields are catered for by two British Standards: B.S.108 and B.S.530 respectively. Perhaps we shall one day see a similar amalgamation of these two Standards: this would prevent inconsistencies between the two Standards, which, although few, are puzzling to a draughtsman who has to choose symbols from both lists for use on one drawing.

The I.R.E. list generally gives two sorts of symbols, "single-line," i.e., simplified, somewhat similar to the British "block diagram," and "complete"—on the lines of our circuit symbols. The supplement to B.S.530 on waveguides uses a similar arrangement.

Mention should first be made of two symbols which may confuse the British reader:

(a) The American open contact, as used on "power" diagrams (left), is very like our capacitor.

(It must be remembered that Americans draw all lines of the same thickness.) Their closed contact (right) is rather like a British variable or pre-set capacitor which has lost the end of its shaft. They avoid confusion by giving their capacitors one curved plate (left). Possibly we could persuade them to change their open contact to our symbol used in Electric Traction diagrams by erasing half the horizontal lines (right). This change would remove any risk of confusion.

(b) Much less important. The American microphone (left) is similar to our buzzer (middle), whereas our microphone (right) has international agreement.

In passing, the British buzzer symbol is supposed to owe its origin to the practice (frowned on by the Post Office) of inverting the dome on a telephone bell to make it produce a quieter buzz. The American bell and buzzer are left and right respectively.

Apart from these contradictions, the symbols are generally self-evident, except, possibly, the plugs and sockets; for example, the socket (left) and plug (right), which are "pictures" of the modern connectors with rectangular pins.

A choice is given for the inductance symbol: the (British) "loop" symbol (right) or a "semi-circle" symbol (left), which is easier to draw and quite unambiguous. As an indication of the American preference between these two, it is interesting to note that the "semi-circle" symbol is used for an inductance in *every* case in the rest of the list. Perhaps we would do well to introduce this symbol in this country—it is already looked on with favour on the Continent.

The American "waveguide" symbols agree well with the "single-line" symbols in the supplement to B.S.530 mentioned above. This is not surprising, since an earlier draft of the American symbols was in the hands of the British "Services" committee which based its symbols on them and subsequently brought its decisions to the attention of the B.S.I.

To sum up, the list appears complete, and (with the few exceptions mentioned above) clearly intelligible to the British reader.

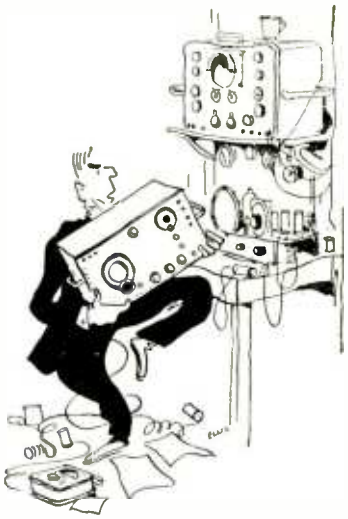
Millimetric Radar

WHAT is believed to be the first millimetric radar surface movement indicator is to be installed at London Airport by the Ministry of Transport and Civil Aviation. It will provide the control staff with an accurate picture of the positions of aircraft and vehicles on the airfield and enable them to supervise movements under conditions of poor visibility more expeditiously than is possible with position reporting by radio telephone. Owing to the expanse of London Airport it should ease the flow of air traffic in and out under all conditions of visibility.

The equipment to be used is the new Decca 8-mm airfield surface movement indicator which employs a beam width of 23 min only and a pulse length of 0.05 μsec, giving a radar picture of exceptional clarity as may be seen from the accompanying p.p.i. display showing the runways at London Airport. The slight masking of the picture in the upper right-hand corner is caused by a temporary obstruction which will be removed before the equipment is installed in its permanent quarters.

High definition p.p.i. display of London Airport's runways produced by the new Decca 8-mm surface movement indicator.

Talking of Test Gear...



A Cynic's View of Electronic Measuring Instruments

By A. J. REYNOLDS*

ONCE upon a time there was an engineer who, for want of a better name, shall be called Mr. P. H. Dee. Having made a great success of a research project at his university, working with apparatus made by himself and his assistants, he landed a highly paid job in industry (the sort in the small ads. section of *W.W.* at a salary at least twice what your firm pays), and looked forward to using some good professional apparatus. He was given an "X"-band development job and set about buying the necessary instruments. His first move was to study the advertisements in the technical press and the catalogues in the library. He picked out the eight most likely manufacturers and telephoned or wrote to them, and in due course finished up with four beautiful leaflets each describing an instrument allegedly suitable for his job. In this case, it was a fairly simple piece of waveguide apparatus, the main requirement being that it should achieve a reasonable degree of match. It was then that his bewilderment began, for he came up against the gentle art of "specification writing." It goes something like this, extracting the relevant passages from the manufacturers' leaflets:—

Instrument A: VSWR 1.2 at 10,000 Mc/s.
Instrument B: Standing wave ratio $\not< 0.8$ at 10,000 Mc/s.
Instrument C: The degree of match achieved is better than 1 db.
Instrument D: The total reflected power is less than 1% over most of the band.

Now when converted to a common terminology all these mean almost the same thing, but it will be apparent to the keen student of Stephen Potter that the writer of leaflet D is a first-class lifeman. How much better his instrument sounds than if he had written:—

VSWR 0.8 over the middle 51% of the band, falling to 0.55 at the extremes.

Having sorted all this out Mr. P. H. Dee found all the literature extremely silent on one most important point—that of the "handleability" of the instrument concerned.

Handleability can perhaps be defined as "possessing the quality that a given movement of the controls produces the expected response in the expected degree." The possession of this quality largely determines whether or not an instrument will meet with wide approval and enormous sales. All of us at some time have had to use a magic box where a meter has to be set to a datum line by means of a knob on the front. How infuriating it is when the slightest touch of the knob causes the meter needle to dash madly to one stop or the other! One can never regard with any affection an instrument which has such tricks in its repertoire.

One or two examples of eminently handleable instruments come to mind. In the field of the humble multi-range meter one particular example has this quality to a high degree. Since it was designed, well before the war, it has successfully fought off challenges from a variety of competitors, some of which required a small chain wrench to turn the knobs and some whose plug and socket range selection could only be adequately operated by an international cribbage-marker—not to mention those with nice easy range factors like 2.5 and 6, and figures of merit like 310 ohm/V. When the equipment designer specifies that the anode voltage of V1 is 275V measured with a 1,000-ohm/V meter, one notes that it reads $34.5V \times 6$ on one's 310-ohm/V meter, so this stage is obviously in order—or is it?

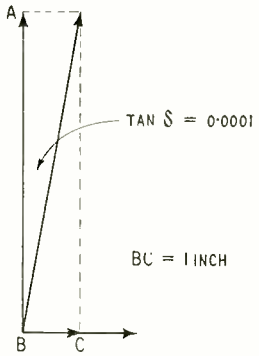
Attenuator Reaction

After the multi-range meter most people would agree that the signal generator is the next instrument to be purchased either for the average laboratory or service workshop. Here again the glossy leaflets are silent on the subject of handleability. It is easy to be misled by the paper specification into believing that generator A at half the price is just as good as generator B. Unfortunately, in instruments as in everything else, one gets just what one pays for (usually a little less). Most engineers have by now caught up with that old bogy of signal generators, spurious f.m., and in many cases the limits are included in the specification, but I have still to see attenuator reaction (that is, the effect of varying the attenuator on the emitted frequency) written into a specification. Yet this quality is by no means negligible in its effect on "handleability." The sequence goes something like

* Livingston Laboratories.

this. The indicating device at the end of the chain reads high, so the output from the generator is reduced by means of the attenuator until the pointer of the output meter is on the datum; this shifts the frequency so the generator is re-tuned to peak. The shift of frequency causes the output to drop, so the "Set Carrier" is advanced to its proper place. One then notices that the output meter is still a bit high and repeats the process.

Another quality of the signal generator rarely specified is the harmonic content of the r.f. signal. It may come as a surprise to hear that figures such as 25% second and third harmonic distortion are quite common even in high-grade instruments. The ever-widening bandwidths used to-day plus the use of feedback-type valve millivoltmeters as indicators make this point a matter of some importance. Before roundly condemning all signal generator manufacturers as scoundrels, remember that many of the best-known examples were designed in the days of bandwidths measured in small kc/s rather than large Mc/s, and that in these conditions the effect of r.f. harmonic distortion is small. 25% distortion only affects the level of the signal some 4%, and it is rarely that the level accuracy can be guaranteed to better than 10% for reasons quite unconnected with harmonic distortion.



In the last paragraph, passing mention was made of a now popular type of instrument, the valve millivoltmeter. Careful investigation is necessary before buying one of these. Apart from the usual points to watch such as zero stability and, in the case of the most sensitive types, noise on the lowest range, the form factor error is a variable and usually unspecified error that can affect the handling in many common applications. (Form factor being defined as the ratio of average voltage to peak voltage, that is, 1.11 for a sine wave.) One of these applications, the use of the instrument with a signal generator having a bad waveform, has been quoted above. These instruments are invariably calibrated in terms of r.m.s. volts and yet actually may be measuring peak voltage, half-wave average voltage, full-wave average, or a quantity that is not quite any of these. When fed from a distorting source, reading errors up to 50% are quite common between different instruments that agree extremely well on a pure sine wave.

Practically all the foregoing could be read as though my intention were to "debunk" the instrument industry, but this is not at all the case. The blame for many of the apparent shortcomings of instruments rests with the user who consistently demands an instrument having an enormously wide range of measurements.

We have grown so used to our micros and megas that we have lost a sense of wonder about such things. People look at a pulse displayed on an oscilloscope, for example, and say "the front edge is not too good—it is not much better than a twentieth, I suppose," meaning, of course, that the rise time of the pulse in question is some 0.05μsec. Recently a well-known and well-liked pulse generator was being roundly criticized for daring to have a time jitter in the "free run" position of 0.05μsec! It may come as a surprise to those who have never stopped to think about it that

0.05μsec is to 1 sec as 1 sec is to 7 months,

and yet people are now demanding presentation of an event lasting a fraction of a millimicrosecond!

A somewhat similar state of affairs exists in other fields. Insulating materials having a loss angle (tan δ) of 0.0001 are in common use. For those not familiar with the expression "loss angle," perhaps a word of explanation will not be amiss here. The perfect insulator when used as a dielectric material forms a capacitor that takes a current truly 90° ahead of the voltage in phase and hence has no loss. In practice, of course, this state never exists, and all practical capacitors have a small resistive component which modifies the resultant phase angle and represents the power dissipated in the dielectric. As, in the case of very small angles, the tangent is numerically equal to the angle, this figure is normally used to describe the merit of a particular dielectric material. Those readers whose arithmetic is better than mine can, for amusement, calculate the missing dimensions in the accompanying vector diagram (left). Yet this quantity is regularly measured at 10 Mc/s or even 100 Mc/s.

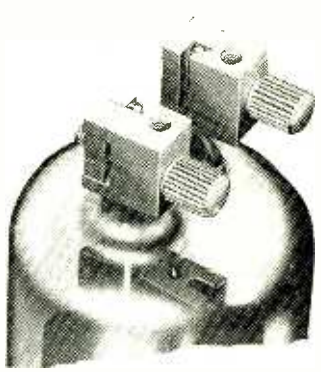
Perhaps these two example have been sufficiently striking to help you to appreciate the magnitude of the task that faces the instrument designer these days. This task is made even more difficult by the demand for instruments having a wider and wider range. The ideal signal generator covers from 0.1 c/s to 50,000 Mc/s in one range; has an output of several watts which can be attenuated (without leakage, of course) to 0.01μV; has internal f.m., a.m., p.c.m.; does not weigh more than 10lb or cost more than £100. It will then exhibit all the faults mentioned and have a few of its own. In general a narrow-range single-purpose instrument can be made to do its job supremely well, but, of course, the Sales Department can't sell it as the customer will always buy a slightly worse one with a wider range.

V.H.F. Valve Connector

A NEW product of interest to users of v.h.f. equipment is an anode connector for transmitting valves such as the QQV06-40, 829, 832 and similar types with top anode pins. It is made of silver-plated brass, measures $\frac{1}{2} \times \frac{1}{2} \times \frac{5}{16}$in and while being massive enough to provide effective cooling of the anode pins adds little to the capacitance of the anode circuit.

Its construction and method of fitting are shown clearly in the illustration, which shows also the 6-BA tapped hole providing the means of connecting to the external anode circuit.

Made by Power Controls, Ltd., Exning Road, Newmarket, Cambridge (one of the Pye group of companies) the price is provisionally 2s 3d each, but is subject to adjustment for quantities.



Top anode connectors for v.h.f. transmitting valves made by Power Controls.

JANUARY MEETINGS

Institution of Electrical Engineers

London.—January 12th. "Thermionic Valves of Improved Quality for Government and Industrial Purposes" by E. G. Rowe, P. Welch and W. W. Wright at 5.30 at Savoy Place, W.C.2.

January 24th. "Radio Aids to Marine Navigation" by Capt. F. J. Wylie, R.N. (Ret.), at 5.30 at Savoy Place, W.C.2.

January 27th. Faraday lecture on "Courier to Carrier in Communications" by T. B. D. Terroni at 6.0 at the Central Hall, Westminster, S.W.1. Admission by ticket obtainable from the Institution.

East Midland Centre.—January 25th. "Special Effects for Television Studio Productions" by A. M. Spooner and T. Worswick at 6.30 at the Gas Demonstration Theatre, Nottingham.

North-Western Centre.—January 5th. "The Experimental Synthesis of Speech" by W. Lawrence at 6.45 at the Engineers' Club, Albert Square, Manchester.

January 18th. Faraday lecture on "Courier to Carrier in Communications" T. B. D. Terroni at 7.30 at the Free Trade Hall, Manchester.

South Midland Centre.—January 24th. "Some Applications of Electronics to Telecommunications" by Col. C. E. Calverley at 6.0 at the James Watt Memorial Institute, Great Charles Street, Birmingham. (Joint meeting with Birmingham section of Institution of P.O. Electrical Engineers.)

Southern Centre.—January 28th. "Transistor Circuits" by G. B. B. Chaplin at 6.30 at the Technical College, Weymouth.

Oxford District.—January 12th. "The Future of Electronics in Industry" by E. R. Davies at 7.0 at the Demonstration Room, Southern Electricity Board, 37, George Street, Oxford.

British Sound Recording Association

London.—January 21st. Demonstration of a high-fidelity reproducing chain by T. S. Livingstone and N. C. Mordaunt at 7.0 at the Royal Society of Arts, John Adam Street, W.C.2.

Manchester Centre.—January 10th. "Design of a Recording System" by H. G. Bennetts at 7.30 at the Engineers' Club, Albert Square, Manchester.

Television Society

London.—January 19th. Fleming Memorial Lecture, "The Perception of Colour" by Prof. W. D. Wright (Imperial College) at 7.0 at the Royal Institution, Albemarle Street, W.1.

Radio Society of Great Britain

January 28th. Presidential address followed by "Antenna Matching with the Antennamatch" (with practical demonstrations) by Frank Hicks-Arnold, G6MB, at 6.30 at the I.E.E., Savoy Place, London, W.C.2.

Institution of Production Engineers

Luton.—January 25th. "Induction Heating" by Dr. R. H. Barfield at 7.15 in The Town Hall, Luton.

Electro-Physiological Technologists' Association

February 5th. Papers and demonstrations at 10.30 a.m. at the National Hospital, Queen Square, London, W.C.1.

British Institution of Radio Engineers

London Section.—January 26th. "A Survey of Tuner Designs for Multi-Channel Television Reception" by D. J. Fewings and S. L. Fife at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

West Midlands Section.—January 12th. "Electronics in Materials Handling" by L. Landon Goodman (British Electrical Development Association) at 7.15 at the Wolverhampton and Staffs Technical College, Wulfruna Street Wolverhampton.

North-Eastern Section.—January 12th. Address by the president, Rear-Admiral (L) Sir Philip Clarke, K.B.E., at 6.0 at Neville Hall, Westgate Road, Newcastle-upon-Tyne.

Merseyside Section.—January 6th. "Some Interesting Applications of Electronics to Photography" by D. M. Neale (Ilford, Ltd.) at 7.15 at the College of Technology, Byrom Street, Liverpool, 3.

North-Western Section.—January 6th. Discussion on the "Problems in the Design and Production of Car Radio," opened by C. L. Caiger (E. K. Cole) at 7.0 at the College of Technology, Sackville Street, Manchester.

South Wales Section.—January 12th. "Electronic Counting Devices" by Dr. F. H. Gage at 6.30 at the Glamorgan Technical College, Treforest.

Scottish Section.—January 13th. Discussion on "Band III Commercial Television" at 7.0 at the Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, C.2

January 20th. "Modern Ship-to-Shore Communication" by G. Macdonald (Marconi's) at 7.0 at the Department of Natural Philosophy, the University, Edinburgh.

Radar Association

London.—January 12th. "Invention and Development of SARAH" by D. Kerr (Ultra) at 7.30 in the Anatomy Theatre, University College, Gower Street, W.C.1.

Incorporated Practical Radio Engineers

South Coast Section.—January 13th. "Some Practical Applications of Transistors" by R. A. L. Cole (S.T.C.) at 7.30 at the Kings Arms Hotel, Castle Street, Christchurch.

North-West Section.—January 6th. "Cathode Ray Tubes" by a representative of the Edison Swan Electric Company at 7.30 at the Barley Mow Hotel. Turner Street, Manchester, 4.

East Midlands Section.—January 28th. "Electronics in the Radio and Electrical Industry" by C. Cowell (Fielden Electronics) at 7.15 at the Demonstration Theatre, Electricity Showrooms, Smithy Row, Nottingham.

Midlands Section.—January 5th. "K.B. Television Receivers and Modern Trends in Design" by a representative of Kolster-Brandes at 7.30 at the Crown Hotel, Broad Street, Birmingham.

North-East Section.—January 11th. "Rectifiers" by a representative of Standard Telephones and Cables at the Y.W.C.A., Saville Place, Newcastle-upon-Tyne.

Berks, Bucks & Oxon Section.—January 12th. "Visual Alignment" by J. Tomlin and G. Timberlake at 7.30 at the White Hart Hotel, St. Mary's Butts, Reading.

RANDOM RADIATIONS

By "DIALLIST"

TV Reception Freaks

INTERFERENCE with television reception by continental sound broadcasting stations has been widespread in recent months. I expect you've had some of it; I certainly have. It normally takes the form of faint, narrow, dark lines, sloping across the whole screen, now from left to right, now the other way. In severe cases these may give way to stationary vertical black bars, forming a sort of portcullis over the entire picture But the most curious television freak I've yet come across is reported by a friend who lives near Folkestone. The words "Télévision Française" appeared, faint, but perfectly legible, on his screen. Then a dim picture was seen accompanied by speech in French from the loudspeaker.

Shining 'Em Up

DURING a stay in Devonshire, in the late unlamented travesty of a summer, I was enormously impressed by the beautiful polish on the cabinet of my host's TV console. When I expressed my admiration he told me that it was due to a new kind of furniture polish which he'd been recommended to try a few months before. I brought some home and after giving it a thorough trial I feel that it is something of real value not only to owners of radio and television sets but to dealers and servicemen as well. "Topps," as it is called, is the easiest thing to use, as I found when I made my first experiment on a very old cabinet.

Live-chassis Sets

IT WAS stupid of me to suggest in these notes in the November issue that on d.c. all was well with a.c./d.c. receivers because they wouldn't work unless the mains connection was made the right way round. It must have been one of my absent-minded moments, for I know perfectly well that it's an even chance whether the live wire of most domestic d.c. systems is positive or negative to the earthed neutral. Apologies to readers and best thanks to A. B. Grief and others for pointing out the slip. A Dutch reader tells me that transformerless sets are used in Holland and asks whether the people of that country are thereby branded as uncivilized! I didn't know that the live chassis was permitted in the Netherlands, but I *do* know that the Dutch are amongst the most charming and cultured people in the world. A pity that they've followed our bad example with the live chassis. Most of those who have written to me share my dislike of a.c./d.c. television and radio receivers; but if the present trend continues I fear that this will soon be the only kind obtainable.

Reactivated C.R. Tubes

IT WOULD BE interesting to know, though no one is ever likely to do so, how many television c.r. tubes are needlessly scrapped in the course of a year. Leaving out of accounts the not inconsiderable number consigned to the rubbish dump by the kind of dealer who prescribes a new tube as the cure for ringing, or even for distorted sound, there are two common causes of failure which need *not* render a tube past redemption. The first of these is lost emission; and for this there are two possible remedies. One is to reactivate the cathode by raising it for a brief period to a temperature a good deal above that of normal working conditions. The other is to isolate the heater by fitting a special booster transformer and to apply permanently to it a voltage quite a bit above that reaching it when it was in the heater line. Neither kind of treatment can be guaranteed to be effective in every instance; but I know both reactivated and "boosted" tubes which are still going strong after months of use. The second kind of breakdown is the cathode-heater "short." Here again, the remedy is an isolating transformer, which, so far as my experience goes, is completely effective. Heater transformers of either kind can, naturally, be used only in sets worked off a.c. mains; but when he does fit one the knowledgeable dealer can kill two birds with one stone by improving the d.c. amplification on the lines suggested by W. T Cocking in the February, 1954, issue.

The Magic of Numbers

OLD HANDS will recall how in the early days of wireless we were wont to boast of the number of valves which our sets contained: the more of them there were, the greater our feeling of superiority and the better the sets sold. In one case the total was increased by the use of four little half-wave rectifiers instead of a single man-sized full-wave one! Screen size used to be the "criterion" of television sets, but

that has now rather given way to the number of channels to which they can be tuned: the man in the street feels at least a head taller if he can boast of his 13-channel receiver. One's always meeting or hearing of people hailing from remote parts of the country who, when buying sets this year, have chosen to put down an extra £5 or more to pay for Band III tuners for which they're unlikely to have the slightest use before the said sets are worn out. As they say in the North, "There's nowt so queer as folk."

Maintenance Schemes

THE OWNER of such a complex assembly of expensive bits and pieces as a television receiver is probably wise to take out a maintenance contract or insurance policy with a reputable firm. This does not apply so much to readers of *Wireless World*, who can do their own repairs, as to those less gifted folk who don't know the first thing about the "works." Still, even boffins can find, if they are unlucky, valve after valve packing up after the guarantee on them has expired. Only the other day I met one who was bewailing the failure of a 17-inch c.r. tube after a life of seven months; and, as you know, there are other vulnerable parts which can provide unpleasantly expensive surprises. There are many soundly and honestly run maintenance schemes; but there are, one fears, certain others in different parts of the country which are far from being anything of the kind. The existence of these is a blot on the radio trade and I sincerely hope that steps will be taken to stamp them out.

"Well, actually Mrs. B, we've got a 27-inch screen."

UNBIASED

By FREE GRID

Render Unto Cæsar

FAR be it from me to join issue with the mighty who have been arguing about the origin of the valve. But the noise of conflict certainly set me thinking as to what exactly is meant by the word "valve." The Greeks had a word for it, but it isn't necessary to go farther back than the Latin word *volvere*, meaning "to turn." In the days of Cicero that part of an entrance which had to be turned or moved round in order to get through it was called a *valva*; in fact, Cicero himself used the word. The use of the word "valves" to describe the "leaves" of a folding door was not uncommon in Elizabethan days.

In 1615 the medical profession particularized the meaning of "valve" as a *one-way* door, using the word to describe those parts of the circulatory system which stop the blood regurgitating when the heart is not on its actual firing stroke. Forty-five years later it was used in engineering circles to describe an automatic one-way device inserted in a pipe through which water or air was flowing.

It seems obvious, therefore, that although literally there is no suggestion of unilateral conductivity in the word valve, its use as meaning a one-way device was well established three hundred years ago and so the expression "non-return valve" which we sometimes hear is tautological.

I have stated these facts at some length because attempts have been made in some quarters to say that de Forest and not Fleming patented the first *real* thermionic valve. Actually, of course, the addition of de Forest's grid to the existing thermionic valve turned Fleming's device into something else, namely, a thermionic relay.

A Vested Interest

MY ATTENTION has been drawn to a new question on the form which has to be filled in at the local post office if letters are to be redirected. This question demands to know the date of expiry of your sound or television licence.

Doubtless this question can be defended on the ground that it is merely a convenience to the P.M.G.'s clerical staff and also to the licence holder. But if this be so why does not the form ask about the date of expiry of the dog licence, another annually renewable affair handled by the P.O.? The reason is, I think, the entirely sordid one that the P.M.G. has a vested interest in one but not in the other. The £1 or £3 wireless licence yields quite a healthy rake-off to the P.M.G. but he would not get more than a few coppers out of the humble 7s 6d dog licence. Actually I believe I am right in saying he gets nothing at all but has to hand it all over to the local County Council, which is the authority responsible for licensing dogs. It is obvious, therefore, that the P.M.G. couldn't care less if we renew our dog licences or not.

How Many Microsqueers?

MORE than twenty years ago I published in these columns details of an appliance whereby a schoolmaster could put the administration of corporal punishment on a proper scientific basis so that there were "fair shares for all" in this matter.

Gauging the Vigour.

The haphazard methods employed at that time are unfortunately still in use with the result that those at the tail end of the queue in a mass caning receive less than their just due owing to pedagogic fatigue.

As you will see from the sketch reproduced from *W.W.* for April 7th, 1933, the apparatus was simple, consisting merely of two beams of light projected on to photocells so that the rate at which the cane moved, and, therefore, the force of the blow, was automatically calculated and shown on a large dial.

With the great advances in electronics which have been made in the past twenty years, the whole idea is now hopelessly out of date. Nowadays with modern technique it would be possible to dispense with the human element altogether and hand the delinquent schoolboy over to an electronic caner which would administer justice scientifically after the schoolmaster had decided on the correct number of microsqueers which the culprit deserved. The unit of flagellation is, of course, named after the famous Dickensian character.

Needless to say the electronic caner would incorporate some of the features of the Ace computer and also the encephalograph so that it could first measure the boy's nervous reactions and then adjust the strength of its blows accordingly, as some boys feel pain more acutely than others. The machine could thus, in some cases, modify the schoolmaster's sentence by applying electronically calculated mercy to human justice.

Telepathy by V.H.F.

THE name of Maskelyne usually conjures up—surely *le mot juste*—visions of a woman being sawn in half and it is a little odd to find that this well-known illusionist was one of the pioneers of radio. My attention has been drawn by the Rector of Ewhurst, Sussex, to an article in his parish magazine of over fifty years ago (July, 1901) in which are described experiments successfully undertaken by the Maskelyne concern and the Rev. J. M. Bacon, M.A., in wireless communication between the earth and a balloon in flight.

From this it is obvious that wireless signalling between aircraft and ground followed very hard on the heels of ship and shore communication. These aeronautical experiments were conducted in the summer of 1899 and in that same year the first wireless distress call was sent out by the East Goodwin lightship.

Four years later Nevil Maskelyne was still engaged in wireless experiments. There was some acrimonious correspondence in *The Times* following his attempt in 1903 to show certain weaknesses in wireless tuning by transmitting signals which broke in upon the receiver which Fleming was demonstrating at the Royal Institute. This incident is recorded in the recently published biography of the late Sir Ambrose Fleming.*

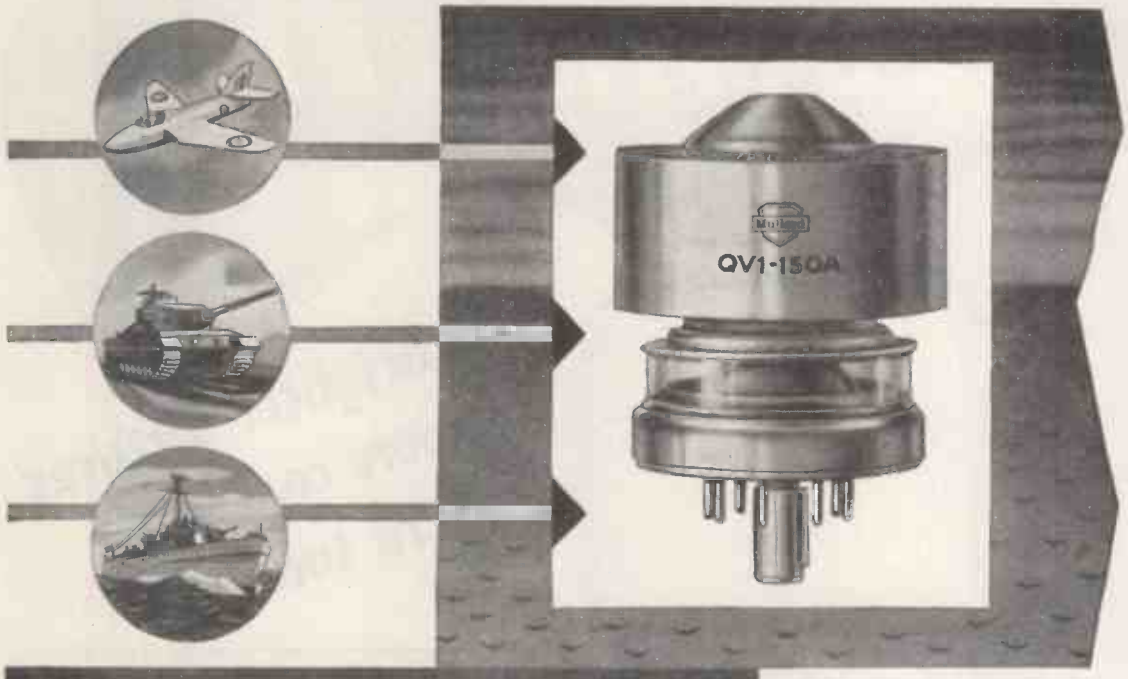
It is difficult to say from the meagre information available whether the famous conjurer had a genuine scientific interest in radio or was merely seeking to use it as a stage stunt as is done to-day with tiny v.h.f. transmitters in music-hall "telepathic" turns.

In the old days of stage "telepathy" a clever and elaborate code either of words, vocal intonation or even body posture was used by the stooge in the stalls to let the seer on the stage know what he was holding in his hand. According to Dr. D. J. West, M.B., the experimental research officer to the Society of Psychical Research, the successful use of the code required long practice, and I can well believe it. In his recently published book, "Psychical Research To-day," he remarks how much simpler is the modern technique of using a small radio transmitter. Unfortunately, Dr. West gives no technical details, but obviously the stooge must use a midriff mike and be a ventriloquist in the literal meaning of that term.

* "The Inventor of the Valve," by Dr. J. T. MacGregor-Morris. (Television Society.)

A

FOR AIR, LAND AND SEA U.H.F. STATIONS



QV1-150A POWER TETRODE

The new Mullard QV1-150A is an external anode tetrode of exceptionally small dimensions, completely interchangeable with the popular American 4X-150A. It is forced-air cooled and will operate with excellent efficiency and power gain at frequencies as high as 500 Mc/s.

Although the maximum d.c. anode voltage is 1.25kV, the performance of the QV1-150A is little reduced at half this figure and recommends it for both fixed and high power mobile transmitting equipments.

High permissible anode dissipation, high current density and very favourable ratio of mutual conductance to capacitance particularly suit this new tetrode for wide-band applications.

The modified loctal base of the QV1-150A is so arranged that, when equipped with its special socket, forced-air cooling is facilitated and coaxial or linear circuits may be used. Excellent circuit separation is achieved at U.H.F. by a disc-seal screen-grid connection located between anode and base which is by-passed to cathode by a capacitor built into the socket.

Further information on this and a wide range of other transmitting valves may be readily obtained from the address below.

Typical Applications	Va (kV)	Pload (W)	f(Mc/s)
R.F. POWER AMPLIFIER			
Class "B" (Television Service)	1.25	200	216
Class "C" Telegraphy and F.M. Telephony	1.25	156	165
	1.25	112	500
Class "C" Anode Modulated	1.0	112	165
A.F. POWER AMPLIFIER AND MODULATOR (two valves)			
Class "AB1"	1.25	310	A.F.
Class "AB2"	1.25	425	A.F.

HEATER		LIMITING VALUES		BASE
Vh	6.0V	Va max.	1.25 kV	B8F
Ih	2.6A	pa max.	150 W	
		Vg2 max.	400 V	
		pg2 max.	12 W	
		f max.	500 Mc/s	

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT. CENTURY HOUSE, SHAFTESBURY AVENUE, W.C.2.

MVT 168

Or an inexpensive

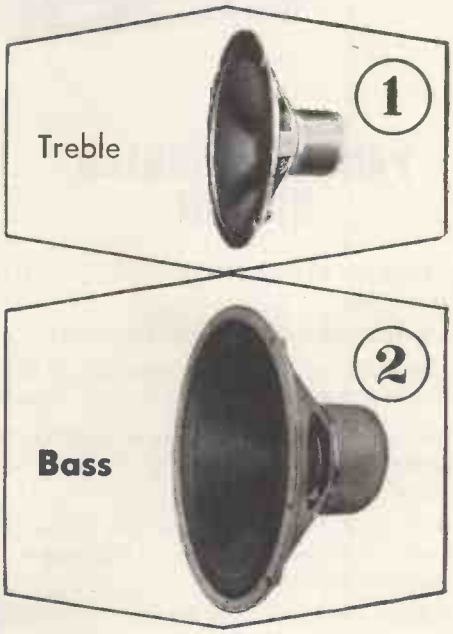
CROSSOVER SYSTEM

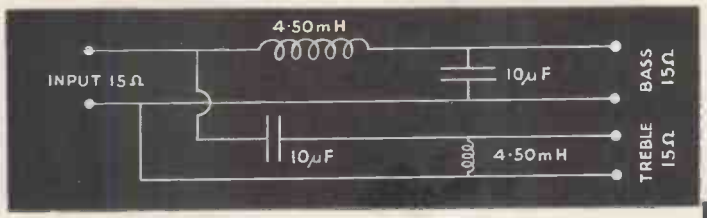
30 c.p.s.—15,000 c.p.s.

8-in. AXIOM 101
£5 . 0 . 0
Plus P.T. £1 . 12 . 1

An example of the twin unit system was recently demonstrated by us at the Radio Show. It received such praise that we have made public full details of the system. We shall be pleased to forward full details on application.

12-in. AUDIOM 60
(Bass) 15 watts
£8 . 12 . 6





4.50 mH Choke Type "1005"
PRICE 37/- pair.

Post coupon now **for literature on High Fidelity Systems and/or Units, Bass Reflex Chambers, etc.**

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AXIOM WORKS, WEMBLEY, MIDDX.
I am interested in :

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Address .....

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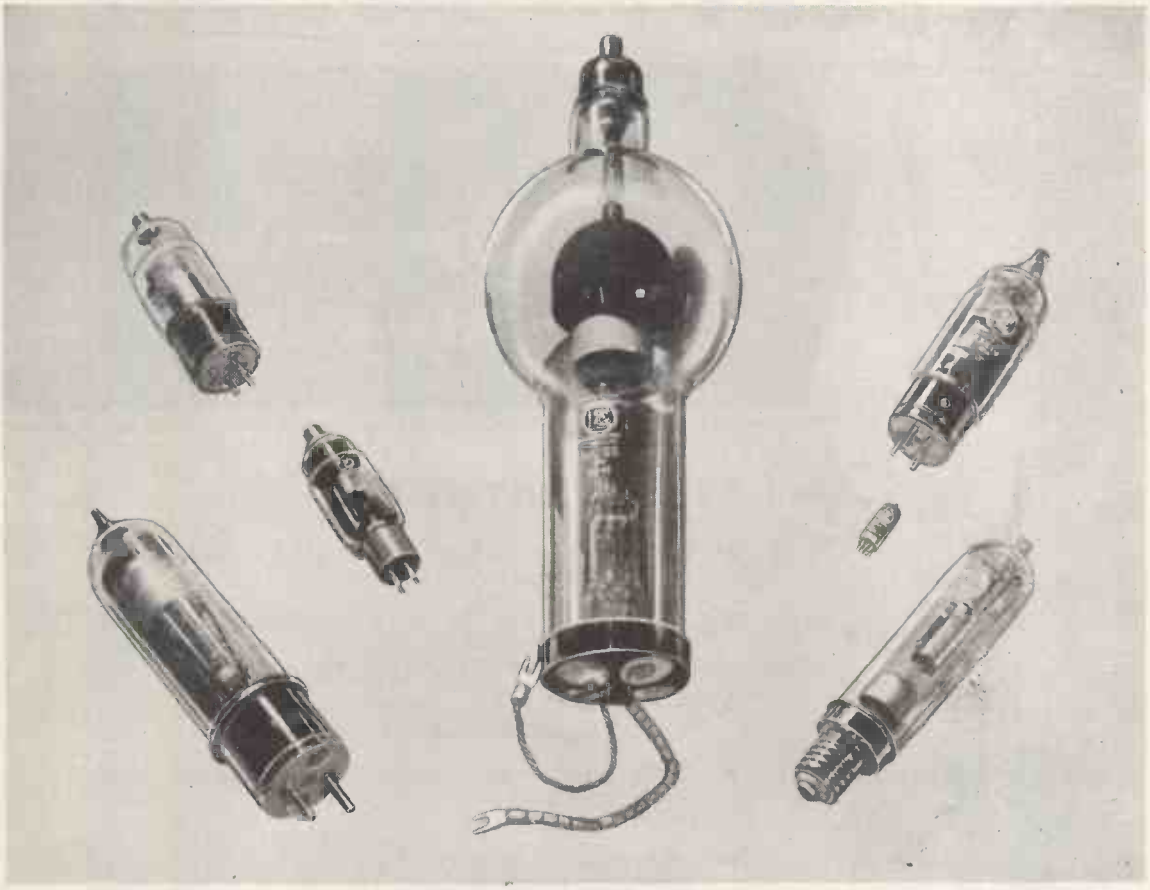
WW/1/55 (Please write in block capitals)

POWER RECTIFIERS & THYRATRONS



POWER RECTIFIERS

	Type	Max Dimensions in m/m.		Filament		P.I. Voltage	Peak Anode Current	Mean Anode Current	3 Phase F.W. Output		British Services Number	American Equivalent
		Length	Dia.	Volts	Amps				D.C. Volts	Rect. Cur't		
Mercury Vapour Filled	AH.200	456	133	2.5	40	16,000	8.0(a) 14.0(b)	2.0(a) 3.5(b)	15,000	5.5(a) 10.0(b)	CV 1628	—
	AH.201	179	42	2.5	5	11,000	1.0	0.25	10,000	0.75	—	—
	AH.205	505	194	5.0	30	22,000	40	10	21,000	30.0	CV 2673	857B
	AH.211 / AFH.220 (c)	314	97	2.5	30	16,000	8.0	2.0	15,000	6.0	CV 532	—
	AH.213	456	133	5.0	19	16,000	8.0(a) 14.0(b)	2.0(a) 3.5(b)	15,000	5.5(a) 10.0(b)	—	869B
	AH.217	220	63	5.0	7.5	11,000	5.0	1.25	10,000	3.6	—	872A
	AH.221	270	63	4.0	11	11,000	4.7	1.2	10,000	3.6	CV 5	—
Xenon Filled	AX.224	157	53	2.5	5.0	10,000 5,000	1.0 2.0	0.25 0.5	9,600 4,800	0.75 1.5	CV 1835	3B28
	AX.228	270	63	4.0	11.0	11,000	5.0	1.25	10,000	3.6	—	—
	AX.230	216	59	5.0	7.1	10,000	5.0	1.25	9,600	3.75	CV 2518	4B32

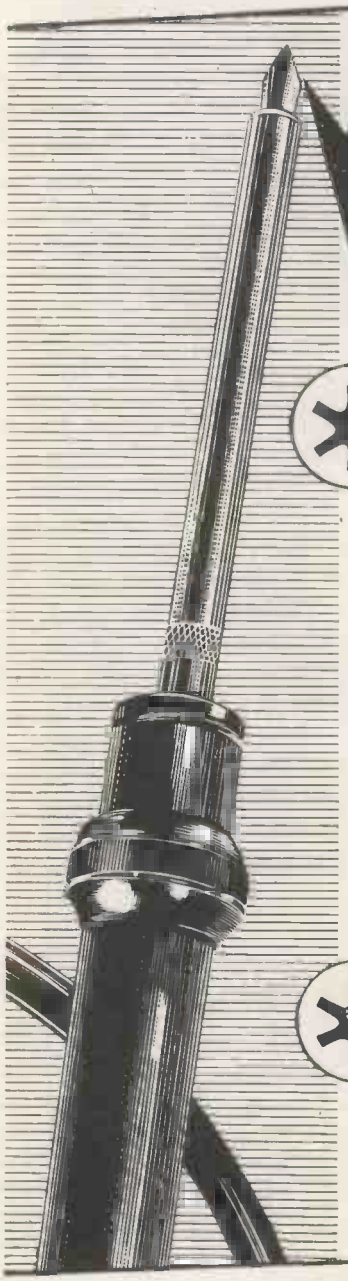
(a) Filament Voltage in phase with anode current.
(b) Filament Voltage 60°—120° out of phase with anode current.
(c) AFH.220 is grid controlled with positive characteristics.

THYRATRONS

	Type	Max Dimensions in m/m.		Filament		P.I. Voltage	Peak Forward Volts	Peak Current	Mean Current	Tube Drop	Peak Power Level (a)	British Services Number	American Equivalent
		Length	Dia.	Volts	Amps								
Xenon Filled	AFX.212	54	19	6.3	0.25	350	350	0.11	0.025	16	—	CV 1949	6D4
	AFX.203	176	57	2.5	4.0	300	280	1.7	0.40	11	—	CV 2868	C1A
Hydrogen Filled	FX.215	286	97	2.5	27.5	16,000	16,000	200	0.20	100	2.0×10^9	CV 2203	—
	FX.219	222	65	6.3	10.6	16,000	16,000	350	0.20	100	3.2×10^9	CV 2520	5C22
	FX.225	175	65	6.3	6.1	8,000	8,000	90	0.10	100	2.0×10^9	CV 1787	4C35
	FX.227	132	40	6.3	2.25	3,000	3,000	35	0.045	100	0.3×10^9	CV 372	3C45

Note (a) Product of Peak forward Voltage, Peak current and pulse repetition frequency.

m-i-n-u-t-e-s *into seconds...*



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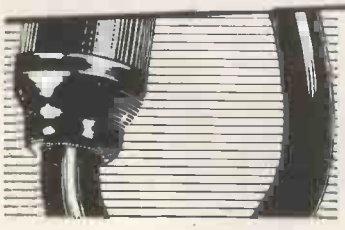

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G.E.C.

BRT 400D

SHORT SPECIFICATION

BAND COVERAGE

0.150—0.385 Mc/s } in 6 bands
0.510—30.0 Mc/s }

SENSITIVITY

Better than 1.0 μV for 1.5 watts output, over the whole band.

SIGNAL/NOISE RATIO

Standard input for 20 db:—

1.3—30.0 Mc/s	< 7.0 μV
0.150—1.3 Mc/s	< 10.0 μV

SELECTIVITY

Six switched bandwidths:—

0.5 kc/s	1.0 kc/s	2.0 kc/s
5.5 kc/s	9.0 kc/s	13.0 kc/s

OVERALL FIDELITY

Less than 2 db down at 50 c/s
Less than 6 db down at 5,500 c/s

A.G.C. CHARACTERISTICS

Output constant within 3 db for 100 db change in signal input.

OUTPUT CIRCUITS

At 2.5 or 15 ohms	2.5 watts
At 120 ohms	0.05 watts
At 600 ohms	0.2 watts

POWER SUPPLY

95—130 and 195—250 volts, 40/80 c/s. Also from 12 volt battery, using BRT 401 auxiliary power unit.

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For moulding, potting or sealing purposes, no resin can compare with 'Araldite'. Added to remarkable electrical and mechanical qualities, it offers outstanding adhesion to metals, while shrinkage in setting is exceptionally low. 'Araldite' resists high temperatures, humidity and corrosive agents and fulfils the Services specification for sealing and potting electrical equipment.

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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 155-255 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 75 ohms and is adjustable from a maximum of 40 millivolts to a minimum of 10 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.

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R	¼ watt	1 watt	500		⅞" × ¼"
Tolerance available ± 20%, 10%, 5%					
HIGH STABILITY RESISTORS					
HS3	½ watt	¼ watt	750	1 ohm to 500 megohms	1.1" × 0.1"
Tolerance available ±5%, 2%, 1%					
WIREWOUND RESISTORS					
5 ohms to 100K ohms — 5 - 10 watts					
'CERAMICAPS'					
Tubulars 3 - 470 pf 500 - 5000 pf				Tolerances ±2%, 10% Hi-K	

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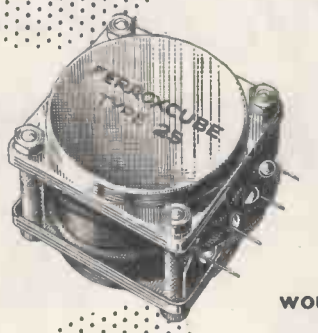

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wound on Ferroxcube cores

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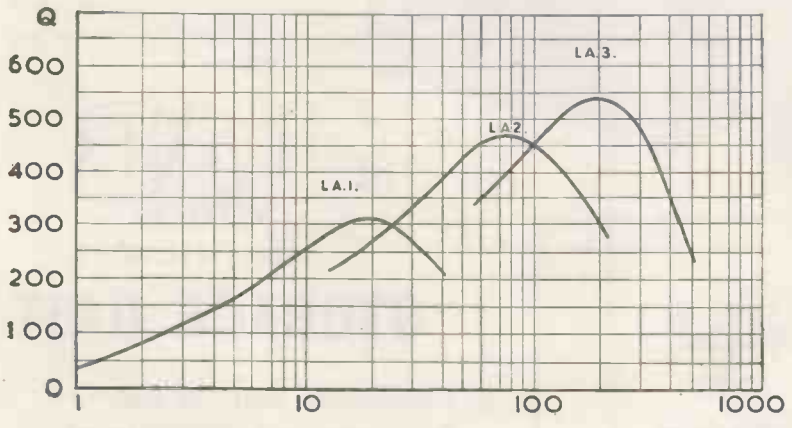

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Self screening

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Operation over a wide frequency range

Easily mounted

Mullard

'Ticonal' permanent magnets,
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Ferroxcube magnetic cores.

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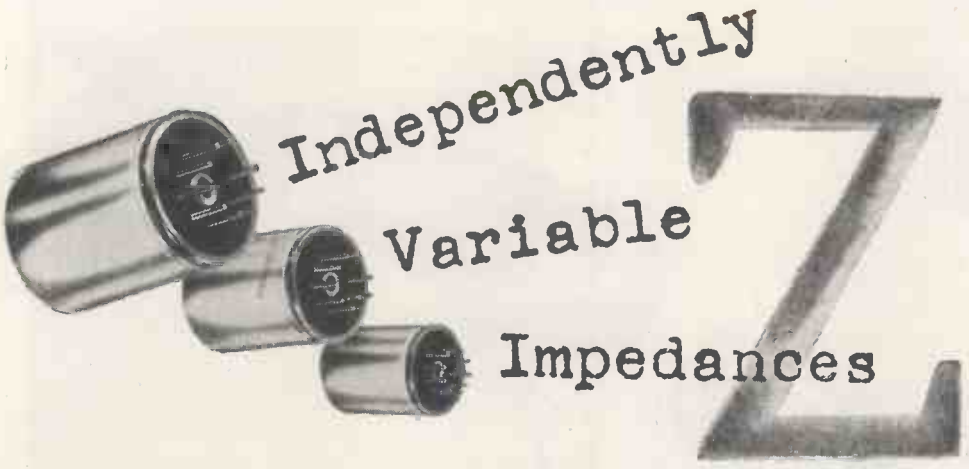
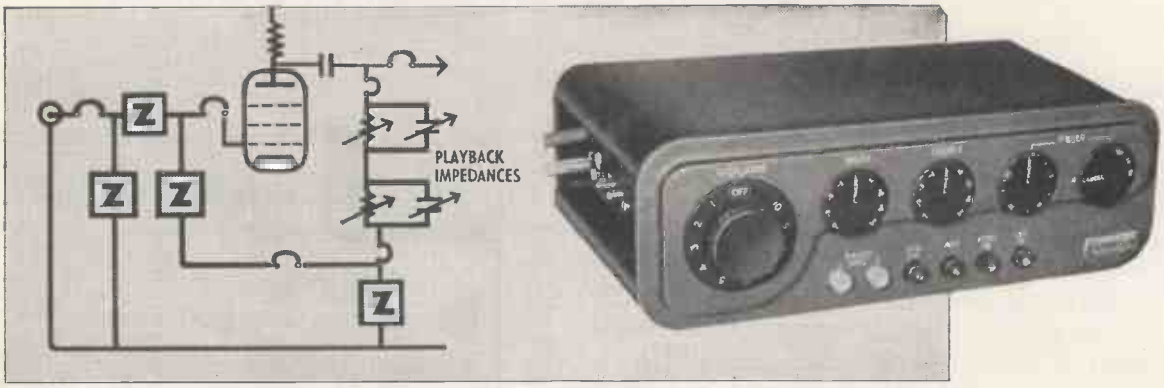


When a designer contemplates the input stage from a gramophone pickup he can (a) amplify and then compensate, (b) compensate before amplification, (c) compensate over the first stage by feedback.

No single method is acceptable over a wide range of impedances if the requirement is low distortion and low noise. His choice and the circuit impedances used will depend upon the output level of the pickup, its source impedance, its load impedance and its characteristic.

In the QUAD 11, the first stage circuit connections and their impedances are contained within a detachable plug unit. A range of units covers optimum design requirements for all types of pickups.



ONLY THE QUAD 11 GIVES PERFECT MATCHING AND OPTIMUM INPUT CIRCUIT ARRANGEMENTS. ONE OF THE REASONS WHY THE QUAD 11 GIVES THE CLOSEST APPROACH TO THE ORIGINAL SOUND.

ACOUSTICAL MANUFACTURING CO LTD

The Acoustical Manufacturing Co. Ltd Huntingdon, England

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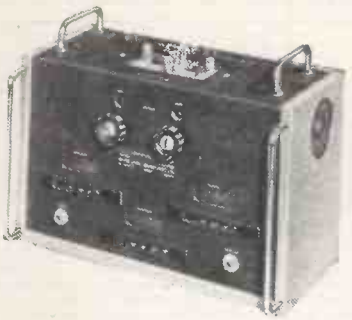
FROM THE WAYNE KERR RANGE

V.H.F. Impedance Bridge Type B.801



For balanced and unbalanced measurement from 1-100 Mc/s.

Susceptance: Equivalent to ± 230 pF.	Conductance: 0-100 mmho.
Accuracy: ±2%, ±0·5 pF.	Accuracy: ±2%, ±0·1 mmho.

This is one of a range of bridges for use with external source and detector for the measurement of aerials, cables, feeders, and a variety of components and materials between 15 kc/s and 250 Mc/s. Bridge sources and detectors are available for use between 1-100 Mc/s and 50-250 Mc/s.

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A moderately priced 50 c/s instrument with a very wide range, capable of 3-terminal and a variety of in situ measurements.
R: 3Ω to 1000 mΩ, C: 1 pF to 1000 mF, L: 100 mH to 10,000 H.

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To measure the relative levels of the components of a complex waveform over a range of 75 db between 50 c/s and 20 kc/s. Input impedance 100KΩ unbalanced or >25KΩ balanced. In transportable case as shown, or for standard 19" mounting.

Wayne Kerr

Full details from:

THE WAYNE KERR LABORATORIES LIMITED

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HIGH FIDELITY LOUDSPEAKERS

We have made an extensive survey of the high-fidelity loudspeaker market and, after careful tests in our laboratory, we can recommend the following as representing the best value for money. The actual choice of a model is determined largely by the amount of money which can be allocated to this item, and we advise customers to get the best they can afford, as it is a very important item in the reproduction chain. The mounting of the speaker is just as important as the speaker itself, and for maximum results the speaker should be mounted in one of our Bass Reflex Cabinets (except the Axiom 150 which has its own cabinet). Advice freely given. If in town, call for a demonstration.

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GOODMANS: Axiom 101 8in., £6 12s. 1d.; Axiom 102 8in., £9 18s. 2d.; Axiom 150 Mark 2 12in. twin-cone model, £10 5s. 6d.; Audiom 60, £8 12. 6d.; Audiom 60B, special 35 c.p.s. bass-resonance model to act as bass unit in twin speaker outfits, £8 12s. 6d. New model Orlin III 12in., £9 15s.

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We have carefully tested the few makes of F.M. Tuners on the market at present and are pleased to be able to recommend and supply the following:

CHAPMAN Model FM81. Tuneable Model with attractive facia panel and dial. Will provide amazing degree of realism with complete absence of background noise when working with the N.R.S. No. 2 Symphony Amplifier or other high grade amplifier. Price £21. Call for a demonstration or send for leaflet.

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ELPICO Tape Deck as per "Impressario" Recorder, push-button controls, high-fidelity heads. Price 19 gns.

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TRUVOX Tape Deck Mark III. Price 22 gns.

TAPE AMPLIFIER TYPE C, expressly designed by Truvox to work perfectly with their Deck 3 valves plus rectifier and Magic Eye level Indicator. Price 16 gns.

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The G.E.C. metal cone loudspeaker gives lifelike reproduction of any type of sound over a range of 9 octaves. This includes the entire musical fundamental range together with overtones which give tonal quality and character to the performance of each musical instrument.

The sound engineer will appreciate the simplification and improvement in performance which has been achieved by combining the following attributes in a single unit.

- **Smooth response over a range of nine octaves with extremely good low frequency response**
- **Negligible inter-modulation**
- **Unequalled transient response due to special coil and cone construction**

£8.15.0
TAX PAID

For the Home Constructor

This is a professional instrument and must be used under the correct conditions to obtain the optimum results. Cabinets have been specially designed for use with this loudspeaker, details of which are available.

G.E.C.

Metal Cone Loudspeaker

THE GENERAL ELECTRIC COMPANY LTD., MAGNET HOUSE, KINGSWAY, W.C.2

HIGH QUALITY SOUND REPRODUCTION

A growing domestic market

The great advances which have been made in sound reproduction, notably in recordings, gramophone equipment and loudspeakers, have led to a growing public demand for high quality reproducing apparatus.

Mullard's contribution to these trends has been the development of a range of audio valves of advanced design which meet the most exacting requirements of amplifier designers, and which are already used by leading amplifier manufacturers.

During the development of these valves appropriate circuitry was devised in the Mullard Valve Applications Laboratory. In accordance with normal Mullard practice this circuit data is being made available to manufacturers of components and equipment, and also to home constructors.

A High Quality 10 watt Amplifier circuit using 5 of the latest audio valves was demonstrated by Mullard at the recent Radio Exhibition at Earls Court to a large and enthusiastic audience. This particular circuit is designed for easy construction at relatively low cost and will especially appeal to those enthusiasts who up to the moment have been unable to afford the higher cost of more elaborate equipment.

The circuit and the valves are fully described in Mullard publication MV8104 which is now being advertised. Manufacturers of components and complete equipment who may wish to utilise the circuit information or to offer components which conform with the specification are cordially invited to apply for full details. Arrangements have been made to check and approve prototypes and components if manufacturers wish to refer to the Mullard specification in their own literature and advertising.

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SHAFTESBURY AVENUE, LONDON, W.C.2

Mullard

MVE 112B

MODERN TELEVISION TECHNIQUE

"SYNC. CANCELLED A.G.C."

Before it became necessary for television receiver designers to make provision for Band III reception, vision automatic gain control was, generally speaking, essential only in fringe area models. Long period signal fading, which A.G.C. combats, is normally severe only in fringe areas, although special circumstances can arise that make A.G.C. desirable in areas of good signal strength.

But now that alternative programmes are imminent, and most receivers are being designed for two band operation, vision A.G.C. has become necessary on standard as well as fringe models. The difference in strength between Band I and Band III signals may be found appreciable in many areas, and if viewers are to be saved major adjustments to sensitivity controls every time they switch from one band to the other vision A.G.C. is essential.

Vision A.G.C. Systems

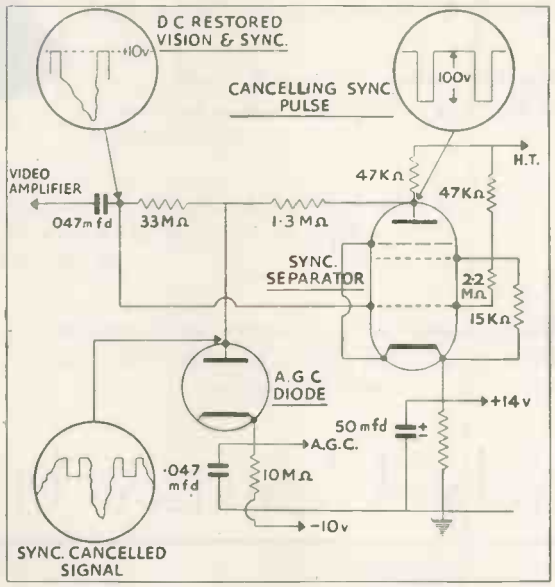
Broadly speaking, there are three forms of vision A.G.C. that can be employed: mean level A.G.C., gated A.G.C. and "Sync. Cancelled A.G.C." Each of these circuits has its own special merits, depending upon the particular circumstances prevailing.

The mean level circuit is especially useful in fringe area conditions and is incorporated in the current "His Master's Voice" fringe models. It relies in its operation on the fact that in any series of pictures the average of black and white areas is reasonably proportional to the strength of the signal, and so an A.G.C. voltage can be derived relatively easily. Its value as a fringe circuit is enhanced by its ability to correct automatically the tonal quality of pictures containing an abnormally high proportion of black, as occurs, say, in transmission of night-time scenes.

Gated A.G.C. is a good circuit, but requires rather more components than the other systems. This circuit works on the principle that the amplitude of the "back porch" is directly proportional to the signal level. The video signal is applied to a valve which is rendered conducting by a "gating" pulse from one of the scanning circuits in the receiver. If the gating pulse is made to occur at the correct time and for the correct duration to be coincident with the back porch, then the valve conducts and measures the amplitude of the back porch, thereby providing an A.G.C. voltage.

"Sync. Cancelled A.G.C."

The third system, evolved by "His Master's Voice" engineers, is "Sync. Cancelled A.G.C.", which combines the advantages of the systems previously mentioned with simplicity, low cost and consistent performance in difficult, varying conditions. "Sync. Cancelled A.G.C." has been incorporated in the current "His Master's Voice" two-band "Highlight" receivers. The technique of the system consists very simply of measuring the amplitude of the sync. pulse, which is, of course, directly proportional to the signal strength. This is done in two steps. The peak of the inverted television signal (sync. pulses positive going) is clamped to a known reference voltage by a diode circuit, such as the grid-cathode of the sync. separator valve. The sync. pulses are then completely cancelled by pulses from the sync. separator valve, and the resultant signal is re-measured by peak detection of the A.G.C. diode. If the reference voltage is zero, then the output of the A.G.C. diode will be a negative voltage proportional to the sync. pulse amplitude. If the reference voltage is positive, then a negative A.G.C. output will not be produced until the signal has reached a prescribed amplitude. Since noise pulses are essentially in the same direction as picture signals, this circuit has the advantage that A.G.C. voltages are unaffected by interference.



"Sync. Cancelled A.G.C." circuit diagram.

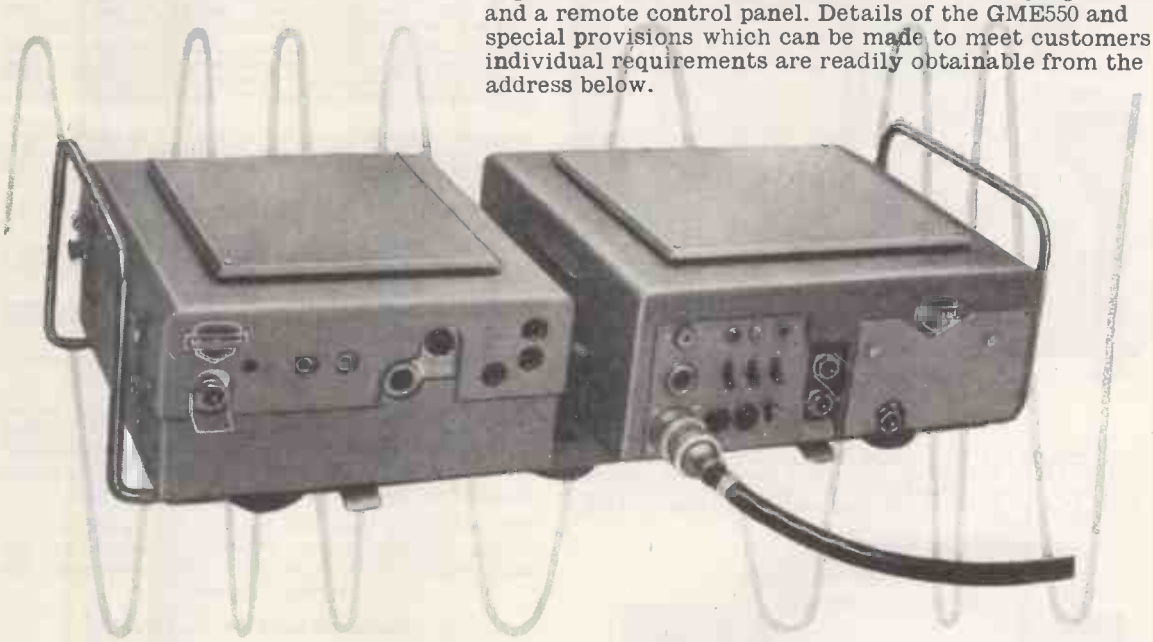
A High Quality F.M. Link for Outside Broadcasts

The GME550 F.M. Transmitter/Receiver is a compact and easily handled equipment ideal for outside broadcast link applications. Both transmitter and receiver handle the programme channel or cueing signals as required.

The units are robustly constructed and mounted on shock absorbers, and have been used with marked success in stationary and moving vehicles. A generously rated convertor is built into the transmitter unit for 12V or 6V d.c. operation, and an a.c. power unit can be supplied for mains operation.

The employment of frequency modulation keeps distortion to a low level over a wide dynamic range. Quality is further maintained by high note pre-emphasis in the transmitter and i.f. limiting in the receiver—this results in an audio output with a low noise content even with weak signals.

Duplex operation with two aerials is possible if required. Other optional features include carrying handles and a remote control panel. Details of the GME550 and special provisions which can be made to meet customers individual requirements are readily obtainable from the address below.



Technical Summary

FREQUENCY: Single spot in range 65 to 80 Mc/s or 80 to 100 Mc/s.

FREQUENCY TOLERANCE: ± .01%.

FREQUENCY STABILITY: Within 1 part in 10^6 per °C.

AUDIO RESPONSE: (from transmitter audio input to receiver output) ± 1½dB referred to 1,000 c/s over the frequency range 50 to 6,000 c/s, falling to —7dB at 10,000 c/s.

RECEIVER SELECTIVITY: 6dB down at ± 16 kc/s. 40dB down at ± 60 kc/s.

SIGNAL-TO-NOISE RATIO: 10dB for 1μV input increasing to 40dB for 10μV input, with 1 kc/s modulation and a frequency deviation of ± 5 kc/s.

TRANSMITTER POWER OUTPUT: 17 to 20W.

Mullard

SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LTD., EQUIPMENT DIVISION CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

PREMIER RADIO COMPANY

Limited supplies of C.R. TUBES

VCR517C
6½in. picture. This tube is a replacement for the VCR97 and VCR517. Guaranteed full size picture.
Price 35/-. Plus 2/6 pkg., carr., ins

VCR516
9in. blue picture. Heater volts 4 anode 4 kV. In manufacturer's original carton. £1/19/6, plus 5/- pkg., carr., ins.

ALL BRAND NEW

CABINETS—PORTABLE

Model PC/1
Brown Rexine covered 22/6
Overall dimensions 15 in. x 13¼in. x 5in.
Clearance under lid when closed 2¼in.

Model PC/2
Grey Lizard Rexine covered 45/-
Overall dimensions 15 in. x 13in. x 6in.
Clearance under lid when closed 2¼in.

Model PC/3
Rexine type covering in various cols 69/6
Overall dimensions 16¼ in. x 14¼in. x 10¼in.
Clearance under lid when closed 6¼in.

All the above Cabinets are supplied with Panel, Carrying Handle and Clips.
Packing and Postage 2/6.

5-WATT AMPLIFIER

Enclosed in metal case. Output suitable for 15 ohms and 3 ohms Speakers. Input switched for pickup or microphone. B.V.A. miniature valves. 9½ gns. Postage and packing 7/6.

E.A.R. MULLARD 510 AMPLIFIER

Based on the Mullard circuit. Combined change-over switch for standard, L.P. records and radio. Plug-in filter network. 18 gns. Postage and packing 7/6.

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.	21/8
,, 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

6 v. 1 amp.	4/-
12 v. 1 amp.	8/-
12 v. 2 amp.	10/9
12 v. 4 amp.	15/-

BATTERY CHARGERS

200-250 v. A.C. Will charge 2 v., 6 v. and 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size 6in. long, 3¼in. wide, 3¼in. high.
Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain Ex-Govt. components.
Plus 2/6 P. and P. **39/6**

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200-250 v. A.C. cycle mains.

Cat. No.
2002 Charge 6 volt accumulator at 1 amp. Resistance, supplied to charge 2 volt Accumulator 13/6
2004 Charges 2, 6 and 12 v. accumulators at 1 amp. 19/11

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium with four sides:

7 x 5¼ x 2in.	4/-	10 x 9 x 3in.	7/-
7 x 3¼ x 2in.	3/9	12 x 10 x 3in.	7/9
9¼ x 4¼ x 2in.	4/3	14 x 10 x 3in.	7/11
10 x 8 x 2¼in.	5/6	16 x 10 x 3in.	8/3
12 x 9 x 2¼in.	7/-	16 x 8 x 2¼in.	8/-
14 x 9 x 2¼in.	7/6		

ALUMINIUM PANELS 18 s.w.g.

7 x 6in.	1/3	7 x 4in.	1/-
9¼ x 6in.	1/8	9½ x 4in.	1/5
10 x 9in.	2/2	10 x 7in.	1/11
12 x 9in.	2/8	12 x 7in.	2/5
14 x 9in.	3/2	14 x 7in.	2/11
16 x 9in.	3/8	16 x 7in.	3/5
20 x 9in.	4/8	20 x 7in.	4/5
22 x 9in.	5/2	22 x 7in.	4/11

SPECIAL OFFER!!
SAVAGE AUTO-TRANSFORMERS

INPUTS 110 v., 130 v., 200 v., 230 v., 250 v. Stud switch control. OUTPUTS 110 v. and 230 v. at 1,200 w. nominal, tested 2.4 KVA. 15A. 3 pin sockets and fuses on panel in handsome grey cabinet. Brand new, £7/15/-. De Luxe model by Neverlin, £8/15/-. P. & P. 10/-.

A.C.R.I. C.R. TUBES

5¼in. screen. 4 volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television. 15/- plus 2/6 Pkg., carr. and ins. Data sheets supplied.

GRAMOPHONE PRE-AMPLIFIER

Power requirements 200-250 v., 2 mA., and 6.3 v. .3a., this may be taken off existing radio.
All the components to build the above unit, 22/6. plus 1/6 pkg. and postage.

Famous Manufacturer's Surplus of

ANTI-INTERFERENCE AERIALS

offered at a fraction of original cost

The aerial is designed for reception of long, medium and short waves, with any ordinary or communications receiver having an input impedance greater than 1,000 ohms long/medium waves and 150 ohms short waves. The installation discriminates against locally generated electrical interference, especially on the short wavebands. The equipment enables the installation of an 8.3 Mc/s flatly-tuned dipole which operates as a "T" aerial on medium and long waves. The aerial and receiver transformers are intended to be interconnected with a 70 ohms co-axial cable.

COMPONENT PARTS

Aluminium Aerial Transformer Assembly. Comprising one each: Aluminium transformer. Transformer clip rubber sucker, ¼in. x ½in. brass screw. 4AB x ½in. brass bolt, 4BA nut.
Receiver Transformer. Complete with insulators, clips, etc.; porcelain insulators 2 each, 60ft. insulated aerial wire, 60ft. screened co-axial down lead.
Installation instruction leaflet included.
LEAD CO-AXIAL CABLE & AERIAL WIRE, 15/-, plus 1/6 pkg. and carr.
COMPLETE, 35/-, plus 1/6 pkg. and carr.

★ **QUALITY CRYSTAL PICK-UP ROTHERMEL TYPE U48 26/-**
Plus 1/6 Pkg. and Carr.

The New
"PREMIER PORTABLE"
TAPE RECORDER

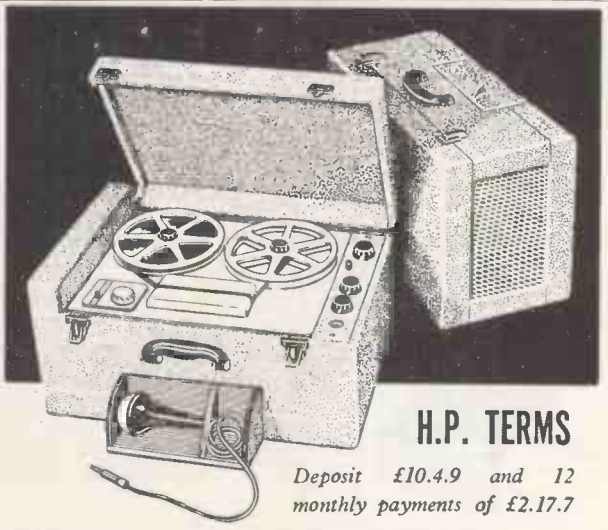
USING THE NEW LANE 2 SPEED TAPE UNIT MARK 6

COMPLETE 39 GNS CASH

Packing & Carriage 1 gn.

(Including Reel of Scotch Boy Tape and Microphone)

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 £10.4.9 and 12 monthly payments of £2.17.7

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 £3/13/9 and 12 monthly payments of £1/0/9.
Amplifier Kit (including Speaker). £11/0/- plus packing and carriage 5/-.
Hire purchase terms, Deposit £2/15/- and 12 monthly payments of 15/6.
New Lane 2-speed Tape Unit Mark 6, £18/10/- plus packing and carriage 7/6.
Hire purchase terms, Deposit £4/12/6 and 12 monthly payments of £1/6/-.
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.

Wireless World

RADIO, TELEVISION, ELECTRONICS

Managing Editor:
HUGH S. POCOCK, M.I.E.E

Editor:
H. F. SMITH.

JANUARY 1955

In This Issue

VOLUME 61 NO. 1
PRICE: TWO SHILLINGS

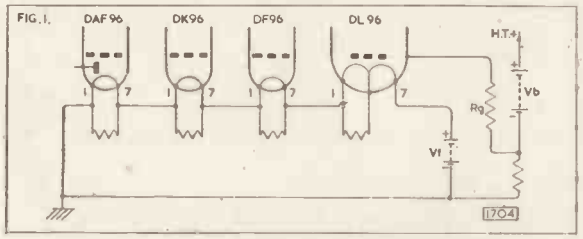
FORTY-FOURTH YEAR OF PUBLICATION

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

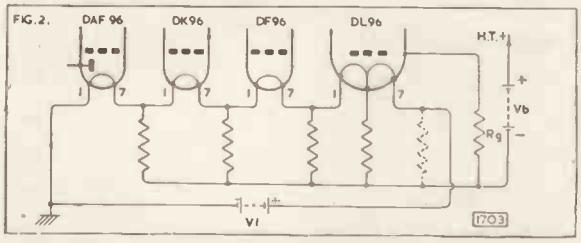
25. DAF96, DK96, DF96 and DL96, in ABC Receivers

The design of 25mA filament chains for ABC receivers is governed by the need to provide satisfactory conditions for the output valve. With the simple series chain of shunted filaments given in Fig. 1, the DL96 bias is derived mainly from the voltage drop across the other filaments. It is, therefore, highly dependent



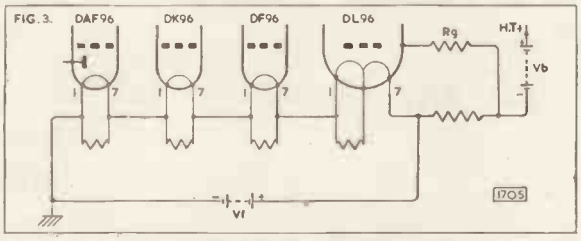
on the l.t. voltage. When the h.t. and l.t. batteries are new, the bias is about 3 x 1.5V = 4.5V, and the h.t. is 90V. Satisfactory operation will continue until the l.t. battery voltage has fallen to 1.1V per cell, when the bias will be 3.3V and the h.t. may be about 65V. If the l.t. battery is renewed at this stage, the bias will increase and the output will be reduced to a very low value. If, instead, the h.t. battery is renewed, the high h.t. voltage and low bias will produce an excessive cathode current in the DL96. Tests in a receiver have shown extremes of 1.5mA and 5.0mA for the DL96 cathode current under these varied battery conditions. Separately renewable h.t. and l.t. batteries can thus be used only if the DL96 bias does not include the voltage drop across the other valves.

This is achieved if the DL96 is placed at the earthy



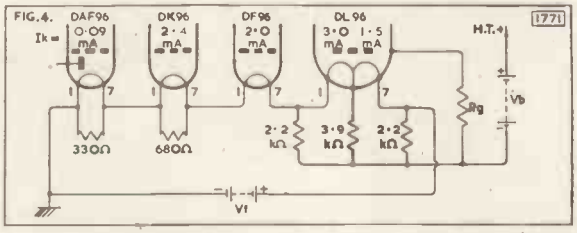
end of the filament chain, with bias taken solely from a resistor in the h.t. negative lead. But three difficulties arise: AGC provision is complicated; decoupling of the filaments will be difficult if the DAF96 is at the positive end of the chain; and, if the DL96 is the next valve in the chain to the DAF96, its filaments may act as a common cathode resistance —producing multivibrator action.

If the h.t. and l.t. negative lines are separated (Fig. 2) the DL96 cathode current is held, in a typical receiver, between 2.4mA and 5.0mA; but dependence on AGC is increased. (One resistor in Fig. 2 is shown



dotted, as it has a high value and it does not greatly affect the operation of the circuit).

High stability (3.0mA to 5.0mA) is achieved with the circuit shown in Fig. 3. There are two additional advantages: the DL96 cathode current falls as the l.t. voltage falls; and valves may be added to the chain without increasing the cathode current variation. But there are two disadvantages: the h.t. current flows through the l.t. battery and increases its consumption by about 30%; and the bias resistor



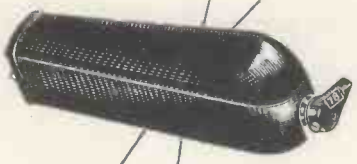
has to produce the required bias plus 2 x 1.4V, therefore it must be a high-value close-tolerance component.

Similar stability, with the extra battery drain reduced from 30% to 12%, is given by the recommended circuit (Fig. 4), which provides satisfactory DL96 conditions at the cost of this smaller increase in l.t. battery consumption. This cost is adequately compensated by the ability of the circuit to work down to low voltages. Practical resistor values, for typical cathode currents, are shown in Fig. 4. Notes on the calculation of resistor values will be included in the reprint of this advertisement. Details of the requirements for mains operation have appeared in the *Additional Notes* to advertisement No. 23 in this series.

Reprints of "Valves, Tubes, and Circuits" (with Additional Notes) are obtainable without charge from the address below.

Longer Life

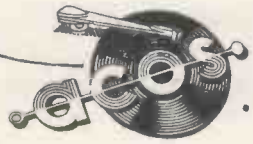
for LONG PLAYING RECORDS



acos REG'D Hi-g

Recording techniques have made such strides over the last two years that if you are to get the really superb reproduction made possible by the latest L.P. records you need one of the Acos "Hi-g" Pick-ups. These have been specially designed to meet the very exacting demands of the new records with their shallow groove and microscopic sound "track". This special design is necessary on two scores — firstly to do justice to the brilliant recording, and secondly to ensure the longest possible life from L.P. records. Such records are expensive; even a single playing with an unsuitable pick-up can cause irreparable harm.

If you want the best reproduction and value from *your* radiogram or record player and L.P. records ask your dealer *(or post the coupon below)* for details of the "plug-in" ACOS "Hi-g" Pick-ups — specially designed to replace existing pick-ups on most famous makes of record playing equipment. The cost? **32/6d. (plus 10/5d. P.T.)**



ACOS devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

... always well ahead

To: COSMOCORD LIMITED, ENFIELD, MIDDLESEX.

Please send me details of ACOS "Hi-g" replacement pick-up heads

NAME.....

ADDRESS .....

.....

WW

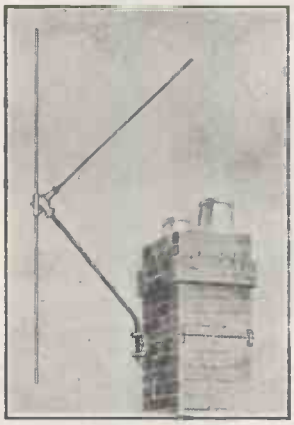
NUMBER PLEASE!

* *The new restricted form of London Telephone Directory no longer includes subscribers, like Cosmocord, in "fringe" areas. Please note therefore that our number is* **ENFIELD 4022.**

"BELLING-LEE" NOTES

New Service Areas

There seems to be a spate of new low-power television transmitters opening up all over the country from Redmoss near Aberdeen to Hessary Tor, near Princetown, Devon. Generally, the transmitters have a period of testing on low power from a low mast, followed by regular transmissions still on low power and low mast. After a pre-arranged period the transmitter is switched to its full power, using its high mast. The time lapse between low power and normal power may be six to nine months. A field strength contour of 100 μV/m on low power might reasonably be expected to become 500 μV/m when the transmitter is on full power. This really means that the power available at a receiving aerial will be 25 times as great as when the transmitter is on low power, Now 100 μV implies that an aerial,



"Belling-Lee" "Kayrod" Director Aerial

certainly as good as a Junior "H" on a 9ft. mast, will be required to provide an acceptable picture, whereas 500 μV/m implies a low outside dipole, or under good conditions, an aerial in the loft such as a "Lofrod." Low gain aerials would be quite useless during the time the temporary transmitter is on the air.

Now all this leads to the fact that if you live outside the declared 100 μV contour low power, you must erect a superior aerial at the very beginning, unless you are prepared to wait until the transmitter goes on full power.

This situation is accentuated in cases where the low power or temporary transmitter is situated some distance from the high power or permanent transmitter. We have just seen what happened at Brighton in the case of Truleigh Hill or Rowridge. When Rowridge is using its 5 kW transmitter and 400ft. mast, Brighton is expected to get a good signal, but even then, there may be a few viewers within a short distance of the Truleigh Hill mast who will have become accustomed to a "swamp" signal and who will miss it.

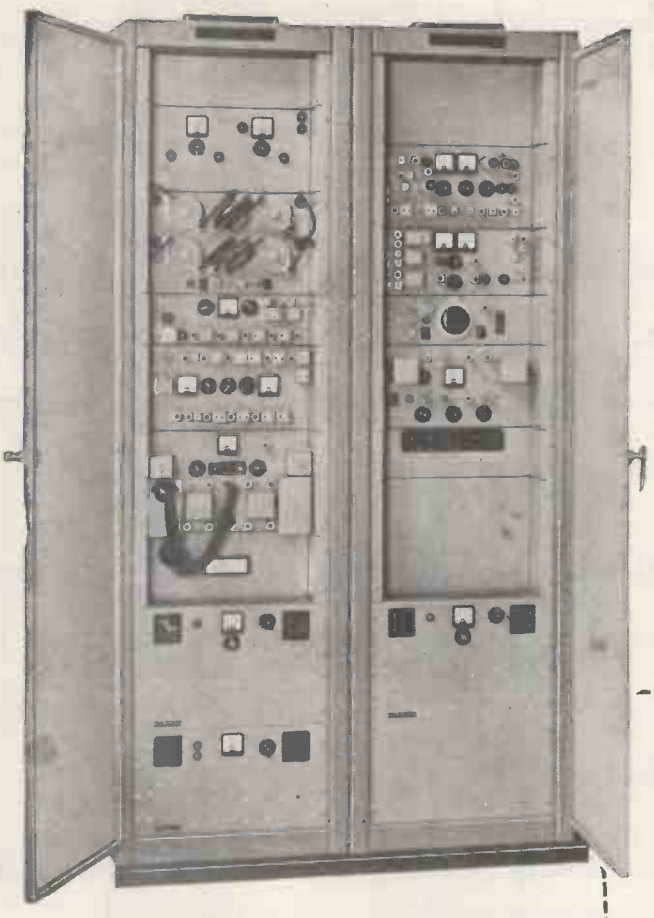
The "Belling-Lee" mobile research unit has been in Brighton for a few days; our engineers were endeavouring to sort out fact from rumour: that there are bad spots is not to be denied. The unit is continuing west into the Rowridge area investigating suspected difficult points, with particular attention to localities just north of the Downs; Petworth, Midhurst and Petersfield for example.

Band I *v.* Band III

After the research unit's return from the South, it will be used in an investigation into a comparison of reception conditions between band I and band III, using the Sutton Coldfield transmissions as a basis. It may not be generally known that Sutton Coldfield is sending out a low power square wave signal on band III. We will take the research unit to an open site and balance the band I and band III signals, and will then drive the unit around, behind hills, through woods, in built-up areas, etc., all the time watching and recording the effect on the two signals. We suspect that band III will be more troublesome with reflections and shadowing, but we must be sure. Science is truth, and we do want to approach this matter in a scientific manner eliminating guesswork. Our findings will be made available to the industry, and others will benefit from the thought, time and money expended on such a project. As we have manufactured more than half the total number of television aerials that have been erected, it is worth our while to do this work, in fact we feel it our duty to the industry.

During a very recent run round the coast in the region of Hastings and Rye, the writer was agreeably surprised to see the number of "Belling-Lee" aerials that were up, and that were looking really smart. In general they stand up well and do not lose their elements, and that is how we can give with each a three-year guarantee and insurance cover.

Marconi VHF FM Multi-Channel Terminal and Repeater Units



HM 100 AND 150 SERIES

Marconi VHF multi-channel systems provide reliable and economical communication. Up to 48 telephone channels can be provided simultaneously and some of these may be further sub-divided by VF telegraph channelling equipment to give either 18 or 24 telegraph channels. The equipment operates in conjunction with carrier apparatus which is the same as that already standardised for use on line systems. Such a radio system can operate over hundreds of miles by placing repeater units at suitable points along the route.

★ The HM 100 and 150 series of equipment will operate entirely unattended and change-over is automatic in duplicate systems.

All units can be easily withdrawn for inspection and maintenance.

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

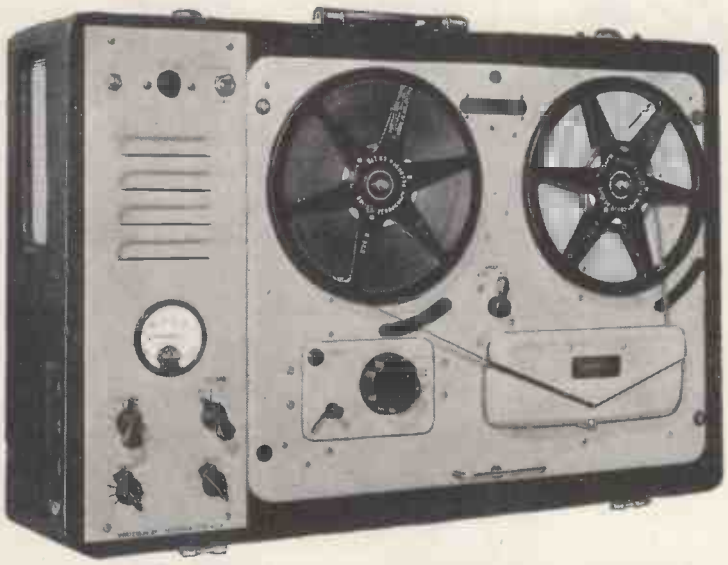
Surveyed, planned, installed, maintained

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD., CHELMSFORD, ESSEX

Partners in progress with The **'ENGLISH ELECTRIC'** *Company Ltd.*

LC 8

VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The noise level is extremely low and audibly the hum level and Johnson noise of the amplifier and deck are approximately equal. Only 25% of this small amount of hum is given by the amplifier alone.

★ Extremely low distortion and background noise, with a frequency response of 50 c/s.—10 Kc/s., plus or minus 1.5 db. A meter is fitted for the measurement of signal level and bias level.

★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ 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.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ 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.

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ The unit may be left running on record or play back even with 1,750 ft. reels with the lid closed.

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

3-WAY MIXER AND PEAK PROGRAMME METER

FOR RECORDING AND LARGE SOUND INSTALLATIONS, ETC.

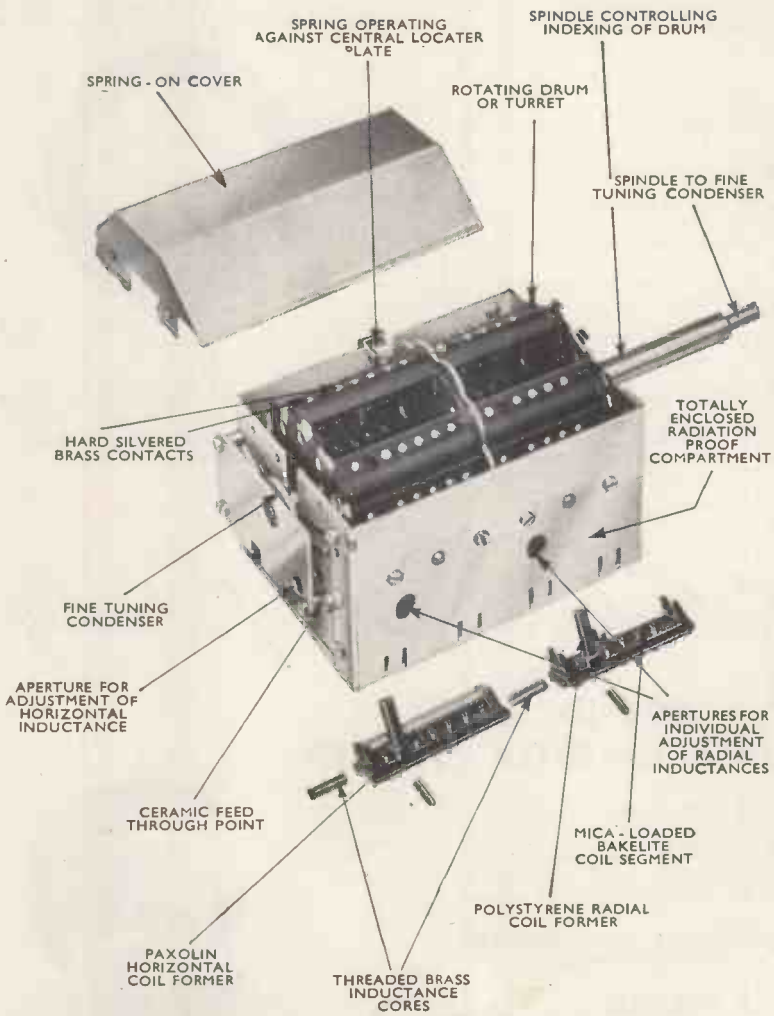
One milliwatt output on 600 ohm line (.775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.
Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient peaks.
Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

Manufactured by

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

Six Advantages of the Clix TELEVISION TURRET TUNER



Full technical information and prices on request.

Available to set manufacturers only

EDISWAN

CLIX

THE EDISON SWAN ELECTRIC CO. LTD.

Member of the A.E.I. Group of Companies

1 *Accurate switching.*

The rotating drum of the Ediswan Clix Television Turret Tuner indexes accurately to any of twelve positions and re-sets precisely in these positions after switching. No question of mistuning after switching.

2 *All circuits are adjustable with the unit in position in a Television receiver.*

Adjustable cores to all inductances are easily accessible with the tuner in position in a Television receiver.

The tuner can, therefore, be set up or re-adjusted in its actual operating position.

3 *Additional tuned circuits may be added at any time without removing the Tuner from the receiver.*

The Ediswan Clix tuner is designed so that additional coil segments can be added at any time while the tuner is in position in a receiver.

To tune to another channel the serviceman merely clips into position additional coil segments, carrying correctly wound coils, and trims them by the adjustable cores provided.

There is no need to dismantle the tuner or return it to the Factory for any part of this operation.

4 *Wiring reduced to an absolute minimum thereby eliminating stray capacities.*

Stray capacities between wiring can lead to serious mistuning on the very high frequencies of Television Band 3. The Ediswan Clix Tuner is designed so that wiring is reduced to an absolute minimum and materials are specially selected to overcome the problems of drift and instability encountered on these frequencies.

5 *Easily accessible for servicing.*

The 'L' section and 'U' section which form the Ediswan Clix tuner are easily parted without removing the drum. This gives easy access to the wiring on the 'L' plate for servicing purposes.

6 *Suitable for mounting in deep or shallow chassis.*

Four 4BA tapped holes are provided for mounting the Ediswan Clix Turret Tuner. If required, suitable mounting brackets can be provided for use in shallow chassis.

CR5

155 Charing Cross Road, London, W.C.2. Radio Components Sales Office: 21 Bruton St., London, W.1. *Tel: Mayfair 5543*

Sales up 300%!

with the NEW

LEAK

TL/10 AMPLIFIER &
"POINT-ONE"
PRE-AMPLIFIER

27 GNS COMPLETE
A price made possible only by WORLD-WIDE SALES

★
Make this THE HEART of your HI-FI EQUIPMENT

and this is why

From long experience and by extreme attention to design details during development work on the pre-production models, we enable our labour force to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at *reasonable prices*. The results obtainable with the new Leak TL/10 and "Point One" are indistinguishable from those obtained with the TL/12 model—a fact easily proved by an instantaneous changeover test. The new TL/10 has been used since its introduction for *all* our public demonstrations, including those at the New York Audio Fair. These are some of the reasons why sales of the TL/10 and "Point One," since their introduction in April last year, are three times as great as for the famous TL/12 in the corresponding months of 1953—and why the size of our factory has been more than doubled to cope with this increased demand.

TL/10 POWER AMPLIFIER

This 10 watt amplifier maintains, in every respect, the world renowned Leak reputation for precision engineering, fine appearance and fastidious wiring.

SPECIFICATION

Circuitry

A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.

Maximum power output: 10 watts.

Frequency Response: ± 1 db 20 c/s to 20,000 c/s.

Harmonic Distortion: 0.1%, 1,000 c/s, 7.5 watts output.

Feedback Magnitude: 26 db, main 'oop.

Damping Factor: 25.

Hum: — 80 db referred to 10 watts.

Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

"POINT ONE" PRE-AMPLIFIER

The handsome gold escutcheon plate contributes to the elegant appearance, and blends with all woods.

★ **Pickup**
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

★ **Radio**
The radio input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

★ **Distortion**
Of the order of 0.1%.

★ **Hum**
Negligible, due to the use of recently developed valves and special techniques.

★ **Input selector**
Radio, tape, records; any and all records can be accurately equalised.

★ **Treble**
Continuously variable, + 9 db to — 15 db at 10,000 c/s.

★ **Bass**
Continuously variable. + 12 db to — 13 db at 40 c/s.

★ **Volume Control and Switch**
The switch controls the power supply to the TL/10 power amplifier.

★ **Tape Recording Jacks**
An exclusive feature. Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

★ *Write for leaflet W* ★

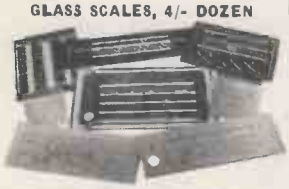
H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

'Phone : SHEpherds Bush 1173/4/5 *Telegrams : Sinusoidal, Ealux, London* *Cables : Sinusoidal, London*

CHASSIS ASSEMBLY

3 colour, 3 waveband scale covering standard, Long, Medium, and Short wavebands, scale pan, chassis punched for standard 5-valve superhet, pulley driving head, springs, etc., to suit. Scale size 14½in. × 3½in. Chassis size 15in. × 5in. × 2in. deep. Price 15/-, plus 1/6 post. Note.—This is the one that fits our 37/6 table cabinet.

GLASS SCALES, 4/- DOZEN



An exceptional bargain this month is our assorted parcel of glass scales. A most useful collection for all who make up experimental or other radios. We offer twelve glass scales mostly in two or three colours for 4/-, plus 9d. post and packing. Limited quantity only.

RESISTORS

50 assorted ½ and ¼ watt resistors. Ranging between 10 ohm. and 10 megohm. (Our selection.) Price 5/- pkt. 50 at 1 watt, 7/6.

EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several headphones are used together will indicate which one is being called. Size 7½in. × 9in. × 7½in., wall mounting, designed for ships' use, but equally suitable for home, office, warehouse, factory, garage, etc. Price 57/6 each, plus 4/6 carriage.

INSTANT HEAT CONVECTOR

The heater with the lowest possible thermal capacity, 4ft. long; made from heavy gauge sheet steel (galvanised), 1 kW., suitable A.C. or D.C. Price only £2, or with thermostat £3/15/-. Note.—The thermostat mounts separately and will control up to three heaters.

CLEVELAND CAR BATTERY CHARGER

Gives 1½ amp. charge—uses everlasting metal rectifier and robust double wound mains transformer in metal carrying case with leads and croc. clips. Price, 6 volt, 29/6; 6 and 12 volts, 39/6, post 2/6.

1in. MICROMETER

Exceptional purchase enables us to offer a 1in. precision micrometer at the very low price of 10/-. A micrometer is an essential part of an engineer's equipment. You will have found the need for one on many occasions in the past for measuring wire gauge, etc. Price 10/-, post free. Note.—We now have a waiting list for this, orders in rotation.

OSRAM 912

The constructional data for this Hi-Fi amplifier is available, price 3/6, which amount will be credited to you if you buy the components later. One "912 Shopping List" will be included with the booklet.

GENUINE HALF-PRICE OFFER

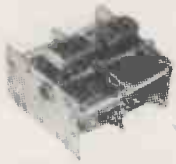
BEETHOVEN CHASSIS

Extremely well built on chassis size approx. 9½ × 7½ × 8½, using only first-class components, fully aligned and tested, 110-240-volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves, frequency changer, double diode triode, pentode output and full wave rectifier. Special cash-with-order price this month, £5/19/6, carriage and insurance 7/6.

KNOBS

Set of four brown knobs ¼in. dia. Engraved tone, volume, tuning, wave band. Push-on type. Post 6d. Ref. 2M46. Price per set 1/3.

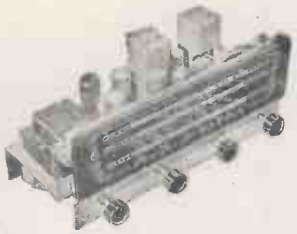
TUNING CONDENSER



.0005 mfd. 2-gang. Ceramic insulation. Price 4/-, post 9d. Ref. 1E89.

TERRIFIC NEW CIRCUIT

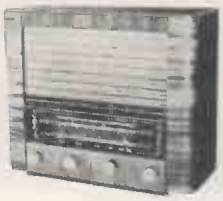
Occasional 55—we have evolved the new T.R.F. circuit and have had really amazing results, equal in fact to many superhets. You really should try this circuit. All parts including valves (6K7 6J7, 6P6, and 6X5) and Bakelite case with back cost only £5/10/-, plus 2/6 post and insurance. Data included with the parts is also available separately price 2/-.



THE "WINDSOR 5"

This is a 5-valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15in. × 6in. × 6in. Price £9/19/6 complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms if required.

TABLE RADIO CABINET



Due to a special purchase, we are able to offer this very fine cabinet, size approx. 15½ × 14 × 6½in. Walnut veneered and satin finished, 37/6, carriage and packing 3/6. Note.—This cabinet is the correct one for the Windsor chassis above with 6½in. speaker.

GRAMOPHONE AUTO-CHANGER

Latest type by all famous makers are invariably in stock at competitive prices.

BARGAIN FOR CONSTRUCTORS

Modern style cabinet in contrasting veneers, with metal chassis, three knobs, coloured scale, and pointer. Price 29/6, post, etc., 2/-. All other components to build 2-waveband superhet. Price £5. Data, 1/6 (free with components.)

TRANSFORMER 100 WATTS

These are transformers with a wound primary tapped 200, 220, 240, but no secondary. There is ample window space, however, for the hand winding of the secondary to suit your own requirements. Approximately two turns per volt are required. The amps. taken out will depend upon volts, e.g., 10 amps. at 10 volts, 50 amps. at 2 volts, etc., etc. Price 10/-, post and packing 2/-.

HEATING TRANSFORMER

2½ volts at 400 amps. Continuous rating, suitable for unfreezing water pipes; setting of resins during casting, setting of glues during cabinet making, edge veneering, etc., etc. Complete in metal case with carrying handle, price £12, carriage and packing 5/-.

P.V.C. HEATER WIRE

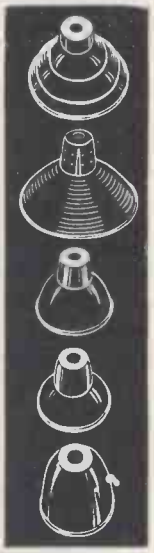
This has a resistance of 16 ohms. per ft. It is wound on non-hygroscopic insulation and covered over with P.V.C. shrunk sleeving. Quite suitable for use underground or under water. Ideal also for twisting around pipes to stop freezing or to preheat liquid. Price 1/- per yard.

COILS—T.R.F. AND SUPERHET

T.R.F. long and medium wave with circuit diagram, 5/6. Superhet long, medium, and short wave, aerial and oscillator coils, e.g., set of six coils with circuit, 10/6.

HIRE PURCHASE TERMS.—Any goods costing £5 or more may be purchased by extended payments—deposit 15% or more—balance spread over 12 months.

LIGHTWEIGHT REFLECTORS



Ideally suitable for all purposes where the intensification of electric illumination or Infra Red is required. The material used is lightweight aluminium, highly polished. All are pierced for Standard Lampholders.

STAR. 7½in. dia. by 6in. deep. Price 7/6 each. Post, etc., 1/3.

SENIOR. 11½in. dia. by 4in. deep. Price 13/6 each. Post, etc., 1/9.

JUNIOR. 6½in. dia. by 3½in. deep. Price 7/3 each. Post, etc., 1/3.

BIJOU. 5½in. dia. by 2in. deep. For 40-60 watt lamps. Price 6/6 each. Post, etc., 1/3.

BELL. 5½in. dia. 5in. deep. Price 6/3 each. Post, etc., 1/3.

DECCA CRYSTAL PICK-UP

A snip for the connoisseur—turnover head suitable all records—limited quantity, 29/6, plus 2/- post and packing.

G.E.C. METAL CONE SPEAKER

This fine speaker is coming to the front rapidly—price £8/15/-. Octagonal cabinet made to maker's specification. £11/10/-, walnut or oak.

SOMWEAVE

This really lovely loudspeaker fabric we offer at approximately a third of to-day's cost. It is 42in. wide and our price is 12/- per yard, or panels 12in. × 12in., 1/9 each. This is also very suitable for covering plain wooden cases, for portable radio amplifiers, etc.

CONNECTING WIRE SNIP

P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red, Orange, Pink, Yellow, White, Transparent. 4 coils for 10/-.

H.T. RECTIFIERS FAMOUS SELENIUM "SENTERCEL"

All are this year's stock—for higher voltages joint two or more in series.

R.M.1	125 v.	60 mA.	3/9
R.M.2	125 v.	100 mA.	4/2
R M 3	125 v	120 mA	5/9
R.M.4	250 v.	250 mA.	16/-

FLUORESCENT LIGHTING

Complete kit comprises 40-watt control unit, starter lamp, lamp holders, clips and wiring diagram. Price, less tube, 22/6, plus 1/6 post. With tube, 30/-, plus 3/6 carr.

EVERLASTING GRAMOPHONE NEEDLES

Jewel (Sapphire) pointed, suit any type of pick-up, precision made — improves quality, eliminates record wear, 3 types, loud, soft, trailer, 2/6 each.

SEE OVER →

MAKE A CONVECTOR

Almost any metal case can be converted into a useful convector type electric heater if you use our porcelain mounted element 250 watt small size. Price 2/6, post 6d.

CAR STARTER/CHARGER KIT

All parts to build 6- and 12-volt charger which can be connected to a "flat" battery and will enable the car to be started instantly. Kit comprising the following:—

Mains transformer	19/6
6-amp. rectifier	22/6
Regulator Stud Switch	3/6
Resistance Wire	2/-
Resistance Former	2/6
Mains on/off Switch	1/-
0-5-amp. Moving Coil Meter	9/6
Constructional Data	1/6

or if bought all together price is 59/6, plus 2/- post and packing.

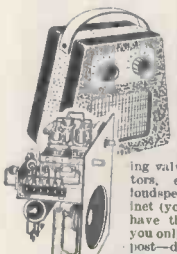
THE TWIN 20

This is a complete fluorescent lighting fitting. It has built-in ballast and starters—stove enamelled white and ready to work. It is an ideal unit for the kitchen, over the work-bench, and in similar location. It uses two 20-watt lamps. Price, complete less tubes, 29/6, or with two tubes, 39/6. Post and insurance 2/6. Extra 20-watt tubes 7/6 each.

THE F.M. FEEDER UNIT

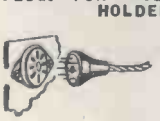
All the parts necessary to make the Denco F.M. Unit are now available. The unit gives an A.F. output suitable for feeding in at the pickup sockets of any standard broadcasting receiver and superior results can be expected. The full constructional details as prepared by the Denco technicians are available—price 1/6 post free. Alternatively, they will be given free to those ordering all the parts which come to £6/7/6, plus 2/6 post and packing. Note: Four valves and everything including a prepared metal chassis is supplied. Approximate chassis measurements are 6×6×1½. Demonstrations at our branches.

ALL MAINS THREE



A handy midget A.C./D.C. 3-valve mains receiver giving powerful reception over long and medium waves. All component parts, including valves, coils, resistors, etc., but not loudspeaker and cabinet (you may already have these) will cost you only 19/6 plus 1/6 post—data available separately 2/- post free.

PLUGS FOR MODERN VALVE HOLDERS



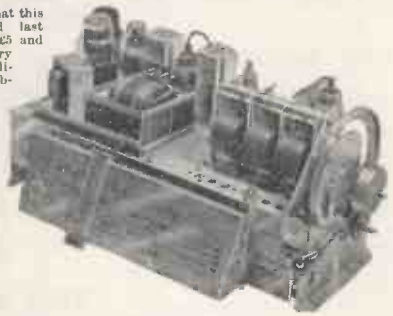
Each is fitted with a rubber shroud. For B7G button base and type 2 for B8A. Price 1/4 each, discounts for quantities.

AMAZING LITTLE MAINS T.R.F.

uses a 4-valve circuit with high-efficiency coils—covers long and medium wave bands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £3/19/6 plus 2/- post. Constructional data free with the parts, or available separately 1/6.

A HAPPY NEW YEAR TO YOU ALL. We take this opportunity to wish you Good Luck and Good Health. May 1955 be your best year yet.

LAST CHANCE TO SECURE THIS BARGAIN



Readers will remember that this fine receiver was offered last month at the silly price of £5 and they have been going out very quickly. If you send immediately, however, you will probably be just in time to secure one. The set a product of one of our famous manufacturers, has H.F. stage, tuning indicator, and all modern refinements, covers 6 wavebands including short waves to 11 metres. Offered less valves and power-pack, otherwise complete and unused—price £5, carriage 7/6 (uses octal range valves).

THREE-SPEED GRAMOPHONE MOTORS

The latest types complete with turnover crystal or separate Hi-Fi magnetic heads by famous makers are usually in stock at competitive prices.

ANOTHER CLEVELAND CHASSIS—THE "TREMENDO"

The first Cleveland chassis was 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 £14/10/-, carriage and packing 7/6. H.P. terms if required.

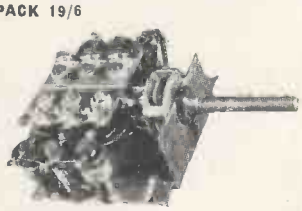
COMPLETE TOOL KITS—THE ELECTRICIAN'S

This is as illustrated and contains 55 fine tools arranged on 5 trays in an automatic steel tool-box. The box opens under slight pressure of the hand and closes automatically when lifted. The tools are all that a practical electrician needs, including tenon saw, ratchet brace, hack-saw, chisels for wood, brick and steel, pliers, side cutters, hammers, spanners, socket wrenches, pad-saw etc. Price £15/10/-, or H.P. if required.

RADIO ENGINEER'S

This again is fitted into an automatic tool-box and contains 50 tools including pliers, side cutters, screwdrivers, side and straight snips, hammers, spanners, and socket wrenches, hand-drill, B.A. taps, drills, etc. Price £11/10/-. H.P. terms if required.

COIL PACK 19/6



Manufactured by quite a famous company, this 3-wave Coil Pack incorporates a gram position and Long, Medium and Short wave band, designed for 465 kc/s. I.F. Brand new and fully guaranteed. Complete with circuit, only 19/6 plus 9d. post.

AMPLIFIER A1134a

This is a 2-stage intercom. and Tx pre-amplifier with transformers, etc. Easily modified as gram amplifier or dictaphone, etc. Complete with 2 2-v. valves, QPP and Triode. Price only 9/6, plus 1/6 post and packing. Circuit diagram, free with unit, or separately, 1/6.

BARGAINS TO CLEAR

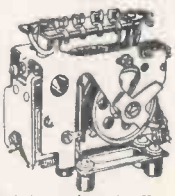
2-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15-amp.-hour, size approx. 6×1½in. square in ebonite case, pre-charged, only need filling with acid, 2/9 each, plus 9d. post and insurance.

PORTABLE CABINET

This is ultra-modern, two-tone, bakelite with integral moulded handle. We can supply, where required, the metal chassis, dial, and all other parts necessary to make a Mains or Battery portable. Note: All of these cabinets have slight imperfections; these are hardly noticeable, however, and will not impair the performance or safety of the set. Price 7/6 each, post and insurance 3/6.

REMOTE CONTROL



With only one pair of wires and a simple push button you can select any one of four stations. This is just one of the many applications of our impulse relay. There are many other purposes to which it can be put. Note they are somewhat soiled, due to storage, but mechanically O.K. Price 1/0, post 6d.

5-AMP. SURFACE SWITCHES—HIGRAFT

Oblong Brown 1-way 1/- each. Oblong White 1-way 1/- each. Oblong Brown 2-way 1/3 each. Oblong White 2-way 1/3 each. Round Brown 1-way 10d. each. Round White 1-way 10d. each. Round Brown 2-way 1/- each. Round White 2-way 1/- each.

WAVE-CHANGE SWITCHES

One dozen assorted wave-change switches, ideal for experimenters. Note, these are unused and not removed from equipment. Our assortment. Price 5/-, post and packing 1/-.

110-VOLT 2½-AMP. RECTIFIER UNIT

This is an excellent unit suitable for driving 110 v. D.C. equipment from 230 v. A.C. mains or for charging batteries for stand-by lighting, etc. Made for the Government—new and unused, with switchgear. Price £17/10/- each.

NAIL INSULATORS

Suitable for electric fences indoor aerials, etc., 3/- per dozen, post and packing 1/-.

WESTINGHOUSE RECTIFIER

Full wave—suitable for up to 80 volts at 15 milliamps. Ideal for relays, meters etc. Price 2/6, post 6d.

SPADE TERMINALS

CZOA

Heavy duty type made for M.O.S. Price 7d. each, 6/- per dozen.

E.P.E. LTD. SEE OVER →

THE INFRAY LAMP

The Infray Lamp is essentially a directional infra-red radiator. It emits rays in a conical formation, the heat intensity being greatest near the lamp. The rays warm the object at which they are directed, but not the air through which they pass.

In addition to the medicinal and other functions of infra red, the Infray Lamp is especially useful in cases where it is impossible, or uneconomical, to warm the atmosphere. Thus a person working in the open could be kept comfortably warm with three or four lamps placed at convenient positions. In other cases the infra-red lamp permits considerable economy of electricity. For instance, a patient sitting in bed can be kept conveniently warm with one lamp costing only ½d. per hour to run, whereas to keep the temperature up to the same comfortable level in the average bedroom would need two 2-kilowatt fires costing 4d. per hour to run, thus the saving of electricity is really considerable. These figures are based upon electricity at one penny per unit. In districts where higher rates apply, then the saving would be even greater.

The Infray Lamp is invaluable to the farmer, poultry keeper and in fact to any breeder of animals. The young creatures will collect under the lamp for warmth and therefore are not likely to be suffocated by the mother.

The Infray Lamp has innumerable other uses: to name a few:—
(1) To speed the drying of paint, cellulose, etc., for instance, in car body repairs.
(2) To dry hair and thus replace the conventional blower type drier. (3) Drying and airing of clothes. (4) In the loft to stop pipes freezing. (5) Warming food.

Price 36/-, plus 2/- post. 1 K.W. MODEL (INFRAY MAJOR)—DETAILS ON REQUEST

AMPLIFIER FOR TAPE RECORDERS

THE CLEVELAND "WIDE-BAND"

Designed in conjunction with Truvox engineers this high-fidelity amplifier ensures that best possible results are obtained from the Truvox Mk. III as well as from other good tape decks. Two input circuits are used—these have separate volume controls and so facilitate the mixing of programme matter. The power pack is on a separate chassis so that a position of minimum hum can be found. Hum level is very low at 50 db down for full output.

The power output is 4 watts internally matched for 3 ohm loudspeaker. A magic eye is used to indicate depth of recording—the circuit of this, however, is disconnected during replay. The frequency response of the amplifier is extremely wide, so ensuring that the best possible reproduction is obtained with modern tapes and heads. Using the Truvox heads the response is virtually level from 50 to 10,000 c.p.s. Price £15. Carriage and insurance 7/6.

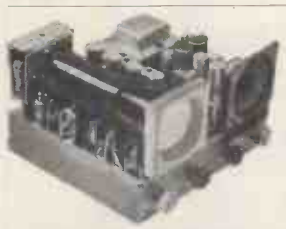
THE SELECTIVE FEED-BACK AMPLIFIER

Although priced at only £5 complete and ready to work this amplifier is truly a high fidelity reproducer. Equal to amplifiers costing three or four times as much. The reason the price is so low is because we were able to buy the valves and materials at very keen prices.

The amplifier is fitted with independent bass and treble controls, connected through separate feed-back loops, so that no "cut" in the ordinary sense is applied.

The price is £5 plus 7/6 carriage and packing. Alternatively the separate components can be supplied together with a booklet of instructions—price for every part is £4—carriage and packing 5/—booklet separately price 1/6.

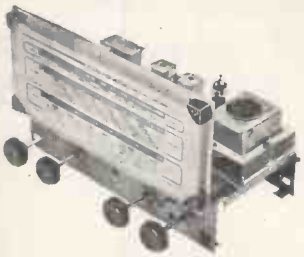
Ask to hear this amplifier when at our depot—you will be really amazed.



MINIATURE PORTABLE T.V.

THE ELPREQ MINIATURE TELEVISOR Uses standard conventional circuitry employing a total of 13 valves and 2 crystal diodes. The Cathode-ray tube used is a 2½in. Service type VCR-139A, which has a standard equivalent and will therefore always be obtainable. The layout is extremely clean, straightforward and professional. The wiring, whilst naturally being a little more intricate due to miniaturisation, is nevertheless completely accessible. The total cost comes to £16-£17. Its size will be approximately 9½in. × 8in. × 6in. Full construction data, layouts, diagrams, templates, etc., running into some 50 sheets, is available, price 5/-, post free.

THE CLEVELAND "ORGANTONE"



The Cleveland "ORGANTONE" is a 5-valve 3-wave band superhet covering long wave (1,020-1,875 metres), medium wave (187.5-545.5 metres) and short wave (16-50 metres). Built to a very stringent specification, it attains a high level of performance, both with regard to sensitivity and fidelity.

Osram all-glass miniature valves are employed throughout and low loss iron cored coils in both aerial and oscillator sections together with permeability tuned I.F.s account for an excellent signal to noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages, and particular care has been taken to ensure freedom from frequency drift.

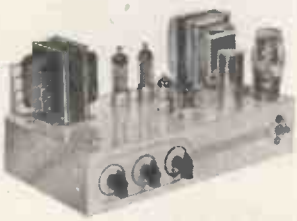
The output stage utilises variable negative feedback for tone control, and, but for standard pentode correction, no cut in the ordinary sense is applied. A gram. position is provided on the wave change switch and reproduction of records is particularly good. An amply proportioned power transfromer with a primary tapped for 110-280 volts gives complete isolation from the mains.

Chassis size is 12in. × 7in. × 7in.—Scale size is 10½in. × 4½in.

This receiver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results. It is an instrument which could fairly be described as a custom-built chassis.

Price £11/10/- or £3/16/8 deposit—carriage, etc., 7/6.

A circuit diagram and photograph available price 2/- post free.



MULLARD AMPLIFIER

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity, with a power output exceeding 10 watts and a harmonic distortion less than .4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pickups. The price of the unit completely made up and ready to work is £12/10/- plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

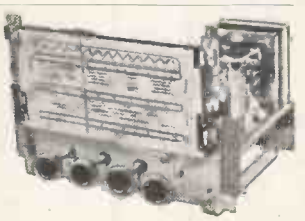
ELPREQ TAPE RECORDER

This instrument combines the Mk. IIIU Truvox Tape Deck and the Cleveland Wide Band Amplifier with a special high flux speaker and forms one of the finest tape recorder combinations available to-day. It will, of course, play pre-recorded tapes as well as make its own recordings of radio, music, meetings, telephone conversations, letters, etc., etc. The price, complete with reel of tape and ready to operate, is

35 Gns.

Carriage and insurance 12/6
Hire Purchase terms if required

DULCI RADIO CHASSIS



Complete range of these famous receivers now availabe at all our branches—cash or Hire Purchase—demonstrations gladly given.

3-wave (L. M. & S.) 5-valve £12/12/- Ref. B3.
Pushpull 6-valve 3-wave £15/15/- Ref. B3PP

	£	s.	d.	Ref.
Pushpull with R.F. stage 3-wave 7-valve	18	18	0	B3PP/RF
6-wave L.M. and 4 short waves (band spread)	15	15	0	B6
6-wave with pushpull	18	18	0	B6PP
6-wave with pushpull and R.F. stage	23	2	0	B6PPRF

All available on H.P.—deposit 15 per cent, balance over 12 months.

ELECTRONIC PRECISION EQUIPMENT LTD.

249, Kilburn High Road, Kilburn. (Now Open.)

42-46, Windmill Hill, Ruislip, Middlesex. Phone: RUISLIP 5780 Half-day Wednesday.

152-153, Fleet Street, E.C.4. Phone: CENTRAL 2833 Half-day Saturday.

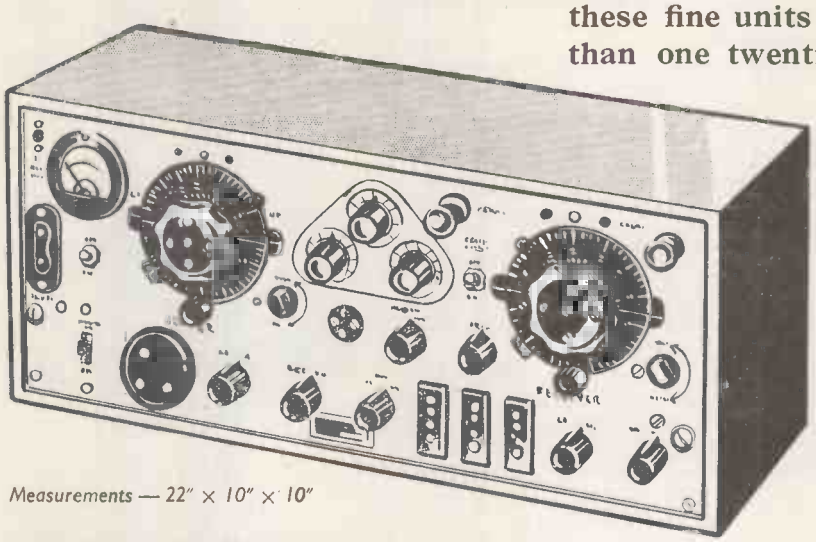
29, Stroud Green Road, Finsbury Park, N.4. Phone: ARCHWAY 1049 Half-day Thursday.

Post orders should be marked "Dept. 2" and addressed to our Ruislip dept.

RATHBONE TRADING CO.

ANNOUNCE the purchase (direct from the Ministry of Supply) of
400 NEW ZEALAND TYPE ZCI MARK II TRANSMITTER/RECEIVERS

We are able to offer amateur transmitters, foreign governments, boat owners, etc., the opportunity to obtain these fine units at what is probably less than one twentieth of their usual cost.



Measurements — 22" × 10" × 10"

WE OFFER THESE
NEW UNUSED UNITS
(Complete with valves)
AT THE
REMARKABLY
LOW PRICE OF

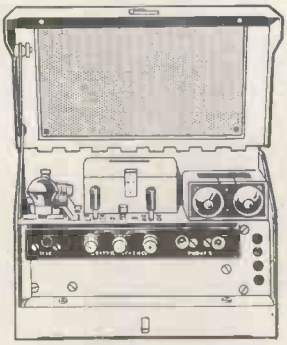
£6-19-6

(Plus 10/- carriage)

TECHNICAL SPECIFICATION.

The frequency covered is 2-4 and 4-8 mc/s (37-150 metres). Power is obtained by means of a self-contained vibrator pack which operates with a 12 v. battery. Battery consumption is under 3 amps for the receiver, under 5 amps for the transmitter. Receiver valve line-up is 6U7G tuned R/F amplifier, 6K8G frequency changer, 6U7G I.F. amplifier, 6Q7G detector and audio amplifier, 6U7G output, 6U7G BFO. Transmitter valve line-up is P.A., Driver, M/O, amp, Pre/amp (osc.) utilising two 6V6G and three 6U7G. The I.F. frequency is 465 kcs. Operation is on C.W., M.C.W. or R.T. Break-in operation is provided. AVC is incorporated on R/T. Two pre-set flick frequencies are provided and may be set to any frequencies within the tuning range.

Controllable pitch BFO, an efficient (switched) crash limiter, a moving coil meter checking both maximum output and battery voltage, are only a few of the refinements incorporated. The transmitter output is up to two watts, reliable communication up to about twenty miles may be obtained with a 12 foot whip aerial. This may be approximately doubled by using a 34 foot rod aerial. By utilising horizontal aerials and sky wave working, considerably greater range may be obtained. The complete unit is fully tropicalised and is fitted with a removable metal cover so that a watertight seal may be obtained. It is built into a substantial reinforced steel cabinet which is mounted on resilient mountings (not illustrated) from which it is readily removable.



ZCI REMOTE CONTROL UNIT

We can also supply the ZCI Remote Control Unit that when used in conjunction with the appropriate headphones and microphones offers the following facilities. "Press-to-talk" R/T or "break-in" CW or MCW either from set unit or distant unit. (Note—Emission switch must be set by operator at wireless set.) Transmission of speech through buzzer-call switchboard by either unit to wireless set, with send-receive control from either unit. Two units may be used for ordinary telephone conversation without speech being emitted. Operator at unit connected to exchange can call and talk to exchange without interfering with the reception or transmission being carried out by other unit.

We can also offer low cost conversions to 6 volt operation, 110/220v 50c operation or 24v operation. Send for details.

We also offer an All-band converter kit to enable you to build an inexpensive 10-31 metre band spread converter (powered from receiver) that will convert the **ZCI** into sensitive all-band communications receiver. Send for details.

REMOTE CONTROL UNITS AND ACCESSORIES

Remote Control Units 15/- each, *Moving Coil Headphones (Type F), 7/6 (for use with transmitter and/or Receiver). Carbon Microphone (No. 8) for use with Remote Control Units, 5/-. Moving Coil Microphones (No. 7), 7/6 (for use with transmitter).
100 yard Coils Connector Cable (twin) on reel with plugs (both ends), 10/-. GPO type one piece handset to replace headphones and microphone, 10/-.
Any of the above sent post paid.

AERIAL ACCESSORIES

8ft. Whip with Base, 7/6. 25ft. Whip with Base, 10/-. 16ft. Whip with Base 12/6. 34ft. Rod Aerial with stay assembly, 30/-. Base. Insulators, etc.

*For those wishing to operate a loudspeaker instead of the moving coil headphones normally used, we can replace the RF pentode output valve with a 6G6G audio pentode at no extra cost. We also supply the necessary simple conversion details.

RATHBONE TRADING CO.

Telephones: *MUSeum 6261 and 9113*

Write to Dept. WW: SKELTON HOUSE, 13 TOTTENHAM STREET, LONDON, W.1

Cables: *PROMCASH, LONDON*

YOU'RE SURE TO GET IT AT STERN'S

BY FAR THE BEST FOR HOME CONSTRUCTORS!

The "TELE-VIEWER"

5 CHANNEL TELEVISOR

DESIGN OF A COMPLETE 12" SUPERHET T.V. RECEIVER

PERFECT PICTURE QUALITY — SIMPLE DIAGRAMS MAKE CONSTRUCTION EASY

PERFECT FRINGE AREA RECEPTION — BETTER RECEPTION AT HALF COMMERCIAL COST

Here are some of the features which combine to make this such a fine receiver

- The Superhet circuit easily tuned to any of the five channels, i.e., LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE and KIRK-O-SHOTTS. (The extreme ease of tuning is accomplished by the provision of pre-aligned I.F.T.s.)
- A lifelike, almost stereoscopic, picture quality made possible by the following factors:
  a. Excellent band width of I.F. circuits.
  b. A really efficient video amplifier.
  c. C.R.T. Grid modulated from low impedance source.
  d. High E.H.T. voltage (approx. 10 kV.).
  The picture brilliance is also much above the average and enables comfortable viewing with normal room lighting or daylight.
- FIRM picture "HOLD" circuits (Frame-Line) ensure a steady picture, free from bounce or flicker, even under the most adverse conditions met with in "fringe" areas and excellent "interlace" ensures the absence of "liney effect."
- Negative feedback is used in the audio frequency circuits which provide 2/3 watts of High Quality Sound.
- Entire receiver built on two chassis units each measuring 14½in. x 6½in. x 3½in.
- Rigid C.R.T. mounting enables entire receiver to be safely handled with tube in position.

All pre-set-controls are mounted on side of chassis, enabling all adjustments to be carried out whilst facing the C.R. Tube.

This complete TELE-VISOR, including all Valves, can be built for only (Plus cost of C.R.T.) **£28/16/4**

As no hire purchase terms are available the receiver can be bought in five separate stages (practical diagrams and circuits are provided for each stage) thus enabling hire purchase interest rates to be avoided. The complete set of ASSEMBLY INSTRUCTIONS is available, price 5/-. The instructions include really detailed PRACTICAL LAYOUTS, WIRING DATA AND COMPONENT PRICE LIST. ALL COMPONENTS ARE AVAILABLE FOR INDIVIDUAL PURCHASE.

The "WIDE ANGLE" TELE-VIEWER

- A design that retains all the distinctive features of the 12in. Televisor but with increased Time Base efficiency, producing 15 to 16 kV. E.H.T., with ample scanning power for C.R. Tubes up to 17in.
- It can be completely built including supply of all valves for **£33** (plus cost of C.R.T.) and is as simple to construct as the 12in. model.
- This is the most efficient "WIDE ANGLE" large screen design yet offered to constructors, and yet it can be built for almost half the cost of similar designs.
- Complete assembly instructions, diagram, etc., available for 5/-.

NOW AVAILABLE AT STERN'S

A COMPLETE KIT OF PARTS TO BUILD A 3-4 WATT HIGH GAIN AMPLIFIER for operation on

A.C. or D.C. Mains, 200-250 volts.

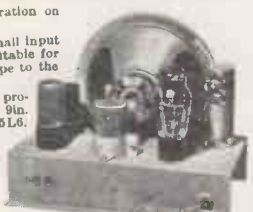
This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. x 5in. x 7in. and valve line-up 25Y5-6sH7-25L6.

Price of complete kit, including drilled chassis and valves, £4/2/9, plus 6½in. P.M. (which fits on chassis), 16/-, or 8in. P.M., 18/9.

Price of fully assembled chassis ready for use, £5/5/- (plus cost of speaker).

Copy of assembly instructions and components price list available for 1/3.



The DENCO M.T.O.I. Modulated Test Oscillator £3/15/-

(Plus 2/- carr. and ins.) Has Frequency range continuously variable from 170-475 Kc/s. and 550-1,600 Kc/s. Battery operated and thereby completely self-contained.

SELENIUM RECTIFIERS

6 or 12 volt 1 amp. rating	7/6
6 or 12 volt 2½ amp. rating	12/6
6 or 12 volt 4 amp. rating	17/6
6 or 12 volt 6 amp. rating	£1/2/9

BRAND NEW C.R.T. MASKS

Latest aspect ratio for 12in. "Round" tubes, finished Ivory (plus 1/- postage) **12/6**

SPEAKER BARGAINS

PLESSEY .10in. 3 ohm V/coil	£1/5/0
GOODMANS, 10in. 3 ohm V/coil	£1/13/6
TRUVOX 12in. 3 ohm V/coil	£2/7/6
ROLA, 12in. 3 ohm V/coil	£3/19/6
BAKERS, 12in. 15 ohm V/coil	£4/19/6
GOODMANS, 12in. 15 ohm V/coil	£5/19/6

(Carriage and Ins. 1/6 extra).

WE HAVE IN STOCK . . . THE DENCO F.M. FEEDER UNIT

Consisting of a 5 valve Superhet design incorporating R.F. (6AM6) and F/C (12AH8) Stages followed by Two I.F.s. (6BA6's) and Ratio Descriminator 6AL5, the coverage provided being 88-100 mc/s.

THE COMPLETE KIT including VALVES and DRILLED CHASSIS is available for £6/13/6 (plus 4/- carriage and insurance)

It is suitable for use with any type of High Fidelity Amplifier.

The descriptive manual, including circuit and Component Layout etc., is available for 1/6.

THE COMPLETELY ASSEMBLED CHASSIS, ready for use, aligned and tuned £8/17/6 (plus 6/- carriage and insurance)

THE NEW W.B. "STENTORIAN" HI FI SPEAKERS ARE IN STOCK

Model H.F. 6-inch	£2/10/6
Model H.F. 9-inch	£3/7/0
Model H.F. 8-inch	£3/0/6
Model H.F. 10-inch	£3/13/6

These speakers are of the very latest design and provide quality reproduction for the lower-price range, 3 or 15 ohm models are available.

WE CAN SUPPLY EX-STOCK

(a) The Editor Tape Recorder complete	£47/5/0
(b) The Truvox Tape Deck	£23/2/0
(c) The Grundig Model TK9 Tape Recorder, complete	£68/5/0
(d) The Grundig Model 700L Tape Recorder, complete	£84/0/0

Each is available on Hire Purchase and descriptive leaflets are available—send S.A.E.

THE NEW DENCO ULTRA MIDGET SUPERHET COIL PACKS

MODEL CP4/L. A 4-station "Pre-set" unit providing any 3 stations on medium waveband and one station on long wave, price £1/13/4.

MODEL CP4/M. A 4-station "Pre-set" unit which provides any 4 stations on medium waveband. Price £1/13/4.

The above are supplied fully wired leaving only four connections to be made.

MODEL CP3/370PF and CP3/500PF. Completely wired 3 waveband Coil Packs for use with either 350 PF or 500PF condensers. Coverages 190-550 metres, 800-2000 and 16-50 metres. Price £2/2/8.

An attractive Dial and Drive Assembly is available for 25/-. Overall size of each unit 3½in. x 2½in. x 1in. deep.

BATTERY CHARGER KITS

All kits are for A.C. Mains 200-250 volts. They comprise a Metal Rectifier and Transformer, tapped for 6 or 12 volt charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied. A M/coil meter 5 amp. max., 13/6 extra.

For 6 or 12 volt batteries at max. 1 amp.	£1/17/6
For 6 or 12 volt batteries at max. 2½ amp.	£2/5/3
For 6 or 12 volt batteries at max. 4 amp.	£3/2/6

An easily followed Wiring Diagram is included with each kit.

FILAMENT TRANSFORMER

6.3 v. 1½ a.	5/9
4 v. 1½ a.	5/9

When submitting orders, please include postage and packing

STERN RADIO LTD.

"Hi-Fi" EQUIPMENT and KITS
TO SUIT ANY BUDGET

TWO COMPLETE "Hi-Fi" AMPLIFIER KITS

"STERNS" 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. **£7/10/-** (Plus 2/6 Carr. & Ins.)

We will supply it Completely Built for **£9/10/-** (Plus 5/- Carr. & Ins.)

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 ohms 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.

"STERNS" 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 9in.x4in.x2¼in. and contains four controls, being: Bass-Treble-Volume and a Radio, Gram, Microphone Switch control. It incorporates its own feedback circuit on the Bass Channel. Loop negative feedback is employed on the Main Amplifier which has a valve line up of 6J5-6N7-5U4 with two PX25's in push-pull and 6J5 and 6SN7 are used in the remote control unit

THE COMPLETE KIT IS AVAILABLE FOR **£14/-/-** (Carr. & Ins. 6/- extra.)
THE COMPLETE UNIT ASSEMBLED AND READY FOR USE **£17/-/-**
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/-.

SPECIAL PRICE REDUCTIONS
FOR COMPLETE EQUIPMENT

SELECT A TUNING UNIT and AMPLIFIER or TUNING UNIT, AMPLIFIER and RECORD PLAYER (and a SPEAKER if required) and we will supply at a REDUCED PRICE. H.P. TERMS ALSO QUOTED.

"STERNS" MODEL C.P.3. COMBINED AM/FM TUNING UNIT

A UNIT DESIGNED TO RECEIVE BOTH THE A.M. and F.M. BANDS WITH THE VERY HIGHEST DEGREE OF QUALITY.

A.M. TUNER SECTION. This employs a 4 valve 3 waveband circuit incorporating 2 stages of I.F. Amplification switched to provide bandwidths of 7.10 and 14 kc/s. Valve line-up: X79 (Mixer) W77 (I.F. Amplifier) W77 (2nd I.F. Amplifier) DH77 (Detector A.V.C and 1st A.F. Amplifier).

F.M. TUNER SECTION. This is a design incorporating a wide band R.F. stage followed by a frequency changer which has a variably tuned oscillator enabling the band 88-100 mc/s to be covered. Two stages of I.F. Amplification provides excellent sensitivity and a ratio type discriminator stage gives high output with good A.M. rejection.

SWITCHING. A three position switch incorporated into the chassis enables the F.M. Tuner or the A.M. Tuner, or gramophone pick-up to be selected. This switch also switches the H.T. supply to the tuner selected. The Triode section of the DH77 in the A.M. circuit is also controlled by this switch and becomes the first A.F. amplifier not only for the A.M. Tuner, but for the F.M. tuner and gramophone pick-up also. A volume control is provided for all three.

POWER SUPPLIES. Adequate H.T. and L.T. supply is obtained from the built-in mains power pack for 200-250 v. A.C. mains input. Full wave rectification with a 5Z4 rectifier valve is used.

TUNING. A common tuning control covers both the A.M. and F.M. bands. The dial is calibrated with station names and wave lengths for the A.M. channels and has a logging scale for the short wave and F.M. bands.

CHASSIS DIMENSIONS. 14in. x 9in. x 9in. overall including a three coloured full vision dial. Size 8¼in. x 4¼in.

PRICE, ASSEMBLED AND READY FOR USE £25/10/-.
(Plus 10/- carriage and insurance.)
H.P. Terms. Deposit £6/7/6 and 12 months at £1/15/10.

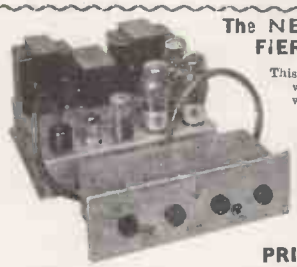
"STERNS" MODEL CP3G 3 WAVEBAND SUPERHET TUNING UNIT

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).

- Valve line-up — 6K8G (Frequency Changer), 6SK7g (I.F. Amplifier), 6Q7g (Detector, AVC 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 pickup.
- Volume control and tone control operative in both radio and gramophone positions of the wavechange switch.
- This unit is precisely similar in appearance to the AM/FM unit illustrated, but the overall chassis dimensions are 12in. x 8¼in. x 8in. including the full vision dial. Size 8¼in. x 4¼in.
- 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 of 15/-.
Price completely assembled excluding power supply £9/-/-. Carriage and insurance 7/6 extra.

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 pickup. A continuously variable input attenuator at the rear of the Pre-amp. permits the instantaneous use of crystal, moving iron and moving coil pickups. 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/-.

WILLIAMSON AMPLIFIERS BY GOODSELL

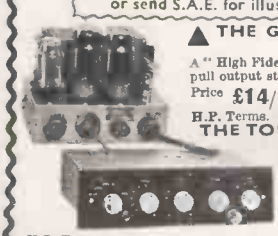
These Amplifiers hardly need enlarging upon, it being sufficient to say that they have now become the accepted standard for quality reproduction by which all others are judged. Two Models are available:

MODEL G.W.18. Built completely to specification and giving 15 watts output.
Price **£33/15/-** (plus 7/6 carriage and insurance.) H.P. Terms. Deposit £8/9/- and 12 months at £2/7/5.

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 £3/17/6 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

WE HAVE THEM IN STOCK AND WILL BE PLEASED TO DEMONSTRATE
or send S.A.E. for illustrated and descriptive leaflet.



THE GOODSELL "ULTRA LINEAR" M.A.5. AMPLIFIER.
A "High Fidelity" Amplifier using a Triode connected push-pull output stage providing 10-12 watts output.
Price **£14/17/6** (plus 7/6 carriage and insurance).
H.P. Terms. Deposit £3/12/6 and 12 months of £1/1/1.

THE TONE CONTROL—PREAMP. UNIT.
Recommended for this Amplifier is the model UL/F/T.C. Its main features are adequate equalising for gramophone reproduction, separate control of bass and treble and low pass filter. Feedback is used over each of four stages.
Price **£12/12/-** (plus 6/- carriage and insurance).

H.P. Terms. Deposit £3/4/- and 12 months at 17/8.

When submitting orders, please include postage and packing.

STERN RADIO LTD.

CONSTRUCTORS say "IT'S STILL THE BEST MAINS or BATTERY PORTABLE SET"

A Midget 4-valve Superhet Portable covering medium and long wavebands. Designed to operate on A.C. mains 200/240 volts or by an "Alldry" battery. The set is designed so that the main section can be supplied as a separate unit, and can be added at any time. The set supplied as an "Alldry" battery Superhet can be accommodated in the attache case illustrated (size 9½in. × 4½in. × 7in.). This is attractively finished in lizard, maroon, dark green or blue rexine. As a combined Mains/Battery Superhet Portable a polished cabinet is available to accommodate both Mains Unit and Batteries. Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. The Set is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. transf. and drilled chassis etc. Overall size of assembled chassis 8in. × 4in. × 2½in. This receiver as illustrated, can be completely built for £8/16/3 (plus Mains Unit if required). Send 1/3 for the fully descriptive Assembly Book which includes Practical Layouts and complete Price List of Components. Attache case available separately, 37/6.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 69 volts and 1.4 volts. 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. × 3¾in. 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 and 1.4 volts. Size of assembled unit 7in. × 2¾in. × 1¾in. Price 47/6.

A COMPLETE "CAR RADIO" FOR THE HOME CONSTRUCTOR

11½in. × 4½in. × 3½in.

A design of a complete 5-VALVE SUPERHET RECEIVER employing an R.F. Stage, and incorporating a separate VIBRATOR PACK size 4½ × 2½ × 4½in. for use on 6 or 12 volt D.C. supplies. We can supply all components to build this complete Receiver and Vibrator Pack including a Metal Case, Valves, Drilled Chassis and 5in. P.M. Speaker for £13/9/6. (Carr. and Ins. 5/6 extra.) Or the Receiver Components for £9/19/6 and the Vibrator Components for £3/10/-. This is NOT an EX-GOVT. Receiver, it is a new design employing new Components. Send 2/8 for the complete set of ASSEMBLY INSTRUCTIONS, CIRCUITS and PRACTICAL LAYOUTS, including a complete individual Component Price List.

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 requested.

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) An 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.

109 and 115 FLEET ST.

LONDON, E.C.4. *Phone:* CENTRAL 5812-3-4

THE "MINI TWO-THREE"

An "Alldry" Battery Portable of midget size, 6¾in. × 4¾in. × 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 3-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 which enable the most inexperienced constructor to successfully build either set.

!! CONSTRUCTORS !! A NEW SUPERHET TRANSPORTABLE THE "SUPER THREE"

Designed for local station reception without the use of an external aerial. This design provides for a 3-valve (plus Metal Rectifier) Superhet Receiver incorporating a Frame Aerial for "room to room" use, provision is also made for a short external aerial, if required, for the reception of Continental Stations.

Briefly the features are as follows:—

- For use on A.C. Mains 200-250 volts.
- This set includes a Mains Transformer and Chassis is NOT live to mains (as many other sets of this type are) and consequently the Receiver can safely be used in the Kitchen, etc.
- Valve line up 6K8—6J7—KT61, plus Metal Rectifier.
- The I.F. Transformer is supplied "pre-aligned" and thereby ensures extreme simplicity of Tuning—in fact, more simple than most T.R.F. Receivers.
- Compact and easy to build simple "point to point" practical diagrams are supplied with a completely drilled chassis.

The complete Receiver Chassis can be built to cover the Medium Waveband only for **£6 . 6 . 6**

Or to cover both Long and Medium Waves for **£6 . 16 . 3**

The attractive Polished Wood Cabinet 11½ inches wide, 8½ inches high and 6 inches deep illustrated above is **£1 . 1 . 0**

The CONSTRUCTOR'S MANUAL is available for 1/-, this shows the component prices, which are all available for separate purchase.

A DUAL-CHANNEL PRE-AMPLIFIER and TUBE 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/-.

"MINI-TWIN" 1-VALVE BATTERY SET

A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption. Drilled chassis and practical diagrams make it the ideal set for the beginner to build.

The complete chassis, including valve, can be built for 37/6, plus 8/11 P/Tax, the attractive plastic case is 9/6, and suitable headphones, 14/9.

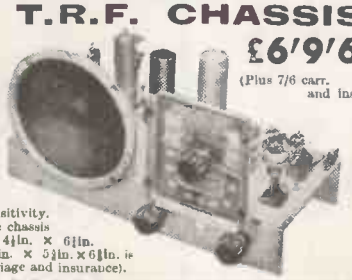
The complete assembly instructions, layouts and a component price list are available for 1/6.

A COMPLETELY ASSEMBLED 4 VALVE T.R.F. CHASSIS

Including a 5 in. P.M. SPEAKER and VALVES

£6/9/6

(Plus 7/6 carr. and ins.)



This receiver is of the very latest design and is for use on A.C. or D.C. Mains. It covers both Long and Medium Wavebands, and includes the modern BVA miniature valves The line up being 12BA6 — 12AT6—12A6—35W4. It incorporates Permeability Tuned Coils, thus ensuring excellent selectivity and sensitivity. The overall size of the complete chassis including speaker is 10¼in. × 4¼in. × 6¼in. An attractive Cabinet size 11½in. × 5½in. × 6¼in. is available for 16/6 (plus 2/6 carriage and insurance).

SPECIAL PURCHASE!
DECCA THREE-SPEED GRAM UNITS

A three-speed quality single player motor complete with 10in. turntable and pickup, with the two famous ffrr magnetic plug-in heads type **G** and **D**, fitted with sapphire styli. Modern Decca cantilever type counter-balanced pick-up arm. Matches the circuit of almost any radiogramophone or record reproducer. The first step towards the achievement of high-fidelity reproduction when used with amplifiers specially designed for this purpose. Automatic stop of entirely new design. Base-plate measures 12¾in. × 11in. Height above motor board 2¾in. and 3in. clearance required below. List price **£13/19/6**, our price only £7/19/6 tax paid, plus 5/- packing and post. Cream finish. We can also supply this unit with the special "3-pin to ACOS" adaptor and two GP19 heads. Price the same, **£7/19/6**!

ANOTHER GRAM UNIT BARGAIN!

Collaro RC/531—8 record auto-changer for 78 r.p.m. Brand new complete with separate plug-in magnetic head. Our price £8/8/- only, plus 5/- p. & p.

Collaro AC/51¼—Single record playing units for 78 r.p.m. Brand new in sealed cartons, with separate plug-in magnetic head. Our price **£4/12/6** plus 3/- p. & p.

DULCI RADIO/RADIOGRAM CHASSIS

This very popular range of superior chassis can be supplied from stock. We will gladly demonstrate any to personal callers. All incorporate latest type valves 6BE6, 6BA6, etc. Flywheel tuning, negative feedback over entire audio section. Engraved knobs—3 tone position for Radio and Gram. All are built on chassis size 11¼in. × 7in. × 8¼in. high. All A.C. 100/110 and 200/250 v. —Dial size 8¼in. × 4¼in. for horizontal tuning. Attractive appearance.

Model B.3. Long, Medium, Short Waves (5 valves). Cash Price **£12/12/-**. H.P. Terms, **£3/4/-** deposit, 12 months at **17/8**.

Model B.3 Plus Push Pull Stage (6 valves). Cash Price **£15/15/-**. H.P. Terms, £3/19/- deposit, 12 months at **£1/2/2**.

Model B.3 Double Feature Push Pull and R.F. Stage (7 valves). Cash Price **£18/18/-** H.P. Terms **£4/13/-** deposit, 12 months at **£1/6/9**.

Model **B.6**. (Medium, Long and Four Short Wavebands, bandspread). Cash Price **£15/15/-**. H.P. Terms, £3/19/- deposit, 12 months at **£1/2/2**.

Model B.6, plus Push Pull Stage (6 valves). Cash Price **£18/18/-**. H.P. Terms **£4/13/-** deposit, 12 months at **£1/6/9**.

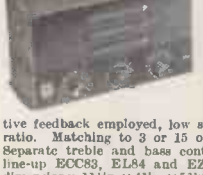
Model B.6 Double Feature Push Pull Plus R.F. Stage (7 valves). Cash Price 22 gns. H.P. Terms **£5/15/6** deposit, 12 months at **£1/12/6**.

All chassis fully guaranteed 12 months. Please include 7/6 packing, carriage and insurance. Illustrated leaflet available Suitable speakers available. Ask for speaker list.

SPECIAL ! ! !

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.

UNITELEX GENERAL PURPOSE AMPLIFIER MG4 AND MG4A.



For Gramophone and Microphone. Also very suitable for electric guitars and all types of electronic musical instruments. Maximum output 5 watts. Negative feedback employed, low signal-to-noise ratio. Matching to 3 or 15 ohm speakers. Separate treble and bass controls. Valve line-up ECC83, EL84 and EZ80. Overall dimensions: 11¼in. × 4¾in. × 5¾in. high. Wgt.: 8lb. Chassis finish is a hard and durable polychromatic stove-enamel. For A.C. mains 200/250 v. Price **£8/18/6**. Type MG4A is the same Amplifier but with cover and plastic baseplate, at **£9/19/6**. Both plus 3/- p. & p. Illustrated leaflet available.

We have in stock the very latest "Elpico" Feeder Unit type RF720. Superhet for L., M., Short and Trawler Bands. Very attractive illuminated black and gold dial. for immediate use with any amplifier. 15 gns. tax paid

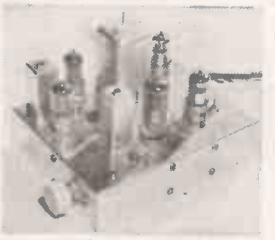
F.M.!!! (Frequency Modulation)

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 6½ × 5½ × 1¼in.

Demonstrations at 18, Tottenham Court Road!!

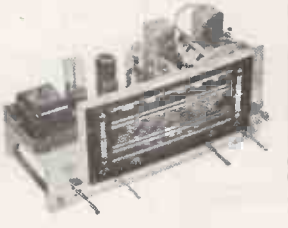


THE "SUPERIOR FOUR" KIT. Our new four-valve receiver. A.C. mains, 200/250 v. M. and Long Waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size, 10¼in. × 10in. wide. Maximum depth at base, 8in., tapering to 3¼in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6, post free. Our price for complete kit, **£6/9/6**!!! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet, Assembly only, comprising Cabinet and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/- plus 2/6 packing and carriage.

N.B.—Our Kits are even supplied with sufficient solder for the job!

THE R.C. GRAM REPLACEMENT CHASSIS KIT

To meet the very great demand for this type of receiver, we have produced this unit. For Long, Medium, and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7 I.F. Amplifier, 6Q7 1st Audio, Detector and A.V.C, 6V6 Output, 6X5 Full-wave rectifier. For A.C. mains 200/250 volts. 4 watts output. Excellent quality. High sensitivity. Provision for gram. Attractive illuminated black, red, green and gold dial for horizontal tuning. Four controls are: Tuning, L/M/S/Gram. Vol./on/off, Tone (variable). Chassis size: 13¼in. × 5¼in. × 2¾in. Dial size: 10in. × 4¼in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list, 1/6, post free. The main items for this receiver can be supplied separately, as under:



Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning condenser and ready-assembled dial and drive at **39/6**. 3 waveband coil pack with gram position, 39/6, tax paid. Pair of 465 Kc/s. I.F. Transformers, 9/6 pair. Half-shrouded drop-through Mains Transformer, **22/6**. The total cost of ALL items purchased separately is nearly £10, but we shall be pleased to supply all the required components right down to the last nut and bolt, at a special inclusive price of £8/8/-, plus 2/6 packing and postage. A set of four small brown or cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled, in very limited quantities, at **£9/19/6**, plus 5/- carriage and packing.

THE "ECONOMY FOUR" T.R.F. KIT

A three valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up, 6K7, 6J7, and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagram. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later—Please, 2/6 packing and carriage for complete kit

THE NEW '88' "EMITAPE"

Magnetic recording Tape PLUS!!!

HIGH SENSITIVITY. Anti-static PVC Base. Non curling. Editing Leader and trailer strip. Wound on plastic spool. 1,200ft., 35/- plus 1/6 P.P. 600ft., 21/- plus 1/- P.P. **F.C.I. 10 WATT AMPLIFIERS.** Measure 12in. × 6in. × 6in. Valve line up—6AM6 6AM6, 68N7, 5Z4, 6F6s Push Pull. Separate Bass and Treble controls, multi-ratio output transformer for 3 ohm or 15 ohm speakers. Fully guaranteed!! **£10/15/-** plus 5/- P.P

ACCUMULATORS!!

Bargain Offer!!

"VOLTALYTE" 2 VOLT 60 AMP. MULTI-PLATE Type in celluloid containers. Size 3in. × 3in. × 4¼in. high at 9/6 each plus 2/- P & P. Or 3 for 28/6, post free.

CABINETS. We can supply a cabinet for every requirement, Table Model, Extension Speaker, Portable Player, Console, even for Projection T/V! Why not call and see us?

THE R.C. RAMBLER ALL-DRY PORTABLE KIT

Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet, measuring only 9in. × 7in. × 5¼in. Weight (less batteries) 4¼lb., with batteries 6¼lb. This set really has everything! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up: 3V4, 1R5, 1S5, 1T4. All the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 P. & P. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 9/3. Also L.T. 1.5 v. A.D.35 at 1/4.

RAMBLER MAINS UNIT!—At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions.

THE R.E.P. ONE-VALVE BATTERY RECEIVER KIT. Simple one-valve all-dry battery receiver for headphones, easily built in one evening. All required components including headphones, can be supplied at inclusive cost of 42/- plus 2/- p. & p. Operated by Ever-Ready B114 type battery available at 7/9. Full assembly details available separately at 9d. plus 3d. post.

THE NEW R.C. HIGH-FIDELITY AMPLIFIER. P.P. 6V6 output. Freq. 25—18,000 cps.—60db at 6½ watts. Treble boost and cut—Bass boost—L.P. correction. Provision for Feeder Unit Max. UNDISTORTED OUTPUT 8½ watts. Price 14 gns., plus 7/6. NOW AVAILABLE 2 — Kit of Parts, complete with fully illustrated instructions **£11/19/6**, plus 5/- carriage. Illustrated booklet available separately at 1/6. Attractive metal cover, now available. With built-in carrying handle **19/6**.

STUPENDOUS HALF-PRICE OFFER! DECCA SINGLE SPEED RECORD PLAYING DESKS 33A. Easily converted to either Standard or L.P. Price with one crystal cartridge of either type. **£4/19/6**; or with both cartridges, £5/19/6. Plus 5/- P. & P.

SPECIAL OFFER. Garrard AC/DC mode "E" centre drive motor—for 78 r.p.m.—Speed regulator—Few only at **£7/19/6**, plus 2/6 packing and carriage. We also have in stock—Connoisseur 3-speed motors, pick-ups. Pick-ups and heads by Garrard, Decc..., Collaro Acos, Chancery etc. etc. at current prices.

AMPLIFIER BARGAIN. "THE EMPRESS" Super quality push-pull 4 valve 4 watt amplifier. Ideal for record or radio tuner reproduction. Measures only 7¾in × 7¾in. × 3¼in. Valve line-up EL42, EL42, EZ41, EC83, for use with one or two 3-ohm speakers. Price **£7/7/-** plus 3/- P. & P.

PORTABLE CABINETS. Manufacturers' surplus. Well made brown rexine covered. Will take any standard single player with bottom clearance of 3in. Total size closed 15in. × 13¾in. × 5¾in., fitted with snap catches and carrying handle. 22/6 only, plus 2/6 P. and P.

CLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1.

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
F.W. Bridge Types			
6/12 v. 1 a.....	4/11	250 v. 80 mA....	7/9
6/12 v. 1.5 a. ...	7/9	250 v. 150 mA...	9/9
6/12 v. 2 a.....	9/9	RM2 125 v. 100 mA.	3/11
6/12 v. 3 a.....	12/3		
6/12 v. 4 a.....	14/9	RM4 250 v. 250 mA.	11/9
6/12 v. 6 a.....	19/9		
6/12 v. 10 a. ...	29/9	300 v. 275 mA.	12/11
24 v. 10 a.	57/6		

CO-AXIAL CABLE. 75 ohms ¼in., 7d yard. Twin screened feeder, 9d. yd.

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. 0.15 a., 6/9 doz.; 4.5 v. 0.3 a., 6/9 doz.

ELECTROLYTICS (Current production) NOT ex Govt.

Tubular Types		Can Types	
8μF 450 v.	1/11	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
24μF 350 v.	3/3	64 mfd. 450 v. ...	4/9
32μF 350 v.	3/9	100 mfd. 450 v.	4/9
32 mfd. 500 v. ...	5/9	8-8μF 350 v. ...	3/9
8-16μF 500 v. ...	4/11	8-8μF 450 v. ...	3/11
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
Can Types		16-32μF 350 v....	4/9
8 mfd. 350 v. ...	1/3	32-32μF 350 v....	4/9
8 mfd. 450 v. ...	2/3	32-32μF 450 v....	5/11
8 mfd. 500 v. ...	2/9		

AMPLIFIER OR CHARGER CASES. Size 14¾ × 5¾ × 7¾in. high. Strongly made in perforated steel. Grey enamel finish. Only 9/6.

R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in.	16/9
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	29/6
300-0-300 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., 5 v. 3 a	22/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	31/6
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.	47/9
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.	12/11
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	15/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
275-0-275 v. 80 mA., 6.3 v. 3 a., 4 v. 2.5 a.	14/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	21/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	21/9
350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	21/9
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.	26/9

E.H.T. TRANSFORMERS. 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 ..... 36/6

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.....	5/9	0-4-6.3 v. 2 a....	7/9
6.3 v. 3 a.	8/11	6.3 v. 6 a.	17/6
12 v. 1 a.....	7/9		
0-2-4-5-6.3 v. 4 a.	16/9	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., 16/9; 0-9-15 v. 4 a., 18/9; 0-9-15 v. 6 a., 22/9; 0-9-15 v. 15 a., 45/-.

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA.	7/11
120 v. 40 mA., 5-0-5 v. 1 a.	14/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/6
Small Pentode, 5,000 Ω to 3 Ω	3/9
Standard Pentode, 5,000 Ω to 3 Ω	4/9
Standard Pentode, 8,000 Ω to 3 Ω	4/9
Standard 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 3 Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15 Ω	16/9
Push-Pull 20 Watts high-quality sectionally wound 6L6, KT66, etc., to 3 or 15 Ω	47/9

SMOOTHING CHOKES

250 mA., 3 H. 50 ohms	11/9
150 mA., 7-10 H. 250 ohms	11/9
100 mA., 10 H. 200 ohms	8/9
80 mA., 10 H. 350 ohms	5/6
60 mA., 10 H. 400 ohms	4/11
50 mA., 40 H. 1,000 ohms. Potted	10/9
20 mA., 30 H. 1,000 ohms	4/9

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, 50K, 100K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K, 50K, Preset type, 1/9 each.

AMMETERS. Moving coil. G.E.C. 0—5 amps., 2in. scale, 11/9.

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. ACCUMULATORS with non-spill vents. Unused and guaranteed. 2 v. 16 A.H., 5/9 each.

EX-GOVT. BLOCK PAPER CONDENSERS

2 mfd. 800 v. ...	1/9	4 mfd. 2,000 v....	6/9
4 mfd. 500 v. ...	2/9	6-6 mfd. 450 v....	5/9
4 mfd. 730 v. ...	3/9	8 mfd. 500 v. ...	5/9
4 mfd. 1,500 v....	4/9	8-8 mfd. 500 v....	6/11
4 mfd. 400 v. plus 2 mfd. 250 v., 1/11.		15 mfd. 500 v. ...	7/9

EX-GOVT. TRANSMITTER-RECEIVER TYPE TR9D, with all valves, only 47/9, plus carr. 5/-.

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola-field 700 ohms, 11/9. 8in. R.A. field, 600 ohms, 11/9. 10in. R.A. field, 1,500 ohms 23/9. 10in. R.A. field, 1,000 ohms, 23/9. **SPECIAL OFFER.** Mains Trans. 200-250 v. 50 c/s. Primary. Secs. 300-0-300v. 150 mA. 6.3 v. 4 a. 5 v. 3 a., half shrounded drop through, 21/9.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT with 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.

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. 7/6. **£6/19/6.**

HEAVY DUTY BATTERY CHARGER KIT

For normal 200/250 v. A.C. mains. Comprises mains Transformer, 2 F.W. Metal Rectifiers, 2 variable resistors, 4 insulated terminals, 2 meters, 4 fuses and circuit. Total output 18 amps. Separate outputs for 6 v. and 12 v. Will make ideal Charger for Garages. Carriage 15/-. **£9/19/6.**

THE SKY CHIEF T.R.F. RECEIVER

A design of a 4-stage, 3 valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It consists of a variable Mu high gain H.F. stage followed by a low distortion grid detector triode. The next stage is a further triode amplifier with tone correction by negative feedback. Finally comes the output stage consisting of a parallel connected double triode giving ample output at an extraordinary low level of distortion. Point to point, wiring diagrams instructions, and parts list, 2/6. This receiver can be built for a maximum of £4/16/- including cabinet.

P.M. SPEAKERS. All 2-3 ohms. 6½in. Plessey, 16/9. 8in. Plessey, 15/9. 10in. R.A., 26/9. 10in. Plessey, 18/6. 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 BLACK 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 5 amp meter. Well ventilated metal case with attractive crackle finish. Guaranteed for 12 months, 69/6. Carr. 2/6.

EX. GOVT. MAINS TRANSFORMERS

All 230 v. 50 c/s. input

8.8 v. 4 a.	9/9
48 v. 1 a.	9/9
0-11-22 v. 15 a.	35/9
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
365-0-365 v. 150 mA.	8/9
300-0-300 v. 80 mA. 5 v. 3 a.	8/11
278-0-278 v. 100 mA.	8/9
300-0-300 v. 150 mA., 610-0-610 v. 150 mA., 1,220 v. 350 mA.	29/9
400 v. C.T. 150 mA. 4 v. 6 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a.	22/9

EX. GOVT. AUTO. TRANSFORMERS

15-10-5-0-195-215-235 v. 500 watts	27/9
Double wound 10-0-200-220-240 v. to 10-0-275-295-315 v. 1,000 watts	69/6
Double wound 0-230 v. to 0-230 v. in steps of 11 volts from 57.5 5KVA (21 amps)	£6/15/-
Double wound 0-110-240 v. to 0-130-140-150-160-170 v. 1,500 watts	69/6

EX. GOVT. SMOOTHING CHOKES

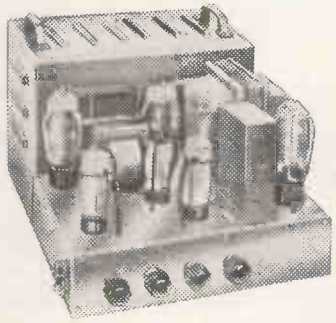
250 mA., 10 H. 50 ohms...	14/9
250 mA. 10 H. 100 ohms	14/9
250 mA. 3 H. 50 ohms	8/9
150 mA. 10 H. 50 ohms	10/11
100 mA. 10 H. 100 ohms, Tropicalised	6/9
100 mA. 5 H. 100 ohms, Tropicalised	3/11
50 mA. 50 H. 1,000 ohms. Potted	8/11
90/100 mA. 10 H. 100 ohms. Potted	8/9
50 mA. 5-10 H.	2/9
L.T. type 1 amp.	2/9

CHASSIS

18 s.w.g. undrilled aluminium amplifier type (4-sided).	16 s.w.g. aluminium, receiver type.
12in. × 9in. × 2½in. 6/11	12in. × 8in. × 2½in. 5/3
14in. × 9in. × 2½in. 6/11	16in. × 8in. × 2½in. 7/6
14in. × 10in. × 3in. 7/11	20in. × 8in. × 2½in. 8/11
16in. × 10in. × 3in. 8/3	
18 s.w.g. aluminium receiver type.	16 s.w.g. aluminium, amplifier type, 4-sided.
6in. × 3½in. × 1½in. 1/11	12in. × 8in. × 2½in. 7/11
7½in. × 4½in. × 2in. 2/9	16in. × 8in. × 2½in. 10/11
10in. × 5½in. × 2in. 3/3	20in × 8in. × 2½in. 13/6
11in. × 6in. × 2½in. 3/11	14in. × 10in. × 3in. 13/6

R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A 4

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. H.P. Terms now available on request. Cover as illustrated if required, price **17/6** extra.

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 approx. 12in. × 10in. × 9in. Weight 20 lb. Power consumption 175 watts. Outputs for 3 and 15 ohms 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. plus carr. 7/6.

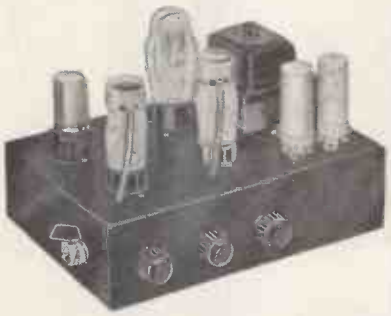
W.B. "STENTORIAN" High fidelity P.M. Speaker, HF1012, 10 watts. 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required we highly recommend this unit with an amazing performance. **£3/13/6.**

MICROPHONES. Crystal, hand type, good quality' £2/19/6. Stand type with base and adjustable stand, £6/19/6. Both suitable for use with our amplifiers.

PLESSEY 3-SPEED MIXER AUTOCHANGERS with high impedance magnetic pick-up with duo point alloy stylus for long playing or standard records. (Will play 2,000 records before replacement stylus required.) Brand new, cartoned, guaranteed. Limited stocks at only 10 gns, plus 5/- carr.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. BRAND NEW. CARTONED. Only £3/19/6 (approx. half price). Carr. 5/-. (For 200-250 v. A.C. Mains).

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5



A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads, in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 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 preamplifier. 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.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/7/6.

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. (We can supply a very suitable 10in. unit by Rola at 27/9.) The amplifier can be supplied ready for use for 25/- extra. Full descr.ptive leaflet, 7d.

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. The unit is in kit form and point-to-po.nt w ring diagrams are supplied. A walnut veneered wood or Brown Bakelite cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHA8818 IS NOT "ALIVE" Ideal for use as "Baby Alarm" Sound amplification 4 watts. Price only £5/19/6. "Listen—Talk Back Unit" in bakelite or walnut veneered cabinet, can be supplied at 30/- each. Full descriptive leaflet 10d. The Master Unit can be supplied assembled and tested for 30/- extra.

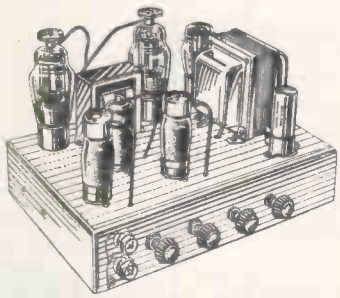
PERSONAL SET BATTERY SUPERSEDER KIT.

All parts for an "All Dry" Battery Eliminator. Complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal. 200-250 v. 50 c/s mains. For 4-valve superhet receivers. Price with circuit, 35/9. Or ready for use, 42/6. Size of units 5½-4-1½in.

BATTERY SET CONVERTER KITS. All parts or 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 AMPLIFIER.

With Self Contained Pre-amplifier and Tone Control.



This amplifier, whilst having sufficient output to fill a small hall, is the ideal amplifier for the quality enthusiast who knows that though the average listening level is less than one watt it is necessary, for the very highest quality, to have an output of at least ten times this figure in order to obtain completely distortionless reproduction of sudden loud sounds.

The layout of the components has been planned to give the very maximum of performance with the minimum of constructional effort. Large safety factors in every component, A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, valves, and with easy-to-follow point-to-point wiring diagrams. The only things necessary to build this superb instrument are a soldering iron, screwdrive and pliers, everything else is supplied down to the last nut and bolt.

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 bass 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 values to suit his personal taste and surroundings. Because of the large negative feedback employed the output transformer can be so designed that it provides all the specified power even with large variations of loudspeaker impedance. 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.
Maximum input for full output 140 millivolts
Frequency response 3 DB 50-20,000 cycles.
Negligible hum and distortion
For A.C. mains input 200/230/250 v. 50 c/s.

COMPLETE Kit of Parts, **£7/19/6** (carriage 5/-).
Supplied assembled and tested for 45/- extra.

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.

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/-, 1/6 extra under £2, 1/11 extra under £3. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5-30 p.m. Saturdays until 1 p.m.

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-. 300-0-300, 100 mA., 6 v. 3 amp. 5 v. 2 amp., 22/6.

Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.

Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

280-0-280, drop through, 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.

250-0-250, 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/-.

Heater Transformer. Pri. 230/250 v. 6 v. 1½ amp., 6/-; 2 v. 2½ amp., 5/-.

Pri, 200/250. Secondary 9 v. 3.5 amp. 6.3 v. 3 amp., 12/6.

Pri. 230 v. Sec.500-0-500 and 500-0-500. 250 mA. both windings 4 v. 3 amp. 4 v. 3 amp., 31/6. P. & P. 5/-.

Mains Transformer, fully impregnated Input 210, 220, 230 and 240. Sec. 600-0-600, 275 mA., and 200 v. at 30 mA., complete with separate heater transformer. Input 210, 220, 230, 240. Sec. 6.3 v. 2 amp. three times, 0, 4, 6.3 v. at 3 amp. and 5 v. 3 amp., 45/-. 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/-.

MAINS TRANSFORMERS, chassis mounting, feet and voltage panel. Primaries 200/250.

250-0-350 75 mA. 6.3 v. 3 a. tap 4 v 6.3 v. 1 a., 13/6.

350-0-350 70 mA. 4 v. 4 a., 4 v. 2.5 a. C.T. 18/6.

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. 5 a. 4 v. C.T. 5 a. 4 v. C.T. 4 a., 39/6.

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/-; 11-pole 12-way single wafer 5/-. P. & P. 3d.

9in. T.V. Cabinet, front in contrasting walnut veneers, size 16½in. long, 11½in. high, by 12½in. wide. Complete with two pieces expanded aluminium in gold. 12×9in. and 5in. speaker baffle and chassis, 20/-, post paid.

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 spindle less switch, 50K, 500K, 1 meg., 2/6 each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each; 10K and 50K, 3/6 each. ¼ 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, 7/3.

Twin-gang .0005, with feet, size 3½ × 3 × 1½in., 6/6.

3-gang .0005, with feet, size 4½ × 3 × 1½in., 7/6.

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only All-can 1½ × 1½in., 1/- each, 2 iron-core All-can 2½ × 1½in., 1/6 each.

Used Metal Rectifier, 250 v. 160 mA. 6/6.

Metal Rectifier. 230 v. 45 mA.. 6/-.

Metal Rectifier. RM2, 125 v., 100 mA 3/6.

D. COHEN

RADIO AND TELEVISION COMPONENTS

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.

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Saturday 9—5 p.m. Wednesday 9—1 p.m. Other days 9—4.30 p.m.

COMPLETELY BUILT SIGNAL GENERATOR

Coverage 120 Kc/s-75 Mc/s., black crackle finished case and white panel. £4/19/6 or 34/- deposit and 3 pymts. of 25/-. Post & Pkg. 4/- extra.

PATTERN GENERATOR

40-70 Mc/s., black crackle finished case, white panel. Will align any T.V. receiver, £3/19/6 or 29/- deposit and 3 pymts. of £1. Post & Pkg. 4/- extra.

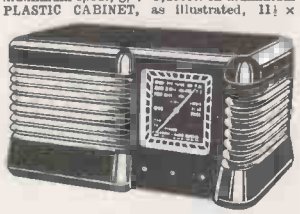
T.V. CONVERTER for the new commercial stations complete with 2 valves. Frequency:—can be set to any channel within the 186-196 Mc/s. band. I.F.:—will work into any existing T.V. receiver designed to work between 42-68 Mc/s. Sensitivity:—10 Mu/v with any normal T.V. set. Input:—arranged for 300 ohm feeder. 80 ohm feeder can be used with slight reduction in R.F. gain. Circuit EF80 as local oscillator. ECC81 as R.F. amplifier and mixer The gain of the first stage, grounded grid R.F. AMPLIFIER 10 db. Required power supply of 200 v. D.C. at 25 mA. 6.3 v. A.C. at 0.6 amp. Input filter ensuring complete freedom from unwanted signals. 2 simple adjustments only. £2/10/-. P. & P. 2/6

USED 12in. TUBE, aluminized, heater cathode-short. 10KV max. 2 v. heater complete with line and E.H.T. transformer 9KV with ferrocart core, line and width control, EY51 rec. winding. frame O.P., scan coils and 12in. Perspex escutcheon. £6/17/6. P. & P. 7/6. As above but with 12in. non-aluminized tube 8KV max. £5/17/6. P. & P. 7/6.

GENERAL PURPOSE 3-IN-1 MAINS TRANSFORMER. Input 200/250. Sec. 250 v., 350 mA., 6.3 v. 4 amp. twice, 2 v. 2 amp. 500 v., 350 mA., 6.3 v. 4 amp. twice, 2 v. 2 amp. Auto-transformer, 110/250 v., 250 watt, 19/6. P. & P. 3/6.

HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer. 600ft. on aluminium spool, 8/-. 1,200ft. on aluminium spool, 17/6 post paid.

PLASTIC CABINET, as illustrated, 11½ × 6½ × 6½in., in Walnut. Cream and Green 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.

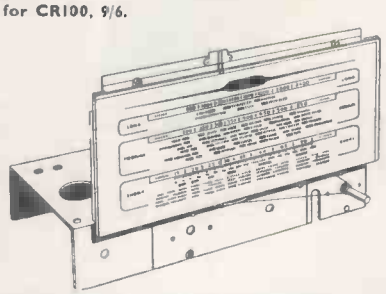
AS ABOVE, complete with new 5in. speaker to fit and O.P. trans., 37/6. P. & P. 3/6. With superhet chassis, 38/6. P. & P. 3/6. Used metal rectifier, 230 v. 50 mA., 3/6, gang with trimmers, 6/6; M. & L. T.R.F. coils, 5/-; 3 obsolete ex-Govt. valve 3 v/h and circuit, 4/6; heater trans., 6/-; volume control with switch, 3/6; wave-change switch, 2/-; 32×32 mfd.,4/-; bias condenser, 1/-; resistor kit, 2/-; condenser kit, 4/-.

Cyldon 5 channel T.V. Tuner uses EF80 and 12AT7, less valves, 12/6 post paid.

Radiogram Chassis 5 valve A.C./D.C. 3-waveband 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/-.

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 B.F.O., new condition, 7/6 each
465 Kc Xtal for CR100, 12/6.
4-gang tuning condenser for CR100, 9/6.

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 waveband 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.



CONSTRUCTOR'S PARCEL, medium and long wave A.C. mains 230/250, 2-valve plus metal rectifier, comprising chassis 10½ × 4½ × 1½in., 2 waveband scale, tuning condenser, wavechange 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.

Battery charger, input 230/250 v. output 6 and 12 volt 1 amp. Black crackle finished case size 10 x 6 x 4in. Incorporating metal rectifier, mains on-off switch, and output switch, 21/-. P. & P. 3/-.

POTATO AND VEGETABLE PEELER

By famous manufacturer. To suit models A200 and A700. Capacity 4½lb., 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/-.

PERSONAL SHOPPERS ONLY. 9in. Enlarger, 17/6: 12in., 27/6.

Germanium Crystal Diode, 1/6. post paid.

Line O.P. Transformer in aluminium can mounted in rubber, 12/6.

Crystal Set, medium and long wave, in plastic cabinet, 16/-.

Headphones, per pair, 8/-.

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. EY51 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. 350 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 with screening can, 1/6 each. B9A with screening can, 1/6.

32 mfd., 350 wkg.	2/-
16×2+, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 400 wkg.	3/6
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/-
32×32 mfd., 350 wkg., and 25 mfd., 25 wkg.	6/6
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., tagends	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
100+200 mfd., 350 wkg.	9/6
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.
32+32 mfd. min. 275 wkg.	4/-
50 mfd., 50 wkg.	1/9

Miniature wire ends moulded, 100 pf., 500 pf., and .001, ea. 7d.

T.V. Filter in lightly tinted Perspex size 13½×11×3/16in., 4/6.

Combined 12in. mask and escutcheon in lightly tinted Perspex. New aspect, edged in brown. Fits on front of cabinet, 12/6. As above for 15in. 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.

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment. 15/-.

P.M. Focus Unit for Mazda, 12in., with Vernier adjustment, 17/6.

Wide Angle P.M. Focus Units, Vernier adj., state tube. 25/-.

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.

Mains Droppers. 0.3 amp., 460 ohms, tapped 280 and 410, 1/6; 0.2 amps 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.

MIDGET RADIO CABINETS

This well-known cabinet of which thousands have been sold is ideal for every constructor. Complete with chassis, dial, backplate, cord drive, pointer and dial drum.
Price 27/6 each.

CHOKES

20H, 250Ω, 60 mA. Clamp construction ..... 6/- ea.
10H, 200Ω, 90 mA. Clamp Construction ..... 9/3 ea.
5H, 250 mA., 200Ω. Fully shrouded ..... 18/3 ea.

TRANSFORMERS FOR BATTERY CHARGERS

230 v. Input Tapped 6-12 v. 1 amp. ..... 13/6 ea.
230 v. Input Tapped 6-12 v. 3 amp. ..... 18/- ea.
(Both with tap on Primary for 2.5 v. Pilot light)

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 8½in. × 8½in. × 4½in. at base. Price 15/6 each.
8in. type:
Measures 10½in. × 10½in × 6in. at base. Price 19/6 each.

CARRYING CASE

Suitable for use as a projector or recording case, size 15in. × 9½in. × 13in. Internal dimensions: 14in. long, 11½in. deep, 5½in. front H.T. 8½in. rear H.T. With a black rexine finish. Weight 8½lb. ... 13/6 ea.
Post and packing 2/6.

DOUBLE TRIMMERS. 250/250 PF; 100/100; 100/50; all 6d. each.

YAXLEY SWITCHES. 3 pole 3 way, 1 bank, 1/6 each; 3 pole 3 way 3 bank, 1/6 each.

OCTAL PLUG AND SOCKET (screened), 1/- each.

PRE-SET CONTROLS (carbon). 50K Ω ½ meg Ω; 1 meg Ω; 2 meg Ω; 1/9 each.

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.

FULL WAVE TYPES

12 v. 1 amp. 4/9 ea.; 12 v. 2 amp., 8/- ea.; 12 v. 3 amp. 13/- ea.; 12 v. 5 amp. 18/- ea.

WE INVITE YOU TO BUILD THIS PORTABLE FOR ONLY 6½gns.

Full details, circuit diagram, point to point wiring instructions, and complete list of components. Available 2/- ea. Case can be supplied separately. Available in the following attractive colours: ● Lizard Grey; ● Blue; ● Maroon; ● Brown. Dial, 1/3 each. Chassis, 3/-.

ALPHA SPECIAL PURPOSE VALVES

2X2	5/-	807	7/6	956	3/6	VR65	3/9
1A5GT ...	6/6	9001	5/6	CV173.....	10/-	VR65A ...	3 6
1LD5 ...	6/9	9002	5/6	CV286 ...	7/6	VR66	3/9
5Z3	8/6	9003	5/6	E1148	2/-	VR91	6/-
6B4	6/-	9004	5/6	VR53	6/6	VR91(SYL)	8/-
6G6G	6/6	9006	6/-	VR54	2/-	VR92	2/-
6ST7	7/6	954	2/-	VR55	7/6	VR105/30	9/-
VR119 ...	4/-	VR136 ...	7/-	VR56	6/-	VR116 ...	4/-
VT52	8/-	TT11	6/-	VR137 ...	6/3	VR150/30	9/-
VU111.....	3/6	VU120A ...	3/-	VU39	8/6	VU64 ...	8/6
77	8/-	955	4/9	VR40	8/-	Full List Available.	

ION TRAPS

Type IT6 for Tubes with 35 mm. neck diameter ..... 2/6 ea.

HEADPHONES—MICROPHONES, Etc.

EX-GOVERNMENT HEADPHONES BY S. G. BROWN, etc.

CLR Low resistance type 120 ohms ..... 7/6 pr.
CHR High resistance type 4,000 ohms ... 11/- pr.
DHR a super phone ..... 13/6 pr.
American phones by Trimm Mfg. Co. of Chicago, U.S.A., 1,200 ohms, each earpiece ..... 13/9 pr.
Headbands, wide type ..... 1/9 ea.
Throat microphones, American surplus. Complete with strap, lead and plug type T30B ..... 4/- set
"Regent" Hand Microphone. Crystal insert, nickel chrome plated head, complete with lead and jack plug, listed at 2 Gns. Our price ..... 21/- ea.
Throat Microphones, type Za.21095. 2 units per box ..... 1/8 per box

HEATER TRANSFORMERS

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/-

OUTPUT TRANSFORMERS

Multi Ratio suitable for all ordinary receivers giving six single ratios ..... 6/6 ea.

CONTROL KNOBS in MODERN STYLING

Tastefully and clearly engraved in gold.
Size A. Diameter 1⅛in. Depth ⅝in.
Size B. Diameter 1½in. Depth ⅝in.
These Mouldings are available in two colours: Walnut and Ivory.
They are suitable for use with ¼in. spindles and are simply and firmly held by means of a grub screw and locking nut.
Prices:
Type "A"—1/6 each.
Type "B"—1/2 each.
Plain Knobs can be supplied in either size or colour: Price 1/- each and 8d each respectively.
Inscriptions available:—
RADIO: "Volume," "VI/On-Off," "Wavechange," "Tuning," "S.M.L. Gram.," "Radio-Gram.," "Tone" "On-Off." TELEVISION: "Contrast," "Brilliance," "Brilliance/On-Off," "Focus," "Brightness." AMPLIFIER: "Treble," "Bass," (plus any of those shown above).
TAPE RECORDER: "Record-Play."

THE COMPACT TELEVISION AERIAL BY ANTIFERENCE LTD.
Supplied complete with universal mounting and backplate in neutral brown finish. Overall length 5ft. 6in. Packed in carton 3ft. 4in. long. Complete with full instructions. Cat. No. CD4. Original price 50/-. Our price 12/6
Post etc. 2/6.

TINNED COPPER WIRE—All 4 oz. Reels.

16 S.W.G. 2/-
18 S.W.G. 2/2
20 S.W.G. 2/4
22 S.W.G. 2/6
24 S.W.G. 2/8
26 S.W.G. 2/10

ENAMELLED COPPER WIRE—All 4 oz. Reels.

S.W.G.	Price	S.W.G.	Price
16	1/11	30.....	3/1
18	2/1	32.....	3/3
20	2/3	34.....	3/5
22	2/5	36.....	3/7
24	2/7	38.....	3/11
26	2/9	40.....	4/2
28	2/11		

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.

SET OF VALVES. Ten VR91 (EF50) valves. Ex-Brand new units, 6/- each, 45/- set.

★ **SPECIAL OFFER. CO-AXIAL CABLE.** Best quality Grade "A" Cable: Solid 1/022 70 ohms, 7½d. yd. Stranded 7/0076, 8½d. yd. Air spaced 1/036, 1/- yd.

GOLDRING PICK-UP HEADS. Pick-up head type No. 112 (2,000 ohms), complete with lead. Price 17/6 each.

LOUDSPEAKER UNITS

PLESSEY 3in. Round type for personal portables 2 to 3 ohm 12/9
GOODMAN'S 6½in. Round type 15/11
LECTRONA 6½in., With transformer 18/-
TRUVOX 6½in. Wafer type, 1½in. deep, 2 to 3 ohm ... 20/-
R. & A. 8in. Lightweight, 2 to 3 ohm 16/11
PLESSEY 8in., PM 2 to 3 ohms 16/6
THE LATEST ELAC 4in. × 7in. ELLIPTICAL UNIT 19/10 each.
ELAC 10in. Units 2 to 3 ohms 22/6
PLESSEY 10in. Lightweight .. 19/6
ROLA 5in., with transformer 16/-
ROLA 6½in. P.M. unit..... 17/6

HUNTS CONDENSERS. Type W99, 200PF 350 v.; Type W99 .005 mfd. 150 v., 7d. each. Type W48, .1 mfd., 400 v., 1/- each. Type L44 .1 mfd. 500 v., 9d. each.
RESISTORS, 2 WATT. 2.2 kΩ; 470Ω; 7.5kΩ; 22Ω; 150Ω;5.6 kΩ; 390Ω; 150kΩ; ½ meg Ω; 39Ω; 1.5 meg; 56kΩ; all 4d. each.

PENCIL RECTIFIERS

K3/25, 5/8; K3/40, 7/6; K3/45, 8/3; K3/50, 8/8; K3/60, 9/8; K3/100. 14/8.

AMPLIFIER

THE "EKE" QUALITY 3 WATT AMPLIFIER

COMPARE THIS PRICE!

This is not a kit of parts but a well-built unit—read this specification.
★ 3 valves—6B8G, 6X5GT, 6V6GT.
★ Components 100%, only recently manufactured condensers used.
★ Strong chassis, sockets for all input and output leads.
★ Output 3Ω secondary.
★ Tone and volume controls.
★ Input for crystal or Hi-Fi magnetic pickups.
★ A.C. mains fully isolated.
★ Negative feedback.
Price 79/6 Packing & Post 2/6.

CONDENSERS

BR Range
BR.350 8 mfd. 500 v. ....ea. 2/9
BR.1650 16 mfd. .....ea. 3/3
BR.2050 20 mfd. 500 v. ....ea. 3/6
8 × 8 mfd. 500 v. .....ea. 4/-
BR.501 50 mfd. 12 v. .....ea. 1/9

Midget Metal Types
2 mfd. 350 v. 1/9
8 mfd. 350 v. 1/1
8 × 8 mfd. 350 v. 3/-
8 × 8 mfd. 450 v. 4/-
16 mfd. 350 v. 2/9
16 × 8 mfd. 450 v. 4/-
16 × 16 mfd. 450 v. 4/6
16 × 24 mfd. 350 v. 4/9
24 mfd. 350 v. 2/9
32 mfd. 350 v. 1/9
32 × 32 mfd. 350 v. 4/9
250 mfd. 12 v. 1/9

Wire ended Types
8 mfd. 450 v. Cardboard covered 1/11
30 mfd. 450 v. 3/9

Bias Condensers
Tag ended metal types
12 mfd. 50 v. 1/-
25 mfd. 25 v. 1/3
50 mfd. 12 v. 1/-
50 mfd. 50 v. 2/6
100 mfd. 12 v. 1/9
100 mfd. 25 v. 1/9

Wire ended Types. Cardboard covered
25 mfd. 25 v. 1/9
50 mfd. 12 v. 1/9
50 mfd. 50 v. 2/3

TECHNICAL PUBLICATIONS AND MANUALS

Radio Aerial Handbook .... ea. 2/6
Radio Hints Manual ..... ea. 2/6
Amateur Transmitter's Construction Manual ..... ea. 2/6
Radio Calculations Manual .. ea. 3/6
Sound Equipment Manual .. ea. 2/6
Radio Designs Manual ..... ea. 2/6
Communications Receivers' Manual ..... ea. 2/6
Frequency Modulation Receivers' Manual ..... ea. 2/6

ONLY A FEW AVAILABLE

VCR 97 Cathode Ray Tubes ea. 29/6
Postage and packing 1/6.
Block Condenser 10 mfd. 450 v. ..... ea. 4/-
High Voltage Condenser, .1 mfd. 4 kV. Ceramic insulated terminals .... ea. 4/-

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

ALPHA RADIO SUPPLY CO.

5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

ALUMINIUM CHASSIS.—18 swg. Plain, undrilled, folded 4 sides and riveted corners lattice fixing holes. Strong and soundly constructed with 2½in. sides. 7in. x 4in., 4/6; 11in. x 7in., 6/9; 13in. x 9in., 8/6; 14 in x 11in., 10/6; and 18in. x 16in. x 3in., 16/6.

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	1/2
SOCKETS	1/-
LINE CONNECTOR	1/2
OUTLET BOXES	4/6

80 ohm CABLE COAXIAL

STANDARD ¼in. diam. Polythene insulated. GRADE "A" ONLY

8d. yd.

SPECIAL.—Semi-air spaced polythene, 80 ohm Coaxial ¼in. diam. Stranded core. Losses cut 50% (just released), 9d. yd.

BALANCED TWIN FEEDER per yd. 6d. } 80
TWIN SCREENED COAXIAL FEEDER per yd. 1/- } ohms

50 OHM COAXIAL CABLE, 8d. per yd.

TRIMMERS, Ceramic, 30, 70 pf., 9d.; 100 pf. 150 pf., 1/3; 250 pf., 1/6; 600 pf., 1/9.

RESISTORS.—All values: ½ w., 4d.; ¼ w., 6d.; 1 w., 8d.; 2 w., 1/-; ½ w., 1½, 2/-.

WIRE-WOUND RESISTORS.—Best Makes Miniature Ceramic Type—5 w., 15 ohms to 4 K., 1/9; 10 w., 20 ohms to 6 K., 2/3; 15 w., 30 ohms to 10 K., 2/9; 5 w. Vitreous, 12 K. to 25 K., 3/-.

WIRE-WOUND POTS, 3 WATT, FAMOUS MAKES Pre-Set Min. TV. Type. Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-. Standard Size Pots, 2½in. Spindle. High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K., 6/6. W/W **EXT. SPEAKER CONTROL** 10Ω, 3/-.

O/P TRANSFORMERS.—Heavy duty 70 ma. 4/6. Ditto tapped primary, 4/9. Tapped small pentode, 3/9.

L.F. CHOKES 10 h. 65 ma., 5/-. 20 h., 150 ma., 12/6, 15 h. 100 ma., 10/6. **SIMPLEX** 10 h. 150 ma. 10/6.

MAINS TRANS.—Made in our own workshops to high grade specification. Fully interleaved and impregnated. Heater Trans. tapped prim. 0200 v./250 v. 0.3 v. 1½ amp. 7/6. 12 v. .75 amp. 7/6. 6.3 v. 3 a. 10/6. 350-0-350, 80 ma., 6.3 v. 4 a., 5 v. 2 a., ditto 300-0-300 ditto 250-0-250, 21/-. Simplex (modified with 4 v. tap), 35/-.

TV. AERIALS. Aerialite all channels in stock. Indoor loft type Inv. T., 13/6.

TYANA.—Midget Soldering Iron. 200/220 v. or 230/250 v., 14/11. Triple Three mod. with detachable bench stand, 19/6. Solon Midget Iron, 19/6.

TAG STRIPS.— 2- or 3-way, 2d.; 4- 5-way, 3d.; 6-way, 4d.; 9- or 10-way, 6d.; 28-way, 1/3.

ENAMEL WIRE.—¼ lb. 14 to 20 s.w.g., 2/-; 22 to 28 s.w.g., 2/6; 30 to 40 s.w.g., 3/9.

XTAL DIODE.—Sensitive G.E.C., 3/6; H.R. Phones (S. G. Brown) or Hi-grade Amer., 15/6 pair.

TAPE RECORDING BARGAIN

LIGHTWEIGHT XTAL HAND MIKES. Chrome finish —quality and sensitivity for only 25/-.

ELECTRODYNAMIC MIKE INSERT.—U.S.A. make, precision engineered. Size only 1in. diam. by ½in. Bargain Price 3/9. Matching Trans., 3/9.

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," "Radiogram," "S., M., L. Gram.," "Record-Play," "Brightness," Ditto not engraved, 1/- each.

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Brand New Plessey 3-speed Autochanger Mixer Unit for 7, 10 and 12in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire styles, Plays 4,000 records, sprung mounting. Superb Quality. Bargain Price 9½ gns., post free.

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WIRE ENDS

★ B.F. Pent. .625 v. Fil.
● L.F. Pent. 1.25 v. Fil.

Brand New. Ex Deaf Aid Apparatus, by Mullard. Hivac and American. Types:—

★ XFW 10	● XFY11	
★ XFW 20	● XFY32	all at
★ 505 AX	● DL66	7/6 each
★ DF66	● DL72	post free
★ DF70	● 503AX	
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VCR97 £2

TESTED FULL PICTURE

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TV. PRE-AMP.—Channel 1, easily modified to other channels or converter use. Midget chassis 6in. x 3in. x 1½in. Complete with coax. lead, plug and EF42 valve. Brand new (boxed). Listed £3/15/-. Special clearance, 27/6, p/p. 1/6.

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THO 1665. Buses 133 or 68 pass door.

307 WHITEHORSE RD., WEST CROYDON

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ALL MAINS TRANS.—1/- extra postage.

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465 Kc/s Slug tuning Miniature Circular Can, 2¼in. by 1¼in. diam. Fits octal V-holder cut out. High Q and good bandwidth. By Pye Radio. Two mounting feet. BRAND NEW, 6/9 pair.

C.R.T. HEATER ISOLATION TRANS. Ratio 1 : 1.25 Low leakage winding with 25% sec. boost, 2 v. 10/6; 4 v. 10/6; 6.3 v., 10/6; 12 v., 10/6.

BRIMISTORS.—CZ1 .3 a., 3/6. CZ2 .15 a., 2/6.

CONDENSERS.—New stock. .001 mfd. 6 Kv. T.C.C., 5/6. Ditto, 12.5 kV., 9/6; 2 pf. to 500 pf. Micas, 6d.; .001 Tub. 500 v. .01 Sprague 500 v., .02 N.S.F. 500 v. .1 mfd. 350 v. Micamould Tub., 9d.; Hunts Moldseal 500 v. .005, .01, 9d.; .05 mfd. and .1 mfd., 1/-; .25 mfd., 1/6. .5 mfd., 350 v. 1/9; .1 mfd., 1,500 v. T.C.C., 3/6.

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 1,000 pf., 2/-.

ELECTROLYTICS ALL TYPES NEW STOCK.

Tubular Wire Ends		Can Type Clips, 3d. ea.	
2/450 v.	2/3	8+8/500 v.	4/6
4/500 v.	2/-	16/450 v.	3/6
8/450 v.	2/3	60/350 v.	6/6
8/450 v.	2/9	250/350 v.	8/6
8/500 v.	2/9	8+16/450 v.	5/-
16/500 v.	4/-	8+16/500 v.	5/6
8+8/500 v.	4/6	16+16/450 v.	5/6
16+16/500 v.	6/-	16+16/500 v.	6/-
32/500 v.	5/-	32+32/275 v.	4/6
32+32/350 v	5/6	32+32/450 v.	6/6
25/25 v.	1/9	32/350 v.	4/-
50/12 v.	1/9	60+100/350 v.	11/6
50/50 v.	2/-	100+200/275 v.	12/6

SPECIALS.—500 mfd. 12 v., 3/-, 1500 mfd. 6 v., 4/6. 6000 mfd. 6 v., 5/6, 1000 + 1000 mfd. 6 v., 6/6.

SENTERCEL RECTIFIERS.—EHT Type. Fly-back Voltage. —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/-.

LOUDSPEAKERS P.M., 3 OHM.—3in. Plessey, 12/6; Goodmans, 4in. square, 15/6; 5in., 14/6; 6½in., 16/-; 8in. R. & A., 17/6; 7in. Eliptical, 18/6; 10in. R. & A., 25/-; 6½in. with transf., 19/6.

SLEEVING.—Various colours, 1, 2 mm., 2d.; 3, 4 mm., 3d. yd.; 6 mm., 5d. yd. **TOGGLE SWITCHES EX-GOVT.** "On-Off," 9d Ersin M'core solder, 60/40, 16 g. or 18 g., 4d. yd., 5/6 ½ lb.; PVC Connecting wire, 10 colours, single or stranded 2d. yd.

V'HOLDERS —Pax: IO, 4d.; EF50, EA50, 6d; **B12A CRT, 1/3.** Moulded: **IO,** 6d.; **B7G,** 9d.; with screening can, 1/6; B8A, B8G, B9A, 1/-; Ceramic: EF50, B7G, 1/- All English, 5, 7, 9 pin and U.S.A. UX types, 1/-. VCR97 moulded holders, 2/6.

ALADDIN FORMERS and core, ½in., 8d.; ¾in. 10d. **INT. OCTAL CABLE PLUG** (8-pin), with cover, 1/3.

Prices slashed at Clydesdale

PLEASE NOTE. Carriage and Postal charges refer to the U.K. only. Overseas freight, etc., extra.

SUPPLY UNIT RECTIFIER FOR No. 43 TRANSMITTER. Ex-Canadian Army, in original wood case. Input 110 v. A.C. 50/60 c/s. 1.7 KVA. Output (HT1) 2,100 v. 375 mA. (HT2) 500 v. 400 mA. plus H.T. lines 450 v., 265 v. also 383 v. regulated and neg. bias 250 v., 150 v., 80 v. Making three complete power supplies all fed via double choke condenser, input circuits. Valves are 4/866A/866, 5Z3, 6S17, 2/6A3, VR150/30 (Stab.) and IV (Time delay). The complete unit mounted in metal case with lid shock mounted. Dim.: 2ft. 6in. x 1ft. 6in. x 1ft. Finish olive drab. Weight 420lb.

ASK FOR X/H26. **£15** CARRIAGE 15/- EXTRA

BC-456 SPEECH MODULATOR UNITS. Part of SCR-274-N. "Command Equipment." (U.S.A. made.) Complete with valves 1625, 1215 and VR150/30 transformers, relays, etc., less dynamotor. Overall dim.: 10¼in. x 7¼in. x 4¼in. Loose stored, etc.

ASK FOR X/E42. **17/6** each CARRIAGE PAID

Also available, BC-456, as above in original carton.

ASK FOR X/E42A. **27/6** each Circuit 1/3. CARRIAGE PAID

EX-U.S.N. TEST OSCILLATORS TS-24/ARR2. Low/High frequency, battery powered for TBX allgnment, H.F. signal 245 mcs. I.F. signal tunable 540 to 830 kc/s. with valves 2/955 acorn triodes and clockwork time switch with calibrated dial 0/30 minutes. Unit dim.: 9¾in. x 7½in. x 7in. Finish black.

ASK FOR X/H364. **27/6** each CARRIAGE 3/- EXTRA

RECEIVER UNIT TYPE 25. Ref. 10P/IL. Part of TR1196. Range 4.3-6.7 Mcs. with valves, 2/VR53 (EF39), 2/VR56 (EF36), VR55 (EBC33), VR57 (EK32) 2/I.F.T. 460 kc/s., etc., in metal case 6½in. x 6½in. x 6½in.

ASK FOR X/H299. **25/-** each POST AND PACKING 3/6

T1154B TRANSMITTER UNIT. Medium/High powered for C.W.-M.C.W. R/T 3 ranges. 10-5.5 mc/s., 5.5-3 mc/s., 500-200 kc/s. Complete with 4 valves, etc., in metal case 14in. x 16½in. x 8½in. External power supply required.

ASK FOR X/E5A. **39/6** each CARRIAGE 7/6 EXTRA

VISUAL INDICATOR TYPE I. Ref. 100/2. Dual reading left/right D.F. meter for R1155, 2½in. Scale overall dim.: 3½in. x 2½in. In used condition.

ASK FOR X/H862A. **12/6** each POST PAID

JEFFERSON TRAVIS UF-2 TRANSCEIVER CHASSIS. (U.S.A. made.) Less valves and partly stripped by the M.O.S.

ASK FOR X/H518. **17/6** each Circuit at 2/3 CARRIAGE PAID

INDICATOR UNIT TYPE 6. With VCR-97 tube and valves, 4-VR91 (EF50), 3-VR92 (EA50), VR78 (DI), etc. With VCR-97 VR54 (EB34). Dim.: 18in. x 8½in. x 7½in. Weight 21lb. In original wood case.

ASK FOR D/H524. **45/-** each CARRIAGE 5/- EXTRA

ELECTRONIC IGNITION TESTER. Type V.E.D. Patt. 563562 by English Electric, in original wood case. A Cathode Ray tester for checking ignition of internal combustion engine while engine is operating, will operate from 6, 12, or 24 volts D.C. or 230 volts A.C. Built into black crackle case with hinged front and carrying handle. Dim.: 15½in. x 8½in. x 11½in. No leads or instruction book available.

ASK FOR X/H535. **£15** each CARRIAGE 10/- EXTRA

SUPPRESSOR UNIT 5C/870. Contains 4 H.F. chokes and 4 tubular condensers 0.1 mfd. 250 v. D.C., carrying 5 amps. (2 sets on each lead), each choke and condenser separately screened in compartments of aluminium alloy box 4½in. x 4in. x 2in. 4-hole fixing.

ASK FOR X/H907. **2/6** each POST 1/- EXTRA

INDICATOR UNIT TYPE 6H. With VCR-97 tube and valves, 4-VR91 (EF50), 3-VR54 (EB34). Dim.: 18in. x 8½in. x 7½in. Weight 22lb. In original wood case.

ASK FOR X/E777. **59/6** each CARRIAGE 5/- EXTRA

R.F. UNIT TYPE 24. In original carton. With valves 3-VR65 (SP61), etc. Range 20-30 mc/s., switched tuning. Dim.: 9½in. x 7½in. x 4½in. Weight 7lb.

ASK FOR X/H850. **10/-** each POST 1/6 EXTRA

R.F. UNIT TYPE 25. In original carton. Range 40-50 mc/s., otherwise as R.F. 24.

ASK FOR X/H847. **12/6** each POST 1/6 EXTRA

R.F. UNIT TYPE 27. With broken dial. Range 65-85 mc/s. Valves 2-VR135 (EF54), VR137 (EC52), etc. Variable tuning. Dim. and weight as R.F. 24.

ASK FOR X/E771. **29/6** each POST 1/6 EXTRA

BRASS GLANDS. ¼in. diam. In three lengths, 1.3/16th, 1in., 1¼in. Bore ¼in. Price 1/3 each. Post paid.

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PLATE TRANSFORMERS FOR BC.610.E TRANSMITTER. Genuine brand new spares for this famous American Transmitter. Primary 115 volts, Secondaries 2,000 volts and 2,500 volts, C.T. IN MAKER'S ORIGINAL CASES. ONLY £7/10/- (carriage extra).

RF UNITS TYPE 26 and 27. For use with the R.1355 or any receiver with a 6.3 v. supply. These are the variable tuning units which use 2 va'ves EF54 and 1 of EC52. Type 26 covers 65-50 Mc/s (5-6 metres) and Type 27 covers 85-65 Mc/s (3.5-5.0 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY 35/- each.

" PYE " 45 MC/S I.F. STRIP. Ready made for London Vision Channel, this 5-stage strip contains 6 valves EF50 and 1 EA 50. Supplied with circuit and details of very slight mods required. BRAND NEW, ONLY 70/- or less valves 50/-.

I.F. STRIP 194. An easily modified strip recommended for T.V. constructors who want good results at moderate cost, or for those who have built televisors but are having trouble in the sound or vision receivers. Size 18in. x 5in. x 5in., it is complete with 6 valves VR65, 1 of VR92, and 1 of VR56 or VR53. Mod. data supplied. ONLY 45/- (postage, etc., 2/6). Less valves, 19/6 (post, etc., 2/6).

TELESCOPIC AERIAL. Pulls out of metal tube 15in. long to extend to 73in. BRAND NEW. ONLY 7/6 (postage 10d.).

AMPLIFIER 208. Ideal for conversion into a high gain TV pre-amp. Complete with 2 valves EF50. ONLY 15/- (postage, etc., 1/6).

INDICATOR TYPE 95. Built on a two-deck chassis, this contains VCR97 tube with mu-metal screen, 16 valves SP61, 4 of EA50, and 2 of EB34 and also shoals of components. ONLY 59/6 (carriage, etc., 7/6)

INDICATOR UNITS, TYPE 6. Contain VCR97 Tube with mu-metal screen, 4 valves EF50 and 2 of EB34. NEW CONDITION. ONLY 59/6 (carriage, etc., 7/6).

INDICATOR 233 CHASSIS. Similar to the type 6 Indicator Unit. This contains VCR97 CRT holder, 11 valve holders, resistors and condensers, etc. In excellent condition. ONLY 10/- (carriage, etc., 5/-).

AMERICAN 12v DYNAMOTORS. Output 255 v. 60 mA. Ideal for car radio or running electric shaver from car battery. ONLY 22/6.

24 v. BLOWER MOTORS. ONLY 12/6.

6 v. VIBRATOR UNITS. Made by the National Co. of America for use with H.R.O. Communications Receivers, supplying 165 v. at 85 mA. fully smoothed D.C. Complete with vibrator and 6X5 rectifier in black crackle cabinet size 7in. x 7¼in. x 6in., only 29/6 (postage, etc., 2/6).

CRYSTALS. British Standard 2-pin 500 kc/s., 15/-. Miniature 200 kc/s. and 465 kc/s., 10/- each.

COMMUNICATIONS RECEIVER R.1155

The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave 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, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. BRAND NEW AND UNUSED IN MAKER'S TRANSIT CASES, ONLY £11/19/6.
SLIGHTLY USED RECEIVERS, Grade 1, also tested working before despatch, £9/19/6.
A.C. MAINS POWER PACK OUTPUT STAGE, in black metal case, enabling the receiver to be operated immediately, by just plugging in, without any modification. Can be supplied as follows, WITH built-in 6½in. P.M. Speaker, £5/10/-, LESS speaker, £4/10/-.
DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.
Please add carriage cost of 10/6 for receiver and 5/- for Power pack.

POWER UNIT TYPE 3

Made for use with the R.1132.A, this is a standard rack mounting job to match the receiver, and is for 200/250 v. 50-cycle mains with outputs of 250 v. D.C. 100 mA., and 6.3 v. 4 amps. Fitted with H.T. current meter and voltmeter, this is a first-class unit, and can be used for a variety of receivers. Used, but tested working before despatch. ONLY 90/- (carriage, etc., 5/-). Connecting Cable with Jones Plugs for receiver and power unit, 10/-.

CLASS D WAVEMETER

Another small-quantity has become available since our " sell out " a few months ago, and intending purchasers should act quickly. This is a really first-class crystal controlled wavemeter, which has been repeatedly reviewed and recommended in the " R.S.G.B." Bulletin. Covers 1.9-8 Mc/s., and is complete with 100/1,000 kc/s. crystal, 2 valves ARTH2, two 6-volt vibrators, and instruction manual. Designed for 6 v. D.C. operation, but modification data for A.C. supplied. UNUSED, IN MAKER'S TRANSIT CASES. ONLY £7/10/-. Transformer for A.C. modification, 7/6.

AMERICAN LORAN INDICATOR UNIT APN.4. The unit recommended as a basis for the " WIRELESS WORLD " TELEVISION OSCILLOSCOPE, copy of which is supplied, contains 5CP1 CRT and screen. 14 valves 6SN7, 3 of 6SL7, 8 of 6H6, 1 of 6SJ7, 100 kc/s crystal, and hundreds of condensers, resistors, etc., etc. BRAND NEW IN MAKER'S TRANSIT CASES. ONLY £6/19/6 (carr., etc., 15/6).

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F.S.D.		SIZE AND TYPE		PRICE
1 milliamp.	D.C.	2½in. Flush circular		22/6
1	,,	D.C.	2½in. Desk type	25/-
5	,,	D.C.	2in. Flush square	7/6
100	,,	D.C.	2½in. Flush circular	12/6
150	,,	D.C.	2in. Flush square	7/6
500	,,	thermo	2in. Flush square	5/-
500	,,	thermo	2in. Proj. circular	5/-
20 amps.		D.C.	2in. Proj. circular	7/6
40 amps.		D.C.	2in. Proj. circular	7/6
30-0-30 amps.		D.C.	Car type moving iron	5/-
15 volts		A.C.	2½in. Flush, circ., mov. iron	8/6

All meters Brand New in Maker's Cartons.

100 MICROAMPS METERS

2½in. circular flush mounting. Widely calibrated scale of 15 divisions marked " yards " which can be rewritten to suit requirements. These movements are almost unobtainable today and being BRAND NEW IN MAKER'S CARTONS are a snip at ONLY 42/6.

TR1196 TRANSMITTER SECTION In perfect condition, less valves ONLY 7/6 (postage, etc., 2/6).

159 RECEIVER UNIT. Contains 1 each valve, types EF50, EA50, SP61, RL37 and 24 v. selector switch, ONLY 12/6.

VACUUM PUMPS. For Handymen and Model Makers. Ex-R.A.F. Type B3. BRAND NEW IN MAKER'S CARTONS. ONLY 22/6 (post 2/-).

TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded, normal primaries.
425 v.-0-425 v. 250 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., 50/-.
350 v.-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., 42/6.
350 v.-0-350 v. 150 mA., 6.3 v. 5 a., 0-4-5 v. 3 a., 32/6.
250 v.-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., 32/6.
250 v.-0-250 v. 60 mA., 6.3 v. 3 a., 5 v. 2 a., 21/-.
Please add 2/- per transformer postage.

TRANSFORMERS, FILAMENT. 6.3 v. 2 a., 7/6 (postage 1/-).

TRANSFORMERS, EHT. Upright mounting.
EHT for VCR97 Tube 2,500 v. 5 mA. 2 v.-0-2 v. 1.1 a., 2 v.-0-2 v. 2 a., 37/6.
EHT 5,500 v. 5 mA., 2 v. 1 a., 72/6.
EHT 7,000 v. 5 mA., 2 v. 1 a., 82/6.
EHT 7,000 v. 5 mA., 4 v. 1 a., 82/6.
Please add 2/- per transformer postage.

MODULATOR TYPE 67. Contains fully smoothed normal A.C. Mains Power Pack, transformer being 345 v.-0-345 v. at 200 mA., 6.3 v. 5 a., 6.3 v. 250 mA., 5 v. 2 a., 6 valves SP61, 3 of EA50, 2 of EB34, and 1 of 5Z4. BRAND NEW IN MAKER'S CASES. ONLY 67/6 (carriage 7/6).

MU-METAL SCREEN FOR VCR97 TUBE, etc., ONLY 8/6.

CABLE. CLEARANCE OFFER of 23/36 twin polythene. Weatherproof, and suitable for outdoor use, 39/6 per 100 yard coil (carriage, etc., 3/6). S.A.E. for sample, trade enquiries invited.

SPECIAL OFFER. Ex-Admiralty L.T. TRANSFORMER. Normal mains input, output 4 v. 20 amps. C.T. New and unused, these have become damaged, but are still usable, the damage being confined to broken fixing lugs, and/or broken bakelite terminal panels. Formerly sold at 30/-, now offered at 17/6 (post, etc., 2/6).

ROTARY POWER UNIT, Type 87. Ex-R.A.F. Input 24 v. Output 230 v. 65 mA., and 6.3 v. 2 amps. Fully filtered, smoothed, and noise suppressed. Ideal for running radio on boats or other 24 v. D.C. source. BRAND NEW. ONLY 15/- (postage, etc., 2/6).

INTERNATIONAL OCTAL PLUG Fits into I.O valveholder, 2/- (post 3d.).

GANGED POTENTIOMETERS. Double 50K and double 1 meg., 7/6 each.

CERAMIC 2-WAY 3-BANK SWITCHES, 7/6 each.

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E.M.I. OUTPUT METER. Desk type incorporating a 2½in. 1 mA. meter together with instrument rectifier, etc. 2 ranges 0-500 milliwatts and 0-5 watts and decibel scale. Brand new in original manufacturer's boxes with instructions. Price **35/-**, post 1/6.

METER BARGAINS, ALL BRAND NEW

15 v. (50~) mov. iron 2½in. pnl. mtg.	8/6
20 volt moving coil 2in. sq. pnl. mtg. ...	7/6
3,500 volts moving coil 3½in. projection	10/-
150 milli-amp. 2in. sq. pnl. mtg.	7/6
5 milli-amp. moving coil 2in. sq. pnl. mtg.	7/6
20 amp. moving coil 2½in. dia.	7/6
1mA. 2½in. barrel flush pnl. mtg.	22/6
1 milli-amp. 2½in. barrel desk type	25/-
100 micro-amps. barrel pnl. mtg. scaled 0-1,500 in 15 clear divisions. Only	42/6
500 mA. Thermo Couple 2in. sq. pnl. mtg.	5/-

METER RECTIFIERS. 1 mA. Salford Instruments, 8/9. 5 mA. Salford Instruments, 6/9. 2mA., S.T.C. as used in E.M.I. Output Meter, 5/6. All are full wave bridge and brand new.

METAL RECTIFIERS. Heavy duty Selenium 10½in. long with 3½in. square plates. Two are required for a full wave bridge giving 48 volts at 10 amps. Brand new and ridiculously cheap at only 57/6 per pair plus 2/6 post. R.M.4 250 volts 250 mA. Only 12/6. R.M.2, 4/3 each or 2 for 8/-. Selenium 300 volts 100 mA. Brand new, ex-W.D., 6/9 each.

X'TALS

465 kc/s S.T.C. ½in. pins suitable for crystal gates, IF checking, etc. Brand new, boxed, 10/- each.
200 kc/s American G.E.C. ½in. pins suitable for crystal calibrators, etc. Brand new, boxed, 10/- each. 100 kc/s ½in. pin spacing. British, ex new units, 15/- each.

6 VOLT H.R.O. VIBRATOR PACK. Gives 165 volts at 80 mA. smoothed D.C. Uses Mallory Vibrator, 6 × 5, heavy duty smoothing choke, etc. In black crackle cabinet size 7in. × 7in. × 6in. Brand new, only 29/6.

POWER UNIT TYPE 285. A.C. mains input 230 v. 50 cps. Outputs E.H.T. 2 kV. @ 5 mA., H.T. 450 volts @ 200 mA., L.T. 6.3 v. @ 17 amps., fully smoothed, 2 chokes, paper condensers, etc., complete with valves 5U4G, VU 120 and EF 50. This was the ground power unit for the "Gee" equipment and should be very useful for T.V., etc. A REAL BARGAIN AT ONLY 69/6.

RACKS. 6ft. "U" channel P.O. type for 19in. panels, heavy angle base. Price 79/6, plus carriage at cost.

MODULATOR TYPE 67. This unit is a pulse modulator with pulse width of 1, 2 and 5 micro-seconds. The pulse amplitude is also variable. It is a particularly useful instrument as it contains a heavy duty power pack suitable for 230 volt 50 cps. mains supply. The mains transofrmer outputs are 6.3 volts twice, 5 volts for the rectifier and the H.T. winding is 345-0-345 volts. Also included are 5 SP61, one VR116, 2 EB34, and 3 EA50. Size of case 18 × 9 × 7 inches. These units are brand new in original packing cases. Price 67/6 plus 7/6 carriage.

ROTARY POWER UNIT TYPE 104. Input 12 v., Output 230 volt 60 mA. and 6.3 v. at 2.5 amp. Fully filtered and smoothed and noise suppressed. Ideal for car radio, etc. Only 15/- each.

COMMUNICATIONS RECEIVER ADMIRALTY TYPE B.28 (MARCONI CR.100). Valve line up 2 RF, F.C. separate local Osc., 3 I.F.'s, 2nd Det., Output, B.F.O., and rectifier. Self contained power supply 200/250 volts A.C. 5 cps. Variable Selectivity (crystal filter). 6,000, 3,000, 1,200, 300 and 100 cycles. Frequency coverage 60 kc/s to 30 Mc/s in six ranges, continuous except for gap between 420 to 500 kc/s. Size 16in. × 13½in. × 12in. Weight 82lb. The set for the serious operator. Thoroughly overhauled and in good condition, complete with new valves and air tested prior to despatch. A real bargain at only £27/10/- plus £1 carriage.

RECEIVER 25/73 (TR.1196). This is a six-valve superhet receiver with 465 kc/s I.F.s. Complete with all valves—2 EF39, 1 EK32, 2 EF36, 1 EBC33. In good condition with full conversion data. Price 27/6 plus 2/6 carriage.

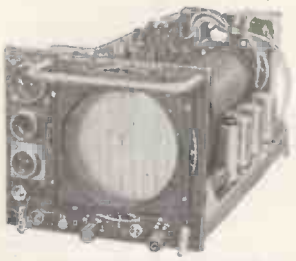
COMMUNICATIONS RECEIVER R.1155

World-wide reception is ensured by the R.F. and 2 I.F. stages. Five wavebands, 2 L.W., M.W. and 2 S.W. Magic-eye, large dial and vernier make tuning simple. Contained in attractive black crackled cabinet, its handsome appearance does justice to its superb performance. Supplied with FREE BOOKLET giving circuit data and details of the power pack required for A.C. mains operation. Fully aerial-tested before despatch. Gladly demonstrated to callers.
BRAND NEW. "MINT" condition, in ORIGINAL MAKER'S TRANSIT CASES, £11/19/6. Shop soiled models, as new, £9/19/6. A few only used models, £7/19/6, 10/6 carriage on each. Send S.A.E. for full details of power packs and receivers, or 1/3 for booklet.
'N' MODELS. Cover Trawler and shipping bands. Excellent condition, £17 19/6, plus 10/6 carriage. D.F. Loops and Visual Indicator Meters available.
A.C. MAINS POWER PACKS AND OUTPUT STAGE. Enable the R.1155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATION WHATEVER. All our power packs have heavy duty transformers, are complete with leads and Jones plugs and are guaranteed for 6 months.
Type A. In smart black metal case, size 8½in. × 4½in. × 6½in., less speaker, price £4/10/- plus 3/6 carriage.
Type B. With built in 5in. speaker in black metal case size 13½in. × 5½in. × 7½in. Price £5/5/- plus 3/6 carriage.
Type C. With an 8in. speaker in specially designed beautiful black crackle cabinet speaker to match receiver, size 11½in. × 10½in. × 6in. A de Luxe job. Price £6/10/- plus 3/6 carriage.
NOTE: 10/- REDUCTION WHEN PURCHASING ANY OF THE ABOVE POWER PACKS WITH RECEIVER.

TRANSFORMER BARGAINS. Brand new ex-manufacturer's surplus drop through. Primary 200/250 volts 50 cps. Secondary 310-0-310 v. 70 mA., 6.3 v. @ 3 a., 4 v. @ 2a. Can be used with either 4 v. or 6.3 v. rectifier. Only 9/6 plus 1/6 post. A similar type transformer 325-0-325 100 mA., 6.3 v. 4 a., etc., can be supplied to callers only at 12/6.
Filament transformers, standard tapped primary, 12 v. 1½ a. and 4 v. 1½ a. secondary. Only 7/6.

U.H.F. SIGNAL GENERATORS BY R.C.A. Two ranges 370 to 445 Mc/s and 445 to 560 Mc/s. Dial is directly calibrated. Output level is monitored by large 200 micro-amp meter. For A.C. mains operation 115 volts 50/60 c/s. BRAND NEW, £35.

3 CENTIMETRE TEST SET. Type 205A. In brand new condition. £17/10/-.



INDICATOR TYPE 182A

Indicator contains 3 EF50, 1 5U4G, 4 SP61 and a 6½in. C.R.T. Type VCR 517, complete with Mu Metal-screen, 9 wire wound pots, with large assortment of resistors and condensers. Can be converted to Oscilloscope (as described in "Radio Constructor.") Circuit supplied. Tubes have no "Cut Off" and can be demonstrated to callers. BRAND NEW (less relays). In original transit case, 67/6 plus 7/6 carriage.

INDICATOR UNIT TYPE 95. Exactly the same as the 62 indicator unit but is 50 cycle version. Double decker chassis, containing loads of components, 16 SP61, 2 EB34, 4 EA50, etc., etc. Brand new condition (less VCR97). Only 45/- plus 7/6 carriage.

45 Mc/s PYE STRIPS. Vision unit for London frequency. Complete with 6 EF50 and EA50. Circuit provided. Brand New. £3/10/- each.

E.H.T. TRANSFORMER. For VCR97, etc. Mains input, output 2,500 volts, 4 volts at 2 amps. and 2-0-2 volts at 2 amps. Fully guaranteed at 35/- plus 1/- post.

VALVE BARGAINS

New and in original boxes. 6AG5, VR53 (EF39), VR56 (EF36), 6K7G, 6C5Met, 6SH7-Met., VT501 (TT11), all at 6/6. RK34, E1148, 954, 2X2, VU120A, all at 2/6. Replacement bargain EL50, 5/-.
New, ex units, 6AK5, VR91 (EF50), Sylvania, VT52 (EL32), 807 7/6. VR65 (SP61), 3/6. VT501 (TT11), 3/6. CV6, VR78. VR92 (EA50), 1/6 each. 15/- dozen.

U.S.A. BLOWER MOTOR for 105 volts A.C. operation. Outlet 2½in. diameter, extremely powerful. Snip for only 22/6 plus 2/- post.

CABLE. Heavy duty twin polythene weatherproof, suitable for extension mains, lead, etc. SPECIAL CLEARANCE OFFER, 39/6 per 100 yd. coil, plus 3/6 carriage. S.A.E. for sample.

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COMMAND RECEIVERS. BC455. Covers 6-9 Mc/s (33-50 Metres), 12SK7, 12K8, 12SK7, 12SK7, 12SR7, 12A6. Brand new. Black crackled, 69/6 plus 2/6 post.

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Readers are warned that Government surplus components and valves which may be offered for sale through our 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, Cross-over 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

OUR new Mullard amplifier-MW/VHF receiver-transistor receiver, can all be heard at—Marlborough Yard, N.19, 8 mins. Archway Station, 25 mins. West End. Ring Arc. 5078. Bel Sound Products Co. [0184

SHIRLEY LABORATORIES, Ltd., 125, Tarring Rd., Worthing, Sussex, announce the superb "Jupiter" amplifier, type SB/1-15E, with pre-amplifier incorporated on same chassis; 15 watts output, response 15 c/s to 60,000 c/s extending to 130,000 c/s; bass lift 18 db, cut 18 db, treble lift 14 db, cut 20 db, hum and distortion almost immeasurable; 230v @ 20 ma, 6.3v @ 2 amps at octal socket; beautifully constructed to instrument standards, B.V.A. valves; price complete with engraved panel, £18/18. Also the "Mullard" 10-watt amplifier with tone-control system, £18/5; and the E.S.2 square-wave generating unit for converting your sine-waves to square-waves, £9.—Write for full details. Tels. 513, 3571. [3579

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

BC348, BC453, 4½in microammeters, other gear, cheap; list free.—Box 0310. [3861

NO. 18 wireless sets 30/-, c.w.o.—Newman, 100, Hampstead Rd., London, N.W.1. [3821

SOUND sales A-Z Junior amplifier, control unit and radio unit, cost £37, as new; take £20.—Box 0572. [3951

R.1355 Sound Receivers as supplied R.A.F., "unused," 27/6, carr. 10/-, England, Wales.—Smith, Highworth Rd., Faringdon, Berks. [3721

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

R.F. units types 26 at 27/6, 25 at 15/-, 24 at 11/-, brand new in original cartons, with valves; postage 2/6.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [3393

WIRELESS WORLD 2 R.F. 3-valve quality tuner, M.W. and L.W., unused, ideal for use with all high fidelity amplifiers; £6/10, including valves, limited number; bargain.—Box 8867. [3748

FOR sale: R.C.A. receivers, type AR88D; National power units, type 697, for H.R.O. receivers; power units, No. P.E.94, for SCR522; complete sets radio compass (SCR269) equipment; wireless sets No. 19 and 68T, P. and R., all in first-class condition.
INDUSTRIAL Suppliers (Cambridge), Ltd., 15a & 17, Brecknock Rd., London, N.7. Gul. 5891. [3826

ACOUSTICAL quad amplifier and pre-amplifier, perfect condition. £25; Dulci A.C./D.C. amplifier and mike (Reis type) £5; H.M.V. amplifier, pre-war model but in perfect condition, high quality, £5.—15, Lemay Ave., S.E.12. Lee 7304. [3812

BENDIX radio compass receivers type MN26M, 3 wavebands, 200 to 410k/cs, 410 to 850k/cs and 3.4 to 7m/cs, valve line-up 2 RF stages, mixer, oscillator, 1.F. (100k/cs), det. output, uses 6.3v valves, built-in power pack for 24v, easily converted to a.c. mains, ideal for double conversion, brand new condition, very limite number only; £6/10 each, plus 10/- packing and carriage.
WALTON'S WIRELESS STORES, 48, Stafford St., Wolverhampton. Tel. 22039. [0147

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND WANTED

WANTED very urgently, Collins 75A-3 receiver and 32V-3 transmitter, exceptional cash price paid for mint equipment, will purchase separately and will collect in U.K.; full details, serial number, etc., with first letter.—G2AMJ, 27, Westella Rd., Kirkella, Hull, Yorkshire. Tel. Kirkella, Hull, 56358. [3883

TV RECEIVERS, AMPLIFIERS—WANTED

SECONDHAND TVs wanted, singly or in bulk.—5, High Rd., Balham, 1509, or 26, Bristol Rd., Brighton, 28440. [3802

NEW LOUDSPEAKERS

GOODMANS loudspeakers, also supplied in polished cabinets, write for list, easy payments.—Stamford (Dept. D.21), 20, College Parade, Salusbury Rd., London, N.W.6. [3660

LOUDSPEAKERS—SURPLUS AND SECONDHAND

WHARFEDALE Super 12 c/s, £11; Wharfedale Super 8 c/s, a/l, £5.—115, London Rd., Chelmsford, Essex. [3862

HARTLEY 215, £5/10.—Wilsher, Lathom, Garratts Lane, Banstead, Surrey. Burgh Heath 3507. [3907

HORNS.—10 new exponential 4ft long, 3ft sq mouth, 7in throat, with 1½in flange, 18 g.M/S, painted; 40/- each.—Box 0441. [3882

TEST EQUIPMENT—SURPLUS AND SECONDHAND

CRO, 2½in dia. tube, with amplifier, spare tube; £10.—Box 0612. [3965

AVO 7, Avo oscillator, Hunt's capacity bridge, several m/coil meters; £25.—Box 0099. [3814

AVOMETER No. 8, latest model, recently purchased new and little used, now redundant; bargain £18.
WRITE Yeovil Sheet Metal Co., Ltd., "Nautilus" Works, Reckleford, Yeovil, Som. [3892

AVO 40, as new, £12; Evershed Wee Megger, 500v, £5/10; d.c. Avo, volts, amps and ohms, £5; Weston meter, model E665, in case, £8.—Box 0568. [3947

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

UNIVERSAL meter Taylor model 90A BS 89 first-grade accuracy, 1000 o.p.v. AC/DC, £8/10 only; also valve tester 45A/S with adaptors measuring mutual conductance of almost all modern valves, £14; both in perfect condition, practically new.—Write: Strauss, 5, Gloucester Ave., Slough, Bucks. [3897

FREQUENCY stabilizing sets by G.E.C., comprising one multivibrator unit, 100kc/s to 1kc/s, one ditto 1k/s to 50c/s, and one 3-phase amplifier unit for 50c/s stabilized output; all three units fitted power pack for 200-250v single phase a.c. mains, mounted in standard rack 56in high, complete with 100kc/s crystal, 27 valves and circuit diagrams, new; £39.
BRIDGE-MEG testing sets by Evershed & Vignoles, 250v self-contained type in alloy case, range 0.01Ω to 50MΩ, leather case, used, accuracy tested, £12/15; ditto, 1,000v, 0.01Ω to 200MΩ, as new, £35.
MICROAMMETERS 2½in M.C., flush, round, centre zero, Sangamo-Weston, 250-0-250 microamps, new, 22/6 p.f.
CAMBRIDGE Unipivot meter, 100 microamps f.s.d., 5in mirror scale, calibrated 0-120, in hardwood case 9in×9in×5in, with Cambridge Vacuo-junction 0-5ma, 20mc/s max., as new; £6/15, carr. paid.
FREQUENCY meters, all 40-60c/s, 4½in dia., flush, 130v, £5; 4½in dia., semi proj., 130v, £4; 6in dia., proj., 230v, £8; 7in dia., proj., 210-455v, £9; all p.f.
ELECTRICAL tachometers, calibrated 40-60c/s, 4½in dia., flush, 12/18v a.c., rect./M.C., complete with separate a.c. tacho-generator, reads 50c/s at T-G speed, 3,000rpm, new; 37/6 p.f.
TONG-TEST ammeters, Crompton-Parkinson 2-range, 0-100 and 0-400amps, leather case; 97/6 p.f.
VARIAC transformers, all 230v input, type 200CUH, 0-270v, 2 amps, £6; type 100L, 0-230v, 8amps, £14; type 50B, 0-270v, 20-31amps, £35.
CONSTANT voltage transformers, input 180-260v, output 230v, 630VA; 1-kva, £12; carr. extra except where stated.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [3945

FOR sale: Marconi signal generator type TF867, £200 (cost £350); Cambridge mutual inductometer, Cat. No. 47241, £65; Cossor D.B. S-cope Model 1035, £45; Avo wide range signal generator, £15; Murphy TV pattern generator, type TPG11, £50; B.S.R. LF oscillator, type LO 80A (with output attenuator), £50; Marconi output power meter, type TF340, £10; Marconi variable attenuator, £10.—Box 0613 [3966

NEW DYNAMOS, MOTORS, ETC.

WARD rotary converters for radio, television, amplifiers, etc.
ALSO, rotary transformers, alternators, D.C. generators, etc.
WARD, 75, South St., Bishop's Stortford, Herts Tel. Bishop's Stortford 1694. [0039

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C., any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0112

NEW DYNAMOS, MOTORS, ETC.

SPECIAL television 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 SECONDHAND

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. [3943
SURPLUS Hoover rotaries, 11.5v/250v 125mA: ZA15147, unused; £4/10 ea.—Box 0591. [3956

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. [3169

FERROGRAPH tape recorders for high grade sound; H.M.V. 2300 Disk Recorder, complete (1 only); Emidiscs and Emitape 88; microphones, speakers, etc.
"EROICA" RECORDING SERVICES. (See "Miscellaneous," page 150.) [0122

TRUVOX Decks.—Amplifier to suit, 8min. Valves, 10w P.P., Latest design, Sep. Power Unit; Treble lift choke; Var. Bias, Mic. and Radio inputs, Mixer control, M. Eye indicator. 30-10Kc/s response; 19gns.
RECORDING Amplifiers with Meter, Treble lift choke, P. Pack, etc., 18gns.; trade supplied; Pre-amp., £3/15.
HARDING ELECTRONICS, 120a, Mora Rd., 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

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 SECONDHAND

VORTEXION tape recorder, as new, with cover, £74.—Box 0569. [3954

GRUNDIG 700L, 2-speed, little used; £60.—28, Ceylon Rd., Blythe Rd., W.14. [3688

A.S.P. wire recorder playing deck, complete, hardly used; offers.—Box 0041. [3798

GRUNDIG 2-speed 700L recorder, as new; £50.—Cryer, 33, Prince's Way, Fleetwood. [3848

C.D.P. disc recorder, 3 sapphires; £10.—32, Woodlands, Raynes Park. Lib. 5096. [3918

LATEST Wearite tape deck, 2B, 3 heads, demonstration in London; 28gns.—Box 0611. [3964

DISC cutter, good condition, 2,000 ohms imp.; £15.—86, Prince Albert Square, Earlswood, Surrey. [3948

FERROGRAPH 2A tape recorder, cover and and accessories, few hours use only; £68.—Box 0570. [3955

"WIRELESS World" 9-valve superhet radiogram and few records, in good order, bargain; £12.—Box 0098. [3813

SALE, Simon tape recorder, Model IA, two-speed, single track, with microphone, two tapes, excellent condition; £35.—Box 0380. [3867

7½/3¾ i.p.s. tape equipment comprising Brad-matic Deck, C.J.R. Amplifier assembly. Includes monitor head and channel, peak programme meter, 2 stage bias oscillator, other professional refinements. For quick sale at £60, or nearest offer.
APIEL SOUND, 57, Lancaster Mews, London W.2. Tel: Paddington 5092. [3866

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

DISC Recorder, Cine Vox C7 J in case with transformer and meter, cost £43 in Aug.; £25.—Castle Studio, Studley, Warks. [3870

GRUNDIG 700L (converted to top track), mic. and foot-switch, clean, perfect order; £48 buyer collects.—Box 0573. [3952

DECCA record-changer, single-speed sapphire stylus, perfect condition, £6; Decca P/U XMS, standard and L/P heads, new and unused, £3/10; symphonic tape recorder, little used, perfect condition, mike and spare tapes, £42; H.M.V. walnut radiogram cabinet, 2-door, £5.—15, Lemay Ave., S.E.12. Lee 7304. [3811

GRAMOPHONE AND SOUND EQUIPMENT—WANTED

WANTED, disk cutting machine, good condition, preferably 3 speed; please state make and year, also technical details and price.—A. J. Oliver, 115, Childeric Rd., London, S.E.14. [3903

NEW COMPONENTS

TRANSFORMERS?

WHY not ask us to give you a quote?
WE manufacture high-quality transformers to suit your requirements at very competitive prices; our delivery is good, and all our work carries a 12 months' guarantee.
WOODROW TRANSFORMERS. Ltd., 7, Dudden Hill Lane, Willesden, N.W.10. Tel. Wil. 1347. [3946

VHF/FM, new combined superhet with good medium wave reception, incorporates large tuning scale, power supply, 5 valves; the end-all of feeder units; lists from Bel Sound Products Co., Marlborough Yard, Archway, N.19. Arch. 5078. [0185

100 new 1ma meters, 2½in flush mounting scaled 0-1ma; makers, Salford, immediate delivery, 35/- each; 300 type 3,000 relays, 10,000ohm resistance coil, S.P.M. and S.P.B., new and boxed, 15/- each.—Douglas Price, Cottage, Claybrooke Grange, Rugby. Leire 287. [3950

COMPONENTS—SURPLUS AND SECONDHAND

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, 1⅛×2, clip, 4/-; 16+16+16, 350v, 1⅛x2, clip, 1⅛×2, 4/9; 16, 350v, ¾×2, lug, 1/9; 40+40, 300v, 1×3, lug, 3/6; 10, 450v, ¾×2, lug, 1/6; 16, 450v, ⅞×2, tag, 2/9; 20, 450v, 1×2, 2/3; 32, 450/525v, 1⅜×2, clip, 3/9; 15+15, 450v+20mf 25v, 1⅛×3, lug, 4/6; 200, 6v, ⅝×1¾, clip, 1/6; 100, 12v, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 50, 12v, ¾×1⅛, tag, 1/6; 150, 25v, ¾×1¾, clip, 2/-; 250, 12v, ¾×1¾, wire 2/3; 16+16, 450v, 1⅛×2, clip, 4/-; 40+40, 275v, 1⅜×2, clip, 3/3; 24+24+16, 350/425v, 1⅜×2, clip, 4/9; 60+200, 275/350v, 1¾×4½, clip, 6/6; 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, 5/-; 8+16, 450×525v, 1×2, clip, 4/-; 2, 450/525v, ¾×1¾, tag, 1/6; 8, 450v, ¾×2, clip, 1/9; 32+32, 450/525v, 1¼in×3in, wire ended, 5/6; 64+120, 275v, 1¾×4½, clip, 5/6; 1,000+1,000, 6v, 1×3in, lug, 3/3; all all cans, some with sleeves, all voltages, WKG, surge where marked, new stock guaranteed.
TELEVISION! Set of 3 components, comprising line output trans. with E.H.T. winding to give 7kV, using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res. 10,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post, diagram of line trans supplied.
UNIVERSAL amplifiers, 8-valve 20watt A.C./D.C., black crackle chassis, and black and chrome cover, overall size 15½in×7½in×7in. First-class components (Partridge O.P.T., and driver, Gardiner choke, A.E.E. Mu-Metal input trans. for mike). Valves, 2×EF37, 4×CL33, 2×UR3C. Switched input for high or low imp., top cut and bass cut switches, V.C., mains switch, mains plug and socket, 220-250v, isolated chassis, 15Ω output. Wired and tested, ready for use, with valves, brand new, £10/19/6, carr. paid.
5mA meters, moving coil, bakelite case, 2in square, flush mounting, new, boxed; 7/- post paid.
MAINS trans., 250-0-250v, 80ma. 6.3v, 2.5A, 6.3v, 0.6A, Pri. 0-210-230-250v 12/- post paid.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

AMATEUR disposing equipment, components, valves; lists available.—Box 0128. [3823

GERMANIUM diodes, 1/- each; quantities cheaper.—B.D.C., 591, Green Lanes, London N.8. [3649

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 148. [0016

VALVES, new and guaranteed surplus; all boxed. CV131, 5/6; CV133, 7/6; CV136, 6/6; CV138, 6/6; CV140, 6/-; CV216, 8/6; CV345, 30/-; CV416, 9/6; CV417, 7/-; CV449, 10/6; CV452, 8/-; CV455, 7/-; CV491, 9/-; CV492, 7/-; CV493, 7/6; CV686, 9/-; CV753, 8/6; CV797, 8/6; CV850, 7/6; CV858, 7/6; CV1758, 6/-; CV2127, 6/6; CV2129, 9/-; CV2179, 10/6; CV2209, 9/6; post 6d each; 500 other types stocked; s.a.e. for full list; 24-hour service, cash with order or C.O.D.—Bentley, Ltd., Radio House, Chalcot Rd., London, N.W.1. Primrose 9090. [3905

COMPONENTS—SURPLUS AND SECONDHAND

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12.
TEL. Ilf. 1260, est. 19 years.
DRYLITIC Cond. chassis fitting can type, 32+8+8mfd 275v, 3/3 ea.; also 32mfd 350v, clip fitting, small, our price, 1/9 ea.
JUST arrived! 16+24mfd 350v, 425 surge clip fitting, can cond., bargain price of 2/9 ea.
ANOTHER popular cond. line, carboard w/end 8mfd 450v, at 1/11 ea.
STEEL chassis, grey finish, ready punched for s/het layout, 14in×6in×3in, 2/6 ea.
2-POLE 2-way w/change switches, 1/- ea., 11/- per doz..
HEATER trans. pri. 0-250v, sec. 6.3v, at 1.5 amp., very popular bargain, 5/9 ea.
VOLT/CANTROLS, small type, long spindle, with single pole switch, 1 meg, ½ meg, or ¼ meg, our price 2/6 ea.
CRYSTAL diodes for crystal sets, 1/6 ea..
DUAL range T.R.F. coils, 200 to 2,000 metres, with cores, 5/6 pr
VERY popular mains trans buy; shrouded upright mounting, with base connections, 290-0-290v, 60 m/a, 6.3v 1.5 amp, and 4v 2 amp, with screen: primary, tapped on vol-panel, 0-200v, 220v, 240v, size H. 3¾in×3⅛in×2¾in D, our price 12/6+1/- pack/post.
TERMS c.w.o. No c.o.d.
SEND 9d extra for postage orders under £5. 2½d. S.a.e. all enquiries and list. [0021

BARGAINS, send s.a.e. for list; CRM121, hcs. 30/-; 3-speed capstan and motor, 50/-; 120w modulator, £7/10; new tapemaster head, £1.—Box 0129. [3824

50,000 metal-glass seals, single way hermetically sealed terminals for soldered connections and fixing, mostly 1kv and 2kv sizes, new; 65/- per 1,000 assorted.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [3944

WANTED, EXCHANGE, ETC.

VHF test equipment.

TS47AP, TS174, TS175/U, TS148 or TSX-4SE; analysers; BC221 freq meters, TS89, and any U.S.A. test gear; Klystrons type 723/AB, 2K33 2K39 2K41; receiver, APR4 and units TN16 17-18-19; RCA AR88D. S27 and SX28s and S27CA; microwave equipment; highest offers given by return.—Ger. 8410. Universal Electronics, 27, Lisle St., Leicester Square, London, W.C.2. [0229

WANTED, receivers A.P.R.4, also T.N.16, 17, 18, 19, etc., and any radio test gear.
LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8 Macaulay 2159. [0176

WANTED, Tuning units, TN17, TN18, TN19, for R54/APR4; £50 each offered.—Box 4963. [0261

G.E.C. miniscopes wanted for cash.—Send details of condition and price to Carr, 49, Brudenell Grove, Leeds, 6. [3705

WANTED, Vibrator Converter, 50v d.c. to 250v ac/dc; suitable for television.—Ritchie, Hopefield, Milnathort, Kinross-shire. [3925

WANTED, HRO coils, Rxs, etc., A.R.88s, BS348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

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. [2703

WANTED, BC610 Halicrafters, ET336 transmitters AR88 Ds and LFs receivers and spare parts for above, also B.C.221 frequency meters; best prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

WANTED, RCA speech amplifiers type MI-11220 J or K and aerial tuning units BC939a.—Offers, stating quality and price, to P.C.A. Radio, Beavor Lane, Hammersmith, W.6 [0080

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [3869

WANTED, signal generators types TF146, TF390G, TF762A, frequency meters BC221, TS174, TS175; also receivers types AR88, etc., APR4 or similar; send price and details to—Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. Tel Ealing 0779/9857. [0037

VALVES WANTED

ALL types of valves required for cash; state quantity and condition.—Radio Facilities, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [3906

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 150. [0224

WALNUT radiogram and television cabinets, soundly constructed; stamp for details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11. [3193

CABINETS made to order; Bass reflex speaker cabinets, all types and finishes. See display advertisement, page 158. Open till 5.30 Saturdays.
A. DAVIES & CO. (Cabinet Makers), 3, Parkhill Place, off Parkhill Rd., Hampstead, N.W.3. Gulliver 5775. [3868

METERS WANTED

WE urgently require meters of all types, meter components test equipment, etc.; any quantity, large or small; prompt cash.
ANDERS ELECTRONICS, Ltd., 91, Hampstead Rd., London, N.W.1. Euston 1639. [3738

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specifications.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0113

LOUDSPEAKERS repaired promptly.—Model Loudspeaker Service, Bullingdon Rd. Oxford. [3690

MAINS transformers, E.H.T.s, chokes, field coils, etc., promptly and efficiently rewound or manufactured to any specification. LADBROKE REWIND SERVICE, LTD., 820a, Harrow Rd., London, N.W.10. [0222

TRANSFORMER rewind service, mains, E.H.T. transformers and chokes, prompt delivery, range of replacement types ex-stock or manufactured to your specification.
METROPOLITAN RADIO SERVICE Co., 75, Kilburn Lane, London, W.10. Ladbroke 2296. [0200

SERVICE sheets for hire or sale over 2,000 models, radio and television; list 1/-; s.a.e. enquiries.—W. Gilbert, 24, Frithville Gardens, London, W.12. Tel. She. 3052. [3315

WAVE winding, specialists rewinds of every description including E.H.T. line outputs, mains armatures etc.—Northern Coil Winding Co., 1, Hollings Mount, Bradford, 8, Yorks. [3478

24-HOUR service, 6 months' guarantee, any transformer; rewind, mains outputs and i.f.s., etc.; all types of new trans., etc., supplied to specification; business heading or service card for trade prices.—Majestic Winding Co., 180, Windham Rd., Bournemouth. [2526

D.C. BOULTON for repairs to any loudspeaker; specialists on heavy and P.A. types; cone assemblies, field coils, repair accessories, pressure units, microphones; transformers rewound and to specification; motor rewinds.—Lumby St., Manchester Rd., Bradford. Tel. 22838. [0171

AS professional sound recordists and members of the Association of Professional Recording Studios we are particularly well qualified to give advice and service on all aspects of sound recording and reproduction. Circuits designed, prototypes built, repairs and modifications carried out quickly and thoroughly
CALLERS by appointment only please.
ARIEL SOUND, 57, Lancaster Mews, London, W.2. Tel. Paddington 5092. [0026

REWINDS, mains transformers, chokes, E.H.T.s, outputs frame and line opt's fields solenoids, R.F., E.H.T. coils, etc.; new types including "C" cores, designed or to specification; your enquiries will receive prompt attention.—Melton Metallurgical Laboratories, Ltd., Transformer Section, 387-9, Ashley Rd., Parkstone, Poole, Dorset. [3781

ARMATURE rewinding service to the trade. vacuums, drills, grinders, hood dryers, dental motors, vacuum cleaner armatures replaced from stock, 24 hours service; every job guaranteed; we also specialise in complete overhauls and rebuilds of vacuum cleaners; all vacuum cleaner parts, hoses, bearings, fans, brushes for any make in stock.—Regam Electric, 95, Park Lane, Leeds, 1. [0028

PAINTS, CELLULOSE, ETC.

PAINT spraying handbook, 3/6 post free, cellulose and synthetic paints and all spraying requisites supplied; catalogues free.—Leonard Brooks, 53, Harold Wood, Romford. [0207

WORK WANTED

ENGINEER-DRAUGHTSMAN wishes to draw: circuit diagrams, scales, details.—Box 0571. [3953

ELECTRONIC equipment made to order; wiring, assembly contractors, prototypes developed.—R.A.E. Mfg. Co., 135a, Kentish Town Rd., N.W.1. Gul. 7011. [0219

A.I.D. approved sub-contractors; capacity for magnetic amplifiers, toroidal coils, precise L.C.R. polythene moulding, polysterene machining.—Bel Sound Products Co., Marlborough Yard, London, Archway, N.19. [0183

SHEARSTONE, PETERS & DUNN, Ltd., offer experienced staff and machine, sheet metal and assembly facilities for batch production of electronic equipment to drawings or specifications; enquiries invited.—89, Arundel St., Sheffield, 1. [3924

CAPACITY AVAILABLE

ELECTRONIC drawing, rapid, efficient and confidential; new office is now available to manufacturers of electronic equipment. "ELECTRONICS DRAWING SERVICE," Rocester, Uttoxeter, Staffs. [3958

VACUUM impregnation capacity available, Hadfields Solventless to RCS214 Specification.—Enquiries to, Avis & Baggs, Ltd., Gosbrook Rd., Caversham, Reading. Tel. 71763. [0094

FINANCIAL & PARTNERSHIP

GRAD. I.E.E., good education seeks manufacturing partnership; small capital available; experience in development of heavy, domestic, and automobile electrical appliances; slight knowledge radio.—Box 0522. [3901

MISCELLANEOUS

HIGH fidelity L.P.s from your own tapes, our experience saves your money. "EROICA" Recording Services (Regd. 1949), 31, Peel St., Eccles, Manchester. ECCLES 1624. Director: Thurlow Smith, A.R.M.C.M. [0121

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

MISCELLANEOUS

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. [3715

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

ALCHO Re Flux @ 4/3 per lb; Alcho Re Cord solder @ 5/8 per lb; Flexotube, flexible lead wire, small rubber grummets, coil tape, impreg. varnish and thinners for air-drying or stoving; plain copper wire, 9 and 10g; many other items all at greatly reduced price, send for list.
YEOVIL SHEET METAL Co., Ltd., "Nautilus" Works, Reckleford, Yeovil, Som. [3891

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 Gardens, London, E.4. [0138

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

PATENTS

THE proprietor of British Patent No. 573313, entitled "Multiple section electronic tube and method of making it," offers same for licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 14E, Jackson Blvd., Chicago 4, Illinois, U.S.A. [3926

AGENCIES

WILLING to act as representative and agents for manufacturers of electrical, radio, television, wide scope in fast developing India?—Write to: Burjor Patel, 1, Cumballa Hill Rd., Bombay, 26, India. [3957

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.

REPRESENTATIVES.

EXPERIENCED sales representatives required in several areas.—Reply direct, giving all details, to General Sales Manager, A.C. Cossor, Ltd., Cossor House, Highbury Grove, London, N.E. Applications will be treated in strict confidence. [3871

ULTRA ELECTRIC, Ltd.,

WESTERN Ave., Acton, London, W.3.
RADIO & television development engineers.
(a) APPLICATIONS are invited from senior development engineers with experience and academic qualifications for important work on new development projects.
THE posts are permanent and pensionable and offer scope for the right men to work in ideal conditions, in modern, well-equipped laboratories.
PLEASE write in strict confidence to the Personnel Manager for an interview appointment.
(b) JUNIOR engineers (aged 21/29) are also required, and applicants for these posts should have some technical training and preferably previous experience. Please write as above. [3572

ULTRA ELECTRIC Ltd.,

WESTERN Ave., Acton, London, W.3.
ELECTRONIC development engineers are required in all grades for work on: (a) subminiaturisation of VHF, radio and audio circuitry; (b) transistor applications; (c) VHF communication; (d) pulse techniques; (e) radar and radio navigation.
APPLICATIONS are invited from.—
(a) SENIOR development engineers with degree or equivalent qualifications, and more than five years' experience in one or more of the above fields.
(b) JUNIOR engineers with degree or HNC with or without experience for work in the above fields.
(c) TEST equipment development engineers with experience of design of test equipment to meet production requirements.
THE posts are permanent and pensionable, and offer scope for the right men to work in ideal conditions, in modern, well-equipped laboratories.
PLEASE write, in strict confidence, to the Personnel Manager for an interview appointment. [3573

RADIO and television engineer (improver) wanted.—Write W. L. & F. M. Jones, Ltd., High St., Cobham, Surrey. [3836

SITUATIONS VACANT

A. V. ROE & Co., Ltd.,
WOODFORD Aerodrome, Cheshire.
HAVE vacancies in their newly formed
WEAPONS Research Division.
AERODYNAMICISTS.
WITH Honours Degree in Physics, Mathematics or Engineering and at least two years experience are required to work on an aerodynamics group on aerodynamic theory and analysis of new weapon projects. Candidates should be familiar with supersonics.
MATHEMATICIANS.
WITH Honours degree to work on flight dynamics and studies of control systems, a knowledge of numerical mathematics would be an advantage.
ELECTRONIC Engineer.
A graduate with research and development experience in electronics or with electro-mechanical devices.
GOOD salaries and prospects.
PENSION and life assurance scheme.
APPLY giving full particulars of academic training and experience to:—
A. V. ROE & Co., Ltd.,
WEAPONS Research Division.
WOODFORD, Cheshire. [3539

ELECTRONICS Engineers.
VACANCIES exist in the expanding electronics division of Saunders-Roe, Ltd. The range of work is unusually wide and interesting, covering design and development of analogue and digital computers, electro-mechanisms, measuring apparatus, strain gauging equipment and techniques, etc. Salaries offered are commensurate with qualifications and experience. Assistance will be given with accommodation.
WRITE stating age, experience, etc., or send P.C. for application form to the
PERSONNEL Department (Ref. WW/17), Saunders-Roe, Ltd., East Cowes, I.o.W. [3929

COMMUNICATION engineers and
DRAUGHTSMEN.
THE expanding programme of the Transmission Department offers vacancies in both senior and junior categories for line transmission laboratory laboratory engineers, and apparatus design engineers, and also for draughtsmen with experience in telecommunications or light current engineering.
SPECIALIST experience in any branch of line transmission engineering is desirable for some of the posts.
POSITIONS offered are on the company staff with contributory pension fund and usual staff conditions.
APPLICANTS should write to Personnel Manager, Automatic Telephone and Electric Co., Ltd., Strowger Works, Edge Lane, Liverpool, 7, giving full details of age, qualifications, and experience. [3788

NORTHAMPTON Polytechnic. E.C.1.
DEPARTMENT of Electrical Engineering.
REQUIRED, a Grade III laboratory technician for development and construction of electrical computing apparatus. The duties initially will be entirely confined to this work and the post will provide valuable experience and training in this important field; day off a week to attend classes leading to H.N.C. or degree in electrical engineering. Salary: age 16, £3/13/6 p.w. to £401 p.a. at approx. age 26, plus supplement for certain qualifications.—Apply with full particulars to Secretary. [3790

VACANCIES in Government Service.
DRAUGHTSMEN required for electrical, electronic and mechanical work.
APPLICANTS with practical workshop experience and holding Ord. Nat. Cert. given preference, but those with design ability and practical workshop experience who are prepared to study for Ord. Nat. Cert. will be considered.
OPPORTUNITIES for permanent and pensionable posts.
APPLY to Personnel Officer, G.C.H.Q. (Foreign Office), 53, Clarence St., Cheltenham. [3815

VACANCIES in Government Service.
SKILLED craftsmen.
VACANCIES exist for skilled craftsmen with experience in the use of electronic equipment, radio equipment and modern communication practice.
OPPORTUNITIES for permanent and pensionable posts.
APPLY in writing, Personnel Officer, G.C.H.Q., 53, Clarence St., Cheltenham. [3809

FERRANTI, Ltd., have vacancies for
JUNIOR and senior design draughtsmen for their London Computer Laboratory.
SUCCESSFUL candidates would be concerned with interesting electro-mechanical design and circuit work, offering scope for using initiative and for advancement in the rapidly expanding field of information handling.
CANDIDATES should be between 25 and 35 years-of-age and possess O.N.C. or H.N.C. or equivalents and should have had workshop training and experience with electronic equipment, instruments, and precision mechanisms.
THE company operates a staff pension scheme.
APPLICATION forms from Mr. T. J. Lunt, staff manager, Ferranti, Ltd., Hollinwood, Lancs. Reference WSE/3. [3911

TESTERS required for television and radio manufacturers; good rates for experienced men; N.W. London area.—Write for full particulars to Box 7628. [0032

TELEVISION engineer required for well-equipped service department; wage £12 per week; only skilled man considered.—Write Box 413, Granthams Advertising, Reading. [3831

SITUATIONS VACANT

TECHNICIANS, Grade I (Radio) required by EAST AFRICAN Posts and Telecommunications Administration on probation for pensionable employment. Salary scale (including present temporary allowance of 35% of salary), £742 rising to £1,134 a year. Outfit allowance £30. Free passages. Liberal leave on full salary. Normal tour 4 years. Candidates should possess a thorough practical knowledge of the working and maintenance of modern HF radio telegraph equipment and VHF multi-channel radio-telephone equipment. G.P.O. staff should apply through departmental channels.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/32424/WF. [3805

MUIRHEAD & Co., Ltd., Beckenham, Kent, DESIGN Draughtsmen.
EXPANDING programme offers vacancies for both senior and junior Design Draughtsmen with experience of light electro-mechanical apparatus.
THE work covers a wide range of developments and the positions offer ample scope for persons with initiative and ability. Salary according to qualifications and experience.
APPLY by letter stating details of age, training and experience, to Personnel Manager. [3794

PHYSICISTS and electrical engineers required by MINISTRY OF SUPPLY, Radar Research Establishment, Malvern, Worcs, for research and development work on radio and electronic equipment, offering ample scope for initiative and originality over a very wide field concerned mainly with electronics. Posts are graded as Scientific Officer, and require first- or second-class Hons. degree or equivalent qualification in Physics or Electrical Engineering. Salary within range, £445–£815. Women somewhat less. F.S.S.U. benefits may be available.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A356/54A. Closing date, January 14, 1955. [3959

ELECTRONICS engineers and physicists required by MINISTRY of Supply, Radar Research Establishment, Malvern, Worcs; Signals Research and Development Establishment, nr. Bournemouth, Hants; Armaments Research and Development Establishment, nr. Sevenoaks, Kent; Royal Aircraft Establishmment, Farnborough, Hants; and outstations, and London H.Q. duties include research, development or design of telecommunications and radar equipment and guidance and control systems, instrumentation for variety of research problems; experience of V.H.F.; pulse techniques; display systems, etc., desirable for some posts; appointments according to qualifications, age and experience, scientific officers (1st or 2nd class honours degree); experimental officers and assistant experimental officers (Higher School Certificate (Science) or equivalent; pass degree, H.N.C. or C. and G.; full Technological Certificate may be an advantage); salary within ranges: S.O. £445-£815; E.O. (minimum age 26), £690-£850; A.E.O., £276 (age 18)—£615; London rates, £14 to £40 higher; women somewhat less; F.S.S.U. benefits may be available for S.O. grade.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D.596/54A. Closing date January 14, 1955. [3923

MUIRHEAD & Co., Ltd., Beckenham, Kent, have vacancies for:
PHYSICIST or electrical engineer (qualified) for development work on data transmission devices, miniature motors and instrument servo-mechanisms, laboratory experience in light electrical engineering desirable.
TECHNICAL assistant for interesting experimental work in laboratory dealing with electro-mechanical devices and electronics, young man having completed his National Service and holding O.N.C. or H.N.C. (Elect.) is desired.
FIRST-CLASS working conditions with modern canteen; pension scheme.
APPLY by letter stating details of age and experience to Personnel Manager. [3893

E.M.I. ENGINEERING DEVELOPMENT, Ltd., have a vacancy for a MATHEMATICIAN or Mathematical Physicist, preferably an Honours degree to study and assess weapon performance. The problems require original thought and a critical approach to the data available. A knowledge of electronics would be useful but not essential.—Applicants should write in confidence, with full details, to Personnel Dept. (ED/205), E.M.I. Eng. Dev., Ltd., Hayes, Middx. [3963

FULHAM AND KENSINGTON HOSPITAL MANAGEMENT COMMITTEE.
METROPOLITAN Ear, Nose and Throat Hospital at St. Mary Abbots Hospital, Marloes Rd., Kensington, W.8.
HEARING aid technician required.
NATIONAL salary scales and conditions.
APPLICATIONS, giving full particulars, should be made to the Hospital Secretary (W.W.58) immediately [3960

ESTIMATING Engineer with knowledge of electronic applications and circuitry required for Electronics Division of Transformer Sales Office
STAFF pension scheme and active Social Club amenities
WRITE, giving full details of experience, to Manager, Sales Office, Gresham Transformers, Ltd., Twickenham Rd., Hanworth, Middlesex. [3855

SITUATIONS VACANT

REGENTONE RADIO & TELEVISION, Ltd., have the following vacancies:—
(a) SENIOR Engineer to take control of section engaged on research and development of television receivers. Candidates with initiative, sound technical background, and experience in this field, will be expected to initiate designs and carry them through to production stage. Salary up to £1,000 p.a. commensurate with ability.
(b) DEVELOPMENT Engineers for work in connection with television and radio receiver design. Candidates must have good technical background and at least five years' laboratory experience.
(c) JUNIOR Development Engineers to assist in development of television, radio and components. Must be educated to at least Higher National Certificate or equivalent, with preferably some labratory experience.
(d) TEST Gear Engineers, with sound experience of the design and manufacture of special equipments required for the testing of Sound technical knowledge and ability to carry mass-produced radio and television receivers. design through to finality.
(e) EXPERIENCED Wiremen/Testers for section engaged on production of specialised equipment designed for mass production testing of television and radio receivers. Experience of this or similar work essential.
(f) PRODUCTION Development Engineers with sound experience of engineering laboratory designs for mass production manufacture. Candidates must have good technical background and have practical outlook with considerable mechanical experience.
EXCELLENT prospects are open to successful candidates, with good salaries, staff status and participation in company's superannuation and life assurance scheme. The laboratories are well equipped and modern in design and afford excellent working conditions.
APPLY at first in writing, giving full details of experience, technical training, salary and all relevant details, to:—
PERSONNEL Manager, Regentone Radio & Television, Ltd., Eastern Avenue West. Romford, Essex. [3818

FERGUSON RADIO CORPN., Ltd., have vacancies for:—
SENIOR Engineers with initiative and sound technical background for work on a wide range of projects in the field of Electronics, including Television, Radio, Communications and Test Equipment. Permanent posts for men able to carry responsibility in rapidly expanding department offering exceptional promotion and long-term prospects.
JUNIOR Engineers of ability to work on Development projects offering a wide experience in the fields of Television, Radio, Communications and Test Equipment with excellent prospects for advancement. Vacancies exist in Laboratories situated both at Enfield and Spennymoor Co. Durham. These Laboratories are well equipped and working conditions excellent. Successful applicants eligible for Company's Pension and Life Assurance Scheme.—Applications specifying the post for which application is made and giving full particulars as to age, qualifications and experience, etc., to Personnel Manager, Ferguson Radio Corpn., Ltd., Gt. Cambridge Rd., Enfield. [3857

THE English Electric Co., Ltd., Stevenage, Herts, requires additional staff for its FUNCTIONAL Test Department, with one or more of the following qualifications:—
(1) H.N.C. Standard.
(2) CITY & Guilds Cert. in Tele-communications.
(3) A GOOD practical experience in the Radar and Radio field.
EX-SERVICE Radar and Radio Mechanics and Technicians are particularly invited to apply.
HOUSING assistance can be given to successful applicants who come from the Greater London Area or from the Regular Services.
APPLY in writing giving details of experience and age to Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. 1356C. [3860

EXPERIENCED TV engineers wanted for field service.—Box 0186. [3833

THE MULLARD RADIO VALVE Co., Ltd., has a number of vacancies for technical assistants in its production and development departments at its Mitcham factory.
APPLICATIONS are invited particularly from persons holding the General Certificate in education at "O" level, in science subjects advanced level, Ordinary and Higher National Certificate in engineering.
THE posts provide for further training in specialised electronics and there are facilities for further study; there are considerable opportunities for promotion in varying expanding fields of electronic work.
COMMENCING salaries are 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 Rd., Mitcham Junction, Surrey, quoting reference JFG/GEN. [3940

TELEVISION and radio engineer required: must be good fault finder and thorough. driver preferred; good salary; permanency; Hampstead district—Box 0283. [3851

ELECTRICAL engineer required for development department of firm engaged on the manufacture of R.F. heaters and other work at Cheltenham, previous experience preferable but not essential, H.N.C. standard.—Box 8822. [3735

SITUATIONS VACANT

THE MULLARD RADIO VALVE Co. invites applications for the following vacancies in its special valve division.

V.H.G. (A)—Applications group.

1. A SENIOR electronic engineer to control a group concerned with work on the fundamental problems connected with gas-filled valves: an aptitude for the design of new circuits would be a particular advantage; in addition the appointment calls for a person who would be able to offer advice and assistance on the application of the finished product; an essential qualification is an Hons. degree coupled with practical experience in this or an allied field of work.

2. A PHYSICIST to work on fundamental problems connected with the application of gas-filled valves; the work will involve assistance and advice on the application of the finished product, the minimum qualification for this appointment is an Hons. degree of physics and previous experience is desirable although not essential.

3. AN electronic engineer to work on specialised circuit problems associated with gas-filled valves; the successful applicant will, in addition, be expected to offer advice and assistance on the application of the finished product; a B.Sc. pass degree or equivalent qualifications together with experience in this or an allied field of work is desirable.

V.H.G. (B)—Equipment design group.

1. AN electronic engineer to supervise a group concerned with the design of equipment for the testing of gas-filled valves; the work will also involve giving advice and assistance in the construction of this type of equipment and to supervise the construction of experimental circuits to meet new demands and applications; a B.Sc. pass degree or equivalent qualifications together with some experience in this or an allied field is desirable; applications are particularly invited from candidates having an interest in circuitry.

2. A TECHNICAL assistant to design test equipment for gas-filled valves; the duties will involve the consideration of experimental circuits for use with these types.

APPLICATIONS are invited from candidates who have experience in circuit techniques and who should preferably possess a Higher National Certificate or equivalent qualifications. THE vacancies outlined above are at the company's Mitcham factory and are due to the expansion of its activities in this field; salaries will be according to individual age, experience and qualifications and can be considered as progressive.

THERE are facilities for further training, a company pension scheme, long service plan, and conditions of employment generally can be considered to be of a high standard.

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 Rd., Mitcham Junction. Surrey, quoting the appropriate reference number. [3939

THE PLESSEY COMPANY, LIMITED, of Ilford, offer attractive permanent positions to

DRAUGHTSMEN.

DUE to expansion of our electronic division. Applicants should be experienced in development and design for production of high-grade communications equipment to service requirements. Good salary and staff conditions. Company superannuation and insurance scheme in operation.—Applications, which will be treated in confidence, should be addressed to the Plessey Company, Limited, Vicarage Lane, Ilford, Essex. [3827

TELEVISION service engineers will be interested to know that one of the leading manufacturers in the industry have vacancies for

TELEVISION service engineers in South London; 5-day week, contributory pension scheme and good conditions of employment; fully qualified man preferred, but a good radio service engineer with some TV experience will be considered.—Reply, giving details of age, experience and present salary, to Box WW 815, LPE, 55, St. Martin's Lane, W.C.2, quoting reference S.1. [3834

A. V. ROE & Company Limited have the following vacancies for electronic and mechanical engineers in their Weapons Research Division at Woodford:

(a) SENIOR Engineer with Honours Degree and considerable experience of development of electronic computors or simulators to take charge of a group developing guided weapon simulators.

(b) SENIOR Engineer with Honours Degree and considerable development experience to take charge of a group developing hydraulic and pneumatic servo and precision mechanical devices.

(c) A number of engineers with either Honours Degree in Physics or Engineering or appropriate research or development experience to work on guided weapon computing navigation and control systems.

SALARIES will be commensurate with ability and experience. Applications, giving full particulars of age, qualifications and experience, etc., should be addressed to: The Chief Designer, Weapons Research Division, A. V. Roe & Company Limited, Woodford, Cheshire. [3792

COMPETENT radio and/or TV serviceman required, old-established firm, good prospects and conditions, permanent.—Nicklins, Barnstaple, North Devon. [3949

EXPERIENCED engineers required for design of electronic instruments for aircraft, marine and industrial applications; salary £600 to £1,000; housing assistance.—Apply: Simmonds Aerocessories, Ltd., Treforest, Pontypridd, Glamorgan, S. Wales. [3878

SITUATIONS VACANT

THE English Electric Co., Ltd., Guided Weapons Division, Luton, has vacancies for all grades of senior and junior staff in the Electronics Department as follows:—
SENIOR Engineer, with experience of production engineering of prototype electronic equipment and a working knowledge of electronic circuitry.
SENIOR Engineer for work on circuit development, and a sound fundamental knowledge of electronics.
SENIOR Engineer, with a wide experience of radar and communications equipment maintenance.
SENIOR Instrumentation Engineers, with Degree or H.N.C. and experience of the design of transducers for use with electronic or bridge measuring systems.
SECTION Leader, to supervise a team of designers and draughtsmen engaged on electronic equipment. Must be familiar with all aspects of RCS.1000.
SENIOR Designer Draughtsman, to undertake preliminary design of special electronic equipment associated with guided missiles.
DRAUGHTSMEN for detail design, of specialised electronic or electromechanical equipment, and of electrical and electronic laboratory test equipment.
DRAUGHTSMAN Checker, for work on production drawings of electronic and electromechanical equipment. Must have previous design experience.
CIRCUIT Draughtsman or woman, for the preparation of circuit and wiring diagrams for electronic equipment, and with a keen interest in electronics and a good knowledge of components.
THESE are permanent and progressive posts, and attractive salaries are offered to the right men. Staff pension after qualifying period. Applications to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1164D. [3791

EXPERIENCED television aerial development engineer; test and design to production stage.—Write fully experience, salary, etc., Box 8454. [3916

ELECTRICIANS or telephone engineers required for installing 999 burgular alarms. —Write to Box D.B., Messrs. Brockie Haslam & Co., 231, Strand, London, W.C.2. [3843

FIRST-CLASS public address engineers required by leading company; good remuneration to right men; own car an advantage.—Apply Box 0058. [3800

RADIO engineer required for training on television: keen man only considered: wage according to ability.—Write Box 420, Granthams Advertising, Reading. [3832

APPLICATIONS are invited for trainees as studio installation and maintenance engineers for home and overseas service with well-known television company.—Apply Box 0483.

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

A PROGRESSIVE post is available for an aerial designer (V.H.F.) in a large group of companies.—Send details immediately of experience and salary required to Box 0199. [3837

RESEARCH engineers, preferably of degree standard and with a sound knowledge of communications and, particularly, electronics, required for experimental work relating to underwater sound apparatus.
APPLICATIONS, giving past experience, technical qualifications, age and salary required, should be addressed to the Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Ilford, Essex. [3845

DEVELOPMENT engineers for circuit design of radio and television receivers; also draughtsmen for radio and mechanical assemblies.—Apply giving brief details to Beethoven, Ltd., N.W.10. Elgar 6687.

APPARATUS development engineers required for design of electromagnetic devices, experience of relays, contactors or switchgear an advantage; good salary, pension scheme and excellent working conditions.
APPLY in writing in first instance to Personnel Manager, Thorn Electrical Industries, Ltd., Gt. Cambridge Rd., Enfield. [3889

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

PYE, Ltd., require experienced development engineers for radio receiver development in Cambridge, salary according to qualifications.—Apply Personnel Department, Pye, Ltd., St. Andrew's Rd., Cambridge. [3521

DRAUGHTSMEN required for detail work and wiring diagrams to Ministry specs.—Details of salary, age and experience to Peto Scott, Ltd., Addlestone Rd., Weybridge, Surrey. Weybridge 4271. [3859

RADIO and electronic engineers required for interesting programme of investigation on American type equipments. The appointments are in the East Anglian area.—Write, giving full particulars, to Box 0016. [3795

TELEVISION/RADIO foreman and service engineer, fully experienced all makes, good references, able to drive, permanent position.—A. G. Allen & Co., Ltd., 3/4, Bridge Rd., Wembley Park. Arn. 2261. [3910

RADIO and radar testers. First-class men required for work on V.H.F. communication gear and Government contracts for radio and radar equipment by Midland manufacturers: men with wide experience of fault finding in any of the fields mentioned should write, giving full details, to Box 0393. [3874

SITUATIONS VACANT

ELECTRONIC engineers required by The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry, in their Development Laboratories for work on the following items:—
(a) DEVELOPMENT of pulse circuitry techniques for guided weapons.
(b) MICROWAVE development.
(c) GENERAL radar circuit development.
(d) TRIALS team in connection with guided weapons.
(e) SERVO mechanisms.
(f) TEST equipment.
(g) MAGNETIC amplifiers.
(h) POWER units including electronic stabilizers and rectifiers systems.
(i) APPLICATION and circuit theory of transistors.
(j) DESIGN of R.F. modulators.
(k) INVESTIGATION into valve parameters.
(l) DESIGN of valve test apparatus associated with (k) above.
APPLICANTS, preferably with a degree or an equivalent qualification, should have had at least two years' experience in the development and engineering of Service equipment as well as experience in one of the above. Reply, stating age, qualifications and experience, to the Personnel Manager, Ref. R.G. [3665

TELEVISION field and bench service engineers for East London area; basic salary £14 per week, plus overtime and car allowance; only competent, fully experienced men should apply.—Box 0526. [3909

MURDOCHS OF MAIDSTONE, Murphy dealer, urgently require senior TV engr.; all leading makes; top salary and service-manager status to right man.—Tel. Maidstone 2300. [3913

OLD-ESTABLISHED dealers of high repute, holding every leading agency, require additional radio and television engineers; top salary and permanency offered to first-class applicants.—E. P. Fox, Ltd., East Molesey, Surrey. [3598

SHORT BROTHERS AND HARLAND, Ltd., require an Engineer to promote the sale of electronic computing equipment; applicants must possess initiative and personality, while a knowledge of analogue computing techniques or electronics is desirable.
THE appointment will be in London but will involve travelling for liaison with customers, and with the Company's Development Laboratories.
SEND details of age, experience and salary required to—Short Brothers & Harland, Ltd., P.O. Box No. 241, Belfast. [3636

THE English Electric Co.'s Guided Weapons Division have vacancies at Luton for Senior engineer inspectors; the work will require close liaison with flight trials and design engineers and may involve participation in trials away from base.
APPLICANTS should have H.N.C. (Electrical) or equivalent qualifications and have several years' experience covering two or more of the following :—
(1) ELECTRONICS (D.C. amplifiers, pulse circuits or microwaves).
(2) GYROS.
(3) HYDRAULICS.
(4) SERVO systems.
THESE are senior appointments carrying attractive salaries and are pensionable after qualifying period; housing assistance can be given to successful applicants normally resident in the Greater London Area.—Applications to Dept., C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1355E. [3927

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH: principal or senior scientific officer; the Civil Service Commissioners invite applications for a pensionable post in the Radio Research Station, Ditton Park, Slough, Bucks.
DUTIES: To lead a small but expanding group investigating the fundamental electrical properties at high frequencies of materials of interest in radio applications and the relation of these properties to their physical and chemical structure; items at present under investigation include semiconductors, ferromagnetic and ferroelectric materials and special dielectrics.
CANDIDATES must have been born on or before 31st December, 1928; they must have a 1st or 2nd class honours degree in Physics or Physical Chemistry or equivalent qualification; exceptionally a candidate without these qualifications may be considered; at least 3 years university or industrial research essential.
INCLUSIVE annual remuneration (for 45½ hour week) £1,122-£1,516 (£1,007-£1,354 women) or £963-£1,122 (£829-£1,007 women) according to grading; a starting salary above the minimum may be granted.
FURTHER particulars and application form from Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1, quoting No. S4399/55. Completed applications to be returned by 20th January, 1955. [3904

DESIGN draughtsman. Leading manufacturers require experienced man to take charge of small group responsible for complete engineering of broadcast and television receivers; the post offers considerable scope with good prospects of advancement.—Apply stating age, experience and salary required to The Personnel Manager, Box 8685. [3692

VALVE Production Engineer required to take charge of small manufacturing section in an established works in N.W. London; must be experienced in production control of transmitting and similar type valves and conversant with all processes.—Please state experience, age, and salary required to Box 0370. [3864

SITUATIONS VACANT

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

YOUNG male radio engineer, with practical experience, for experimental and development work on interference suppression equipment to Ministry requirements to work without supervision in laboratory and on site.—Aish & Co., Ltd., Poole. [3935

WODEN TRANSFORMER Co., Ltd., require an experienced designer for small audio and power transformers, up to 1 KVA; good wages, plus bonus and pension scheme applies. —Apply to Moxley Rd., Bilston, Staffs, with full particulars. [3799

ENGINEER, experienced sub-miniature amplifiers, take charge of test department; opportunity working latest transistor circuits; permanent responsible position, attractive salary.—Amplivox, Ltd., Abbey Maufacturing Estate, Wembley. [3908

TECHNICIAN with experience of carrier telephone transmission or similar work required for development laboratory in large telecommunication works, London area; give particulars of age, experience, qualifications and commencing salary required.—Box 0369. [3863

TECHNICAL assistant required for designs office; knowledge of capacitor manufacture desirable, but engineers with experience of valve manufacture will be considered.—Write, giving details, to A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garrat Lane, S.W.18. [3847

DEVELOPMENT engineers.—Marconi's Wireless Telegraph Co., Ltd., Chelmsford, offer the following appointments to the permanent technical staff of the company; these are well-paid responsible positions suitable for applicants possessing design and development experience in the following fields.

REF. 2120; aircraft aerials.—Experimental design and development of H.F. and V.H.F. aerials systems; applicants should have had some experience in this field and preferably be familiar with small-scale model techniques.

REF. 2130; radio links.—Appointments are in connection with the developments of U.H.F. and S.H.F. wideband multichannel systems; especially suitable for applicants with a knowledge of travelling wave tubes and centimetric techniques.

REF. 2140; marine communication and radar.—Appointments available in connection with the development of marine transmitters, receivers, navigational aids and associated equipment.

REF. 2220; TV equipment.—Vacancies exist in connection with the development of cameras, studio equipment, transmitters and associated apparatus.

REF. 2240; V.H.F. mobile equipment.—Appointments available in connection with the design of mobile transmitters, receivers and associated power supplies.

ALL appointments are in connection with the expansion of activities in the company and carry excellent career prospects for applicants who are able to make an immediate contribution of the work of the groups.—Please write, giving full details of qualifications and experience and quoting ref. SA.55 and appropriate reference number, to Dept. C.P.S., 336/7, Strand, London, W.C.2. [3835

RESEARCH.—A senior engineer is required by a well-known established instrument manufacturer in the London area; knowledge of supersonic flaw detector techniques at an advanced level is essential, whilst a good production engineering and/or mechanical design experience would be a most useful asset.

THE post is pensionable and offers scope to an engineer with initiative combined with the right background; an initial salary will be paid commensurate with experience within the £1,000-£1,500 p.a. range.

APPLICATIONS may be made in the strictest confidence and should give details of experience, academic qualifications, age and salary required, and be addressed to Box 0236. [3844

ENGINEERS required for research and development work on servo-mechanisms; hydraulic, pneumatic and electrical servos are involved in this work covering such devices as guided missiles, radar scanners, motor control gear and turbo-alternators; vacancies as follows:—

(A) THEORETICAL engineers accustomed to carry out mathematical analysis of servo-systems. (Ref. 60.)

(B) PRACTICAL systems engineers capable of directing original work in all above fields. (Ref. 61.)

(C) ASSISTANT grades to work under direction of systems engineers on development work. (Ref. 62.)

CANDIDATES for (A) and (B) should possess honours degree with some practical experience or have had some previous practical experience in similar work. Candidates for (C) should be mechanical engineering or electrical engineering graduates or students. Knowledge of electronics of great value in this work.

WRITE in detail, quoting reference number of position sought, to: The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [3477

DEVELOPMENT engineers with experience required to work on the application of electronic methods to the solution of aeronautical and/or training problems, university degree or equivalent standard, accommodation available to suitable applicants.—Apply in writing to Redifon, Ltd., Kelvin Way, Crawley, Sussex. [3887

SITUATIONS VACANT

ELECTRONIC Development Engineers, Senior and Junior, with a leaning towards technical writing, to undertake the preparation of instruction manuals, specifications, etc., for guided weapons and like projects. A working knowledge of pulse circuitry and microwave techniques essential.
APPLY, giving full details of experience, age, etc., to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [3873

SALES representatives required by leading industrial electronic heating equipment manufacturer; good electrical and general engineering experience desirable; ability to actually book orders essential; territories London, Birmingham, Cardiff, Bristol, Southampton, Derby and Reading.—Write Box 8657. [3686

RADIO and radar testers.—First-class men required for work on V.H.F. communication gear and Government contracts for radio and radar equipment by Midland manufacturers.—Men with wide experience of faults finding in any of the fields mentioned should write, giving full details, to Box 7700. [3470

DEVELOPMENT engineer with sound knowledge of electrical and mechanical theory as applied to light-duty mechanisms; unique opportunity and interesting work for man with the right experience and training; London S.E. area; state age and salary required.—Box 0284. [3853

ELECTRONIC engineers with experience required for responsible positions in connection with development of electronic training aids and computing devices, accommodation available to suitable applicants.—Apply in writing to Redifon, Ltd., Kelvin Way, Crawley, Sussex. [3886

EXPERIENCED technical executive required by successful public television and radio company to supervise national organization for development, manufacture and service; opportunity of directorship for right man; pension.—Full details in strict confidence to Box 0168. [3525

EXPERIENCED Fault-Finders wanted by Midland manufacturers of radio equipment; permanent post located in the Midlands are offered to men with experience of radar, radio control, V.H.F. equipment.—Write, stating fully experience and salary required, to the Personnel Manager, Box 0394. [3875

SENIOR transformer designer required with experience of all types of transformers up to 3,000 kVA; excellent prospects for an energetic man capable of supervising junior engineers, excellent working conditions, pension scheme, canteen, etc.; West London area.—Applications to Box 8135. [3565

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

SENIOR engineers required for research and development work on magnetic amplifiers, transistors and electronics, with particular reference to aircraft and guided weapon applications; only engineers whose experience commands a salary of £600 p.a. and upwards need apply.—Full particulars to Box 0426. [3879

SENIOR electronic engineer required by radio component manufacturers (London area) to take charge of test equipment development and maintenance; would also be appointed chief inspector (AID).—Write fullest particulars of qualifications experience and present salary, Box 0544. [3919

MANAGER for radio and television service department required with first-class administrative ability and sound technical knowledge of service problems; good permanent position in well-established department.—Apply by letter or in person to Personnel Controller, Bentalls of Kingston-on-Thames, Surrey. [3937

ENGINEER, aged 25 to 35, preferably having Higher National Certificate, required for the maintenance of electronic equipment and the testing and alignment of new instruments used for quality control and automatic testing of all types of telecommunication cables.—Apply, giving full particulars, to Box 8632. [3679

ENGINEER reqd. for the maintenance of radio frequency heating equipment; thorough knowledge of the subject required; starting salary according to qualifications and opportunity for advancement; able to drive and mileage allowance if own car.—Apply to the Personnel Dept., E.M.I., Ltd., Hayes, Middx. [3796

EXPERIENCED fault-finders wanted by Midland manufacturers of radio equipment; permanent posts located in the Midlands are offered to men with experience of radar, radio control, V.H.F. equipment.—Write, stating full experience and salary required, to The Personnel Manager, Box 7701. [3471

NELSON RESEARCH LABORATORIES, Stafford, have a vacancy for an experimental graduate Physicist for interesting work on Semi-Conducting materials; Experience in this field is desirable but not essential.—Reply stating age, qualifications and experience to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 312. [3912

ENGINEER or physicist required by large company of world-wide renown in Birmingham; applicants should be well qualified academically and have experience in experimental physics or instrumentation; the appointment offers good prospects and conditions in a substantial organisation; pension scheme.—Apply, giving details of age and qualifications, to Box 0564. [3941

SITUATIONS VACANT

ENGINEERS required for installation and operation of television transmission equipment.—Apply in first instance by letter, to Engineer-in-Charge, Pye, Ltd., 11, Hinde St., London, W.1. [3885

JUNIOR designers required to deal with small transformers power, audio, pulse, etc.; specialised training will be given to engineers with suitable basic training and experience.—Applications to Technical Director, Gresham Transformers, Ltd., Twickenham Rd., Hanworth, Middx. [3569

ELECTRONIC engineer required in the Electronics Section of a large food organisation in N.W. London, for the construction and maintenance of specialised factory equipment; applicants should possess initiative and be between the ages 20-30; salary according to age and experience.—Write Box W.W.635, c/o 191, Gresham House, E.C.2. [3933

TELEVISION Designer required. The successful applicant must have a sound theoretical knowledge of fundamentals, and experience of time base work would be an advantage.—Applications, including full details of experience and qualifications, should be addressed to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City. [3872

TELEVISION engineers required by old-established company holding every one of the well-known agencies; applicants must be fully experienced and preferably able to drive; top rates and permanent progressive positions to the right men.—Apply to A. S. White & Sons. Ltd., 130/2, High Rd., S. Tottenham, London. N.15. Sta. 7861-2. [3178

RADIO testers required, some v.h.f. experience desirable together with some servicing knowledge on domestic or service equipment. —Applications, giving full details of previous experience and qualifications, should be submitted in writing to The Personnel Manager. Pye Telecommunications, Ltd., Newmarket Rd., Cambridge. [3806

BRITISH ACOUSTIC FILMS, LTD., Woodger Rd., W.12, have vacancies for senior and junior development engineers to work on sound recording and reproducing equipment and associated apparatus of all types. Salary according to experience and qualifications, pension scheme.—Application should be made, in writing, to the Personnel Manager. [3795

TELEVISION service engineer required by leading dealer holding all main agencies; good position for first-class engineer with high standard of service; semi-detached modern house with garage available if required and good rate of salary.—Write, stating details of experience, etc., A. E. Hughes & Sons, 28, Clarence Place, Newport, Mon. [3881

WIREMEN required for the laboratory of an engineering company situated in the East London area. Applicants should have had previous experience of electronic computers and ancillary equipment. These are staff appointments and a good salary will be paid to the selected candidates.—Please reply, giving details of past experience, to Box 0169. [3828

CERAMIC capacitor engineer required south London district, age 26-35, to undertake design and technical supervision of manufacturing process; technical education up to Inter. B.Sc. or Higher National Certificate standard in telecommunication engineering or equivalent; industrial experience, preferably in radio, an advantage.—Apply to Box 0235. [3846

AN opportunity is offered to a progressive electronic engineer in a rapidly expanding organisation; good technical education and experience essential, together with a flair for practical work; good salary and prospects; replies treated as confidential.—Apply, Epsylon Research and Development Co., Ltd., The Barons, St. Margarets, Twickenham, Middlesex. [3898

APPLICATIONS are invited from engineers of inter-B.Sc. or Higher National Certificate standard for investigational work on thermionic valves. Five-day week, staff pension scheme, modern welfare amenities.—Apply, giving full particulars of age, qualifications and experience, to Personnel Superintendent, The Edison Swan Electric Co., Ltd., Cosmos Works, Brimsdown, Enfield, Middlesex. [3807

LIVINGSTON LABORATORIES, LIMITED, have a few staff vacancies for engineers for test and calibration work on a wide range of British and American test instruments of the latest type; interesting and congenial work in a progressive company.—Write, giving experience details, to the Chief Engineer, Livingston Laboratories, Limited, Retcar St., London, N.19. [3961

THE GENERAL ELECTRIC Co., Ltd., have vacancies for Television Service Engineers at their service depot in Westminster; excellent opportunities exist for those having had previous experience; the positions are pensionable and the depot operates a 5-day week.—Apply in writing, quoting Ref. S.D., to the Staff Manager, Magnet House, Kingsway, W.C.2. [3865

ELECTRONIC engineer for research and development post with well-known Birmingham company; applicants should possess university degree and have had experience in pulse techniques and digital computer principles; the appointment offers good prospects and conditions in a substantial organisation; pension scheme.—Apply, stating age and qualifications, to Box 0565. [3942

SITUATIONS VACANT

AN opportunity occurs in progressive manufacturing concern in London area for engineer, aged 25/35, with electrical or physicist degree, on development and research work on high frequency telecommunication cable and associated testing equipment; salary will be commensurate with qualifications and experience.—Apply giving full particulars to Box 7677. [3456

ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, have vacancies for young engineers to work on radio valve design and development; applicants should be of degree standard; whilst experience of this type of work is desirable, it is not essential, and otherwise suitable candidates will be considered.—Write, giving full details, quoting Ref. 497L, to Dept. C.P.S., 336-7, Strand, W.C.2. [3962

EX-SERVICE radio-radar mechanics.—A leading company in the electronic field has vacancies for men interested in manufacture and maintenance of radar equipment; opportunities occur in the factory and in the outside maintenance field for men who have had service training and some theoretical knowledge.—Applicants should write, giving full details of their experience, etc., to Box 7699. [3469

RADIO and TV engineer with laboratory experience required by leading London firm of electrical component manufacturers for work in connection with printed circuits; H.N.C. standard; superannuation scheme.—Write, giving full details of education and experience, age and salary required, to Personnel Manager., Box 3M.L9248, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [3849

E.M.I. domestic electronics division have a vacancy for a TV design engineer for an interesting programme in receiver development (including colour receivers); applicants should have good academic background with at least three years' experience in this field.—Please write, with full details, to Personnel Dept. (DED/2), E.M.I. Factories, Ltd., Blyth Rd., Hayes, Middx. [3840

GRADUATES with honours degrees in physics or in electrical engineering are required by the British Thomson-Houston Co., Ltd., Rugby, for research in the field of Klystron development; some knowledge of electronics is desirable. Applicants should write to the Director of Research, giving their age, qualifications and college, quoting the reference DR. [3760

TRAINING by experts for a career in a specialized branch of light electrical engineering is open to students in the age group 20-25; candidates must have been educated to Inter B.Sc. standard in physics or chemistry; after a training period of three years, promotion in this new and well-equipped laboratory would be offered to those applicants who have shown outstanding ability during the qualifying period.
ATTRACTIVE salaries are payable for these posts and the company operates a pension scheme.
REPLIES in confidence to Box 0200, quoting C.L.1. [3838

ELECTRONIC Engineers required; excellent opportunity for men of degree standard to broaden experience in a field of great interest and variety and involving latest techniques; restrictive specialization can be avoided by joining Marconi Instruments who produce light current communication, measuring, and test apparatus for a wide range of requirements.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [3895

TECHNICAL assistants required for investigational work in connection with radio valve manufacture; applicants should possess at least Higher National Certificate; five day week, modern welfare facilities, staff pension scheme.—Apply, giving full personal details, including age, qualifications and experience, to Personnel Superintendent, the Edison Swan Electric Company, Limited, Cosmos Works, Brimsdown, Enfield, Middlesex. [3899

E.M.I. domestic electronics division have a vacancy for a development engineer in their component laboratory, for work which includes design of high fidelity equipment, loud speakers and pick-ups; applicants should have a good academic training and preferably experience in the design of electro-mechanical components.—Please write, with full details, to Personnel Dept. (DED/3), E.M.I. Factories, Ltd., Blyth Rd., Hayes, Middx. [3841

DECCA RADAR, Ltd., require an experienced circuit draughtsman for their development drawing office; good experience of radar and electronic equipment essential; there are also vacancies for a senior draughtsman and a checker draughtsman; all positions offer excellent opportunity for advancement in an expanding laboratory; good salaries offered.—Apply to the Personnel Officer, Decca Radar, Ltd., 2, Tolworth Rise, Tolworth, Surrey. [3890

BRITISH OVERSEAS AIRWAYS CORPORATION urgently require radio mechanics in their radio maintenance unit at London Airport; good opportunities for advancement; rates of pay 3/8⅝d p. hr., plus 3d p. hr. bonus, attracting proficiency pay up to 3d p. hr.; 44-hr. week; shift, including Sunday working; generous pension, insurance and sickness schemes; good holiday facilities.—Apply Staff Superintendent (Recruitment), Building 29, London Airport, nr. Harlington Corner. [3668

SITUATIONS VACANT

RADIO and television engineer.—Applications from experienced men invited by Selfridges, Ltd.; applicant must have current driving licence; excellent working conditions; good wages; staff canteen; discount on most personal shopping.—Apply Staff Manager, Provisions Building, Somerset Street, W.1. [3934

DECCA RADAR, Ltd. require inspectors for quality control of electronic equipment on production line; previous experience desirable; applicants must be capable of following circuits for point to point checks; it is also desirable, but not essential, to have knowledge of A.I.D. requirements for general assembly of electronic equipment.
Apply immediately to The Personnel Officer, Deccar Radar, Ltd., 2, Tolworth Rise, Tolworth, Surrey. [3914

GRADUATES with honours degrees in physics or in electrical engineering are required by the British Thomson-Houston Co., Ltd., Rugby, for research in the field of Thyratron development; some knowledge of electronics is desirable. Applicants should write to the Director of Research giving their age, qualifications and college, quoting the reference KB. [3759

HONOURS graduates in Physics or Electrical Engineering are required for advanced work in a Quartz Crystal Laboratory. The positions offered afford excellent opportunities for young men to specialize in the study of piezo-electric materials, from both the theoretical and practical viewpoints. An interest in mathematics and electronics would be an advantage for this work.
HOUSES can be made available to successful applicants.
APPLY in writing to the Superintendent, Standard Telephones and Cables, Ltd., Crystal Division, Industrial Estate East, Harlow, Essex. [3931

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

SENIOR and junior development engineers required for responsible work in radio and television development laboratories; applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough, Bucks. [3880

DEVELOPMENT engineer required by leading firm of electrical component manufacturers in N.W. London for work in connection with development of printed circuits and application to production; H.N.C. or Inter-B.Sc. standard; experience of radio and TV technique essential; superannuation scheme.—Write, stating age, full details of education, experience and salary required, to Personnel Manager, Box 0121. [3820

TEST engineers are required to assist in the production of a variety of precision electronic laboratory instruments; previous test department experience is essential (preferably in connection with electronic measuring instruments); salaries in the range of £450-£575 p.a. according to qualifications and experience.—Apply, stating full details to the Personnel Manager, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [3920

ELECTRONIC wiremen required to assist in the production of prototype high grade television transmission and similar equipment. Applicants to possess fundamental knowledge of radio and television, to be capable of producing own component layouts and wiring to a high standard. Pension scheme. Canteen.—Write, stating age, experience and salary required, to Cinema-Television, Ltd., Worsley Bridge Rd., Lower Sydenham, S.E.26. [3803

AUSTRALIAN radio manufacturer of repute requires first class television production and design engineer, excellent prospects, passage paid, good salary, accommodation for right applicant. Interviews Jan./Feb. London. Applications stating experience, salary required, whether married or single, age and availability. Copies of references (not originals) if possible, or name of present employers in strict confidence, to Box 0095. [3810

NELSON RESEAPCH LABORATORIES, Stafford, have a vacancy in their electronic test section for an experienced man for initial inspection and testing of electronic equipment, practical experience in the maintenance of electronic, electrical control and recording equipments an advantage; preference will be given to people who hold a City and Guilds final Telecommunications Certificate.—Please write full details to Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. No. 944C. [3888

TEST engineers reqd for interesting work in connection with radar, television film projectors, camera channels, microwave links and similar electronic equipment; applicants must have sound theoretical knowledge of electronics backed by practical experience in H.M. Forces or Industry; staff positions and superannuation scheme; single lodging accommodation available.—Apply, giving full details, to the Personnel Dept. (CE/21), E.M.I., Ltd., Hayes, Middx. [3917

SITUATIONS VACANT

AN electronic or electrical engineer, between the ages of 25 and 35 years, of degree standard is required to take charge of the engineering department of a factory engaged in the manufacture of frequency control equipment. The successful applicant will be responsible for the design and specification of all new items as well as routine engineering problems. THE position offers a wide scope for a person possessing the necesary technical qualificatcns and initiative to expand the work along numerous channels.
HOUSES can be made available to successful applicants.
APPLY in writing to the Superintendent, Standard Telephones and Cables, Ltd., Crystal Factory, Industrial Estate East, Harlow, Essex. [3930

MICROWAVE Engineers reqd. for research and development laboratory at Feltham, Middx. Applicants should have a good academic background with previous experience of microwave problems and design of microwave components. Two vacancies exist, one requiring qualities of leadership.—Applicants should write with full details to Personnel Dept. (ED/201), E.M.I. Eng. Dev., Ltd., Hayes, Middx. [3483

SCIENCE graduates in physics or chemistry (male or female) who wish to make a career in the electrical and electro-chemical field are invited to apply for vacancies which occur in a new and well-equipped modern laboratory; candidates should be in the 23-28 age group, keen, not afraid of work and prepared to take the responsibility of supervising projects into production; opportunities for promotion to section leader in a development team would arise from these positions.
ATTRACTIVE salaries are payable for these posts and the company operates a pension scheme.
REPLIES in confidence to Box 0201, quoting E.C.1. [3839

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

ELECTRONIC engineers with sound basic knowledge of low frequency techniques required for work on design and development of electronic units for servo control work. Candidates should have some practical experience and qualifications in shape of degree; H.N.C. or City & Guilds Cert. desirable but by no means essential. (Ref. 59.)—Write in detail, quoting reference number of position sought, to: The Personnel Manager (Technichal Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [3476

TECHNICAL assistant required with technical and commercial experience of cable accessories, fittings, joints, etc. An important feature of the work will be the preparation of comprehensive information required for commercial purposes, but will include an active interest in development and production undertaken by other departments. Salary £650 per annum. Pension scheme, five-day week and all welfare facilities.—Write details to Personnel Manager, Telcon Works, Greenwich, S.E.10. [3801

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. [3808

RADAR receiver design engineers are required by Decca Radar, Ltd.; the receiver design group covers narrow and wide band I.F. amplifiers, low noise circuits, video amplifiers and mixers, automatic frequency control, subminiaturization and transistor circuit work; for senior positions, experience either in this or a closely allied field is required; for junior positions, applicants should preferably have a University degree or have qualifications equivalent to those needed for Grad. I.E.E. exemption; the company operates a pension scheme.—Applicants should write, quoting ref RLA/68, to Decca Radar Ltd., Radar Research Laboratory, 2, Tolworth Rise, Tolworth, Surbiton, Surrey. [3842

ELECTRONIC engineers with several years' research or development experience are invited to apply for posts with a well established company engaged primarily on the development of precision electronic laboratory instruments; applicants should preferably possess a degree or equivalent qualifications in physics or light electrical engineering, although this is not essential as considerable practical experience is equally acceptable; the appointments are of a permanent nature for engineers able to undertake the responsibility for the development of new projects to the prototype stage, and they offer scope for the exercise of individual initiative; furthermore, the work covers a wide range of electronic instruments and similar devices; salaries are commensurate with qualifications and experience.—Applications should be made in writing, stating full details to Personnel Manager, Furzehill Laboratories Ltd., Boreham Wood, Herts. [3922

SITUATIONS VACANT

MARCONI Instruments, Ltd., have an immediate vacancy at St. Albans in their Technical Literature (Telecommunications) Section; the applicants should have electrical engineering qualifications and/or experience in the design or development of electronic equipment; the duties are varied and interesting and the post provides a permanent and pensionable position in a well-established company.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [3894

BELLING & LEE, Ltd., wish to engage a young graduate electronics engineer with experience of V.H.F. receiver layout and circuit design, the work being in connection with the development of measurement apparatus for their television aerial laboratory and communal broadcast and television amplifiers: British nationality essential: contributory pension scheme.—Applications (which will be treated in confidence), stating age, experience and salary required, to the Secretary, Great Cambridge Rd., Enfield, Middlesex. [3822

AN electronic technician is reqd. by St. Bartholomew's Hospital, London, E.C.1; duties involve servicing, planning, construction and testing of electronic equipment used in radioactive and radiation assaying and in other applications to medicine; salary according to experience in the Medical Laboratory Technicians' scale of £450×£15 to £515, plus London Weighting.—Applications, together with references, to The Clerk to the Governors, marking envelope "Electronic Technician." [3856

TECHNICAL Advertising Assistant required for publicity division of Mullard, Ltd.; a knowledge of electronics to at least O.N.C. standard essential as duties include the preparation of technical material for catalogues, exhibitions and advertisements; this is an interesting and progressive post in an expanding organization; pension scheme and good staff conditions; starting salary according to qualifications.—Write, giving age and full details of education and previous experience, to Personnel Officer, Mullard, Ltd., Century House, Shaftesbury Ave., London, W.C.2. [3876

ASSISTANT liaison officer required in connection with the development and supply of communications, radar and other electronic equipment for the British and Allied Forces; commercial duties based on Central London; candidates should have had good general education, sound technical background and commissioned service in one of the fighting services; early 30s preferred; permanent and pensionable appointment.—Apply in the first instance, giving full particulars and experience, to: Personnel Officer, Mullard, Ltd., Century House, Shaftesbury Ave., London, W.C.2. [3877

A LEADING firm of radio and television manufacturers is establishing a team of mobile technical liaison officers and invites applications from well-qualified and experienced field service engineers; the appointments are progressive, permanent and pensionable and afford unusual opportunities for men 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.768, c/o Central News, Ltd., 43, London Wall, E.C.2. [3852

SENIOR assistant to take charge of small electronics section of laboratory; the work involves acoustics, vibration, use of strain gauges and the development of special equipment for research and development work on steam and gas turbines, gears, pumps, alternators, etc., sound theoretical training to H.N.C. or degree desirable; practical ability essential; experience in engineering an advantage; staff pension scheme.—Apply stating qualifications, age, experience and salary required to the Secretary, W. H. Allen Sons & Co., Ltd., Queens Engineering Works, Bedford. [3900

BRITISH OVERSEAS AIRWAYS CORPORATION require a Radio Instructor in their Central Training Unit near London Airport. The successful candidate will be required to instruct to the standard required for the A/c.Rad.Mtce. Engineers' Licences, Class A & B, and their radar ratings; also instruct Aircrew in the operation, and maintenance personnel in the maintenance and overhaul of current radio, radar and allied equipments; prepare technical manuals on the equipment. Qualifications: A.M.Br.I.R.E., A.M.I.E.E., C. & G. Final Certificate in Telecom. or equivalent. Experience in operation, mtce. and o'haul of a/craft.rad., radar and electronic systems.
SALARY for this post will be from £725 p.a. to £912 10s
APPLICATIONS should be addressed to Staff Supt., Recruitment, Building 29, London Airport, Hounslow, Middlesex. [3854

A MANAGER is required to take charge of the radio components division of an electrical engineering group in the East Midlands. In addition to the control and expansion of the sales organization, the post carries the responsibility for co-ordinating all other considerations such as design, production and estimating, etc. Applicants must have a sound knowledge of the radio components business and its potentialities, and should have initiative and drive to open up new markets. The post, which carries a salary of not less than £1,500 p.a., is permanent and pensionable. —Please write, stating age, qualifications, etc., to Box 2, JL 7392, A.K. Advg., 212a, Shaftesbury Ave, London, W.C.2. [3819

SITUATIONS VACANT

RADIO service technician required to manage car radio department as a self-contained unit of a large motor firm in Wolverhampton; thorough technical knowledge of radio and radio servicing experience essential.
PERSONALITY and appearance important as successful applicant will be responsible for managing and developing the department and its contact with traders and private customers; previous experience in a similar capacity desirable but not essential.
PLEASE send full details of experience, salary, etc., in writing to the Managing Director, Charles Clark & Son, Ltd., Chapel Ash, Wolverhampton. All replies will be treated in confidence. [3789

DECCA RADAR, Ltd., require technicians and engineers for radar installation at home and abroad; previous industrial and/or service experience essential; ex-technical officers and senior N.C.O.s from H.M. Forces are particularly invited to apply.—Applications should be made in writing in the first instance giving full details of qualifications, past experience, and salary required to the Manager, Heavy Installations Division, Decca Radar, Ltd., Malden Way, New Malden, Surrey. [3896

MINISTRY of Supply requires engineers at Bickley, Kent, for technical control of inspection of (a) Army radar equipment (ref. D587/54A) or (b) test gear for Army wireless equipment (ref. D588/54A) or (c) primary and secondary batteries (including quality control) (ref D589/54A); staff supervision and technical correspondence; qualifications, British of British parents; recognised engineering apprenticeship and A.M.I.C.E. or M.E. or E.E. or exempting qualifications; salary within £650 (age 25)–£1,000; not established but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., T. and S.R., 26, King St., London, S.W.1, quoting appropriate reference. [3928

JUNIOR development engineers are urgently required to assist in the development of precision electronic laboratory instruments; successful applicants will be engaged on interesting long-term projects concerned with the development of a wide range of equipment; the appointments are permanent and carry considerable technical responsibility; applicants should have had previous development experience preferably in the instrument field; academic qualifications ranging from H.N.C. to degree standard are preferable; salaries are dependent upon age, qualifications and experience.—Apply, stating full details to the Personnel Manager, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [3921

MINISTRY OF TRANSPORT AND CIVIL AVIATION.—Radio technicians (men only) required at aerodromes and radio stations in various parts of U.K.; special training courses for keen technicians with basic qualifications; interesting work in progress, providing electronic aids to navigation; Prospects of permanent, pensionable posts, and advancement. Rates of pay (London), from £330 p.a. at age 19 to £445 at 25, rising, subject to qualifying test, to £540. Rates slightly lower for provinces. Candidates aged 19 or over with practical experience in maintenance of radio or radar equipment should apply to any Employment Exchange, quoting Order No. Westminster 6627. [3829

MINISTRY OF SUPPLY, Radar Research Establishment, Malvern, Worcs, requires: ELECTRICAL engineers and physicists for research and development work on radio and electronic equipment. Work ranges from fundamental research on circuitry and physics of solids, to devising and developing, in collaboration with industry, electronic devices for the Army, R.A.F. and Naval Aviation. Ample scope for initiative and originality over very wide field concerned mainly with electronics. Minimum qualification Higher School Certificate (science) or equivalent, but further training in physics or elec. eng. to H.N.C. or degree standard may be an advantage. Salaries within ranges, experimental officer (min. age 26) £690–£850, or assistant experimental officer £276 (age 18—£615). Women somewhat less. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King St., London, S.W.1, quoting A 330/54A. [3817

UNIVERSITY of London. — Post-graduate Medical School; assistant required in the biophysics laboratories for development of instruments for medical research; field covered includes electrocardiography, electrical and optical methods of following blood conditions, strain gauge methods of pressure recording, and other applications of electro-mechano transducers and recording devices for use on the human subject; the candidate should have had good basic training in the design and use of electronic circuits; the selected candidate will be a member of a small group, in well-equipped laboratories, with good workshop facilities, and must be capable of independent work under limited supervision and guidance; the age of candidates should be between 20 and 25; the salary will be that of a senior technician and will depend on age and on whether the candidate holds the Ordinary National Certificate in Electrical Engineering (or its equivalent); it will be not less than £460; facilities are given for further study to the level of the Higher National Certificate; superannuation under the University of London Pension Scheme after six months' probation.—Application form from the Dean, Post-graduate Medical School, Ducane Rd., W.12. [3932

SITUATIONS VACANT

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 invited to write fully to the Chief Engineer, Equipment Division. [0198

ELECTRONICS installation and service engineer required for work in field and laboratory; interesting and responsible post in new expanding department; duties embrace V.H.F., electronic and nucleonic activities in commercial sphere; applicants must have practical technical knowledge and servicing experience, preferably with electronic instruments.—Write, stating age, qualifications and experience, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea. [3830

TECHNICAL assistants required for interesting research and development work at the MULLARD Research Laboratories; applicants should preferably have had previous experience in electronic circuitry and in possession of the Ordinary National Certificate, or technically educated to this standard; ex-service candidates with radar or radio experience will be considered; excellent conditions of employment including pension scheme.—Apply Personnel Officer, Mullard Research Laboratories, Cross Oak Lane, Salfords, near Redhill, Surrey. [3938

ASSISTANT Chief Chemist required for Multicore Solders and associated companies' Research Laboratories at Cricklewood, London. Applicants must have a B.Sc. Honours Degree or a Ph.D., and experience in synthetic organic chemistry. A knowledge of metallurgy, detergents and soaps would be an advantage. Age 32 to 42. Commencing salary £800–£1,000 per annum, according to ability and experience. Contributory Pension Fund.—Write in confidence to Managing Director, Multicore Solders, Ltd., Multicore Works, Hemel Hempstead, Herts. [3816

ENGINEER, fully experienced in radio and television design and development, required to assist chief development engineer of leading London electrical component manufacturers in development of printed circuits; qualifications at least to A.M.I.E.E. standard; this position offers scope for the right man who must be capable of initiating and following projects to finality, including contacts with customers; superannuation scheme.—Write, giving full details of qualifications and experience, age and salary, required to Personnel Manager, Box 3M.L9242, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [3850

A. C. COSSOR, Ltd., Highbury, London, N.5, have vacancies for all engineering grades and designer/draughtsmen in their research and development divisions; the programme of work includes radio communications, television, electronic instruments, primary and secondary ground and airborne radar, and navigational aids; in particular vacancies exist for senior engineers of good academic qualifications and industrial experience; for recently qualified scientists and engineers with or without experience who wish to train for a career in the electronic industry, and for sen. draughtsmen experienced in any of the above types of work. SALARIES offered are consistent with present trends in the industry and the London cost of living; pension, welfare and medical services are provided.—Application in writing to the Personnel Manager, Mr. L. V. Cartwright. [3684

SITUATIONS WANTED

EXECUTIVE engineer seeks post offering control of unit engaged in electronic project engineering; 5 years in similar capacity; experienced development and production of high grade equipment for laboratory and works use; exceptional initiative and organising ability; basic background of radio and Radar, A.M.Br.I.R.E., ex-squadron leader R.A.F. signals; age 40; salary £1,500 p.a.—Box 0523. [3902

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TOWN Clerk and Clerk to the Local Education Authority. (J.A.3739.) [3858

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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

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

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. WW.28, London, W.4. [0179

BOOKS, INSTRUCTIONS, ETC.

FOR sale, J. Soc. Mot. Pic. Engrs., June, 1948-June, 1954; Tele-Tech., Mar., 1949-Nov., 1952; J. Acoust. Soc. Amer., July, 1948-March, 1954; R.C.A. Rev., June, 1948-March, 1954; Bell Syst. Tech. J., Oct., 1948-Nov., 1952; Elect. Engineering, N.Y., Jan.-Dec., 1952; odd copies; Proc. I.R.E., 1941-1953; Wireless Engr., 1948-1954; B.B.C. Quart., 1946-1954.
OFFERS and request: to M.S.S. Recording Co., Ltd., Poyle Close, Poyle Rd., Colnbrook, Bucks. [3915

BOOKLETS "How to Use Ex-Govt. Lenses and Prisms," No. 1 and 2, price 2/6 each; ex-Govt. optical lists free for s.a.e.—H. English, Rayleigh Rd., Hutton, Brentwood, Essex. [0181

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. [0089

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