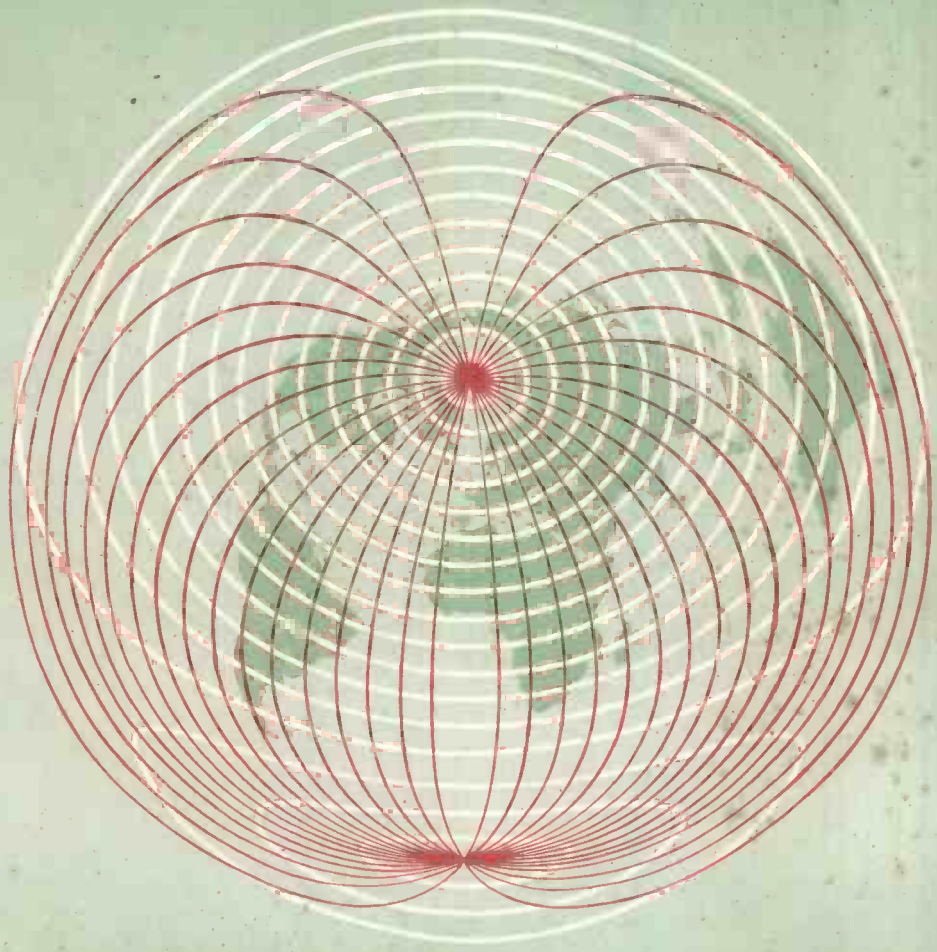
Wireless World

JUNE 1954 TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

Wireless World

RADIO, TELEVISION AND ELECTRONICS

44th YEAR OF PUBLICATION

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

JUNE 1954

In This Issue

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VALVES, TUBES & CIRCUITS

18. VALVES FOR A.C. MAINS-OPERATED F.M./A.M. RECEIVERS

Following the decision to adopt frequency modulation for the British V.H.F. sound broadcasts in Band II (87.5 to 100 Mc/s), attention will be focussed on the design and construction of receivers which, whilst designed for F.M. reception, can also operate on the existing A.M. wavebands. The accompanying table shows how six recently developed Mullard valves may be arranged in a receiver for F.M./A.M. operation with an A.C. mains supply. Each of these valves has a B9A (noval) base and a heater voltage of 6.3 V. By the use of suitable switching arrangements it is possible for some of the valves to perform different functions during F.M. and A.M. reception.

VALVE TYPE		FUNCTION	
		F.M. OPERATION	A.M. OPERATION
ECC85	Triode 1	R.F. amplifier	—
	Triode 2	Additive mixer	—
ECH81	Heptode	1st I.F. amplifier	Mixer
	Triode	—	Local oscillator
EF85		2nd I.F. amplifier	I.F. amplifier
	Diode 1	—	Detector
EABC80	Diodes 2 & 3	Ratio detector	—
	Triode	A.F. amplifier	A.F. amplifier
EL84		Power amplifier	Power amplifier
EZ80		Rectifier	Rectifier

ECC85 Double Triode. Consisting of two identical triodes with separate cathodes, the ECC85 is designed for use in the "front-end" stage of an F.M. receiver at V.H.F. One section is used as a self-oscillating additive mixer and this is preceded by the other section which functions as a low-noise R.F. amplifier. The presence of the R.F. amplifier ensures that oscillator radiation from the aerial is low. With the ECC85, which has been designed with extensive screening between the two sections, the radiation is reduced to an acceptable amount, being less than with earlier double triodes. The use of a triode as R.F. amplifier has the added advantage of a lower noise level combined with higher slope than would be obtained with multi-grid valves.

ECH81 Triode Heptode. For A.M. reception the ECH81 can be used in the conventional type of triode-heptode frequency changer input circuit. The two sections have entirely separate electrode structures thus enabling the heptode section to provide the first stage of I.F. amplification with F.M. operation.

EF85 Variable-mu High-slope Pentode. This valve can be used as an I.F. amplifier for both F.M. and A.M. reception since it combines the high slope required for amplification of the F.M. signals with the variable-mu characteristics desirable for A.M. operation in conjunction with the ECH81 as frequency changer.

EABC80 Triple Diode Triode. One of the three diodes in the EABC80 has a separate cathode, the remaining two diodes and the triode sharing the other cathode. With this construction it is possible to use this valve in a ratio detector circuit in which two diodes with separate cathode are required. In addition these two diodes have been designed with low internal impedances (approx. 200 Ω) whose ratio never exceeds 1.5. The third diode is used in A.M. reception as a conventional detector and generator of A.G.C. voltages. The triode section of this valve is suitable for use as an A.F. amplifier, its characteristics being similar to the triode section of the Mullard EBC41.

EL84 Output Pentode. This output pentode, which is already familiar to amplifier designers, has a maximum anode dissipation of 12W. It has been specially designed to provide the low distortion required for high-fidelity applications such as V.H.F. sound broadcasting using F.M.

EZ80 Full-wave Rectifier. The EZ80, an indirectly-heated full wave rectifier, can supply a maximum output current of 90 mA. It is therefore suitable for use in a combined F.M./A.M. receiver using the range of valves listed above.

Wireless World

JUNE 1954 VOL. 60 No. 6

New Licences

WE have long thought the broadcast sound and vision receiving licences issued by the Post Office to be queer documents. Nearly 10 years ago, we protested that some of the provisions of the sound licence were unduly restrictive. As a result a few changes were made, but fewer than we would have liked. There still remain clauses that must be a source of minor annoyance to the very few people who trouble to read the licences, and, at the same time, have a dislike of unwarranted bureaucratic "bossiness."

For example, on what grounds does the Postmaster-General forbid a direct connection between mains and aerial? A deplorable practice, admittedly, but surely a matter for the P.M.G.'s colleague the Minister of Health, who may have the expense of treating transgressors for shock under the National Health Service. Perhaps, however, this clause is intended rather as a recommendation than a veto; the warning that the licence does not confer authority to infringe copyright is rather more forthright but surely equally irrelevant. A gun licence does not warn the holder against using the weapon for, say, felonious wounding.

Several of the apparently irrelevant clauses of the broadcast licences are perpetuated in the large crop of new radio licences recently issued by the Postmaster-General which are summarized elsewhere in this issue. No doubt these relatively harmless things are done in drafting by over-cautious officials whose main object is to protect their department from possible litigation. There are also several apparent anomalies, particularly in the matter of charges, between one class of licence and another. Why, for instance, should a single ambulance vehicle, equipped with radio-telephony for expediting its journeys of mercy, pay £3 a year, while a whole police communication network, with an unlimited number of stations, pays only £2?

The charge for one new type of licence seems altogether excessive, and will, we hope, be revised. This is the Hotels licence, for which it is apparently proposed to charge, for sound broadcast reception, a fee of £1, plus £1 a year for each room installed. For television the fee is £3 plus £3. We should imagine that only the luxury hotel could afford to pay these charges.

Shared Television Masts

SO far as competitive television is concerned, there is only one point on which the political parties are agreed: this is that the aerials of the Independent Television Authority, if it comes into existence, should be carried on the masts of the B.B.C.'s present stations. What the B.B.C. itself thinks of this proposal, incidentally, is not stated.

At first sight the idea seems technically to have everything in its favour. The existing B.B.C. main stations were planned to give the most economical coverage of the densely populated areas, and it is doubtful if better sites could be chosen. For the viewer there is a distinct advantage in having both the B.B.C. and the I.T.A. transmissions radiated from the same point. This would allow combination receiving aerials to be used, pointed in the same direction. With separate transmitter sites, most viewers would have to erect more clumsy, unsightly and costly aerials. Where neighbours share a chimney stack, an impossible situation might arise.

All the B.B.C. "standard" stations have Band II slot aerials, for future use in sound broadcasting, occupying the top 100ft of the mast. It should be technically possible to interlace a high-gain Band III television aerial with the slot system, but, if this proved unexpectedly difficult, the portion of the mast immediately below the slotted section might be used without excessive loss of range.

On the masts of the five lower-power B.B.C. stations to be erected shortly provision has been made for Band III aerials, and there seems no *technical* reason why they should not be used by the I.T.A. If enough Band III channels could be freed for both B.B.C. and I.T.A. programmes, the two services could be "diplexed" to a common aerial.

Colour Television on 405 Lines

Demonstration of Compatible Systems for British Standards

WHEN the Television Advisory Committee issued their first report in 1953 they suggested that a compatible colour television system for Britain could be achieved by an adaptation of the American N.T.S.C. system,* with the colour signal transmitted outside the normal video band, either in an adjacent clear space or in part of any already-occupied adjacent channel. This method, of course, requires more bandwidth than the normal N.T.S.C. system, where the colour signal is transmitted within the same band as the monochrome signal. It has the great advantage, however, that the colour signal cannot interfere with the monochrome signal and produce a pattern of crawling white dots on the screens of black-and-white receivers. In this respect it is more compatible than the normal N.T.S.C. system—although the T.A.C.'s interpretation of compatibility suggests that the colour signal should be kept within the same band as the monochrome signal. The possible application of this "adjacent channel" system to British television has already been discussed in *Wireless World*.†

The idea has now been tried out on an experimental basis by Marconi's, and recently in London they gave a demonstration of it on a 405-line closed-circuit television system. At the same time a demonstration was given of a straightforward adaptation of the normal N.T.S.C. system to British standards, and it should be mentioned here that Marconi's were really presenting the two systems for comparison purposes: they were not advocating either one or the other. Comparisons could be made between the resultant pictures as they appeared on colour monitors and on ordinary black-and-white commercial receivers. It was also possible to see the effects of different bandwidths in the channels conveying the colour information. The subjects televised were live scenes, both indoor and outdoor, a colour film and some still colour transparencies. On the same evening as the demonstration, L. C. Jesty, of Marconi's, discussed some of the technical points in a lecture to the Institution of Electronics.

* *Wireless World*, Nov. 1953, p. 524
† *Wireless World*, Dec. 1953, p. 599

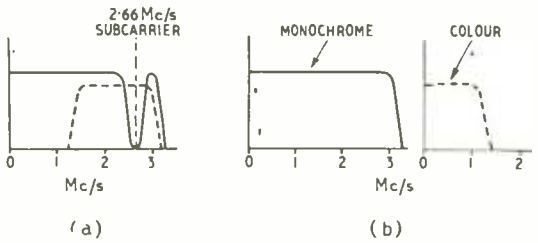


Fig. 1. Frequency characteristics of (a) N.T.S.C.-type signal adapted to British standards and (b) "adjacent channel" signal. The dip in the monochrome characteristic at (a) represents filtering to remove colour-signal interference.

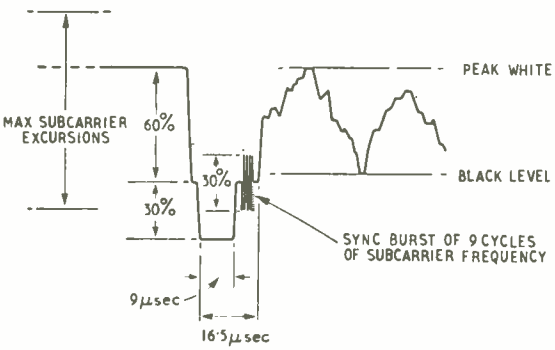


Fig. 2. Showing how the standard 405-line waveform is modified to carry the extra colour information in the N.T.S.C.-type system using a sub-carrier.

The frequency characteristic of the "adjacent channel" type of colour transmission is shown in Fig. 1(b) alongside that of N.T.S.C.-type signal at (a). In both cases the brightness information is transmitted in the full 3-Mc/s bandwidth and provides the ordinary black-and-white picture for existing receivers. The remaining information, hue and saturation, appears at the transmitting end in the form of two colour-difference signals, which are modulated on to two components of a carrier frequency displaced 90 deg in phase. In the wide-band system (b) this carrier is transmitted outside of the monochrome signal, whereas in the N.T.S.C.-type system (a) it takes the form of a sub-carrier (actually 2.6578125 Mc/s) on the main signal, so that the colour information is transmitted within the monochrome 3-Mc/s band. Fig. 2 shows how the standard 405-line waveform is adapted to the N.T.S.C. type of signal. It will be noted that the peak-white/sync-pulse ratio has been reduced from 70/30 to 60/30 to accommodate (partially) the positive excursions of the colour sub-carrier. In addition, the back porch of the sync pulse carries a short burst of sub-carrier frequency which is used for synchronizing the homodyne colour-signal detectors in the receiver.

It was clear from the demonstration that the adjacent-channel system (b) gave better colour pictures than the N.T.S.C. type of system, and on the screens of the ordinary black-and-white receivers there was no sign of an interference pattern. Another point in its favour, mentioned by Mr. Jesty in his lecture, was that it would make for simpler and less expensive receivers than those required for the N.T.S.C. system. For possible colour transmissions in Bands IV and V the extra bandwidth required would not present any difficulties (the T.A.C. having already proposed that channel widths of 7.5 Mc/s should be made available to stations). On Bands I and III, however, it would be necessary, as Mr. Jesty pointed out, to make the colour signal of one station overlap the monochrome signal of the station in the

adjacent channel.** The cross-talk between them would probably be troublesome in fringe areas, but it could possibly be overcome by the use of directional aerials.

At the demonstration comparisons could also be made between two possible methods of presenting the colour pictures, namely the R.C.A. tri-colour cathode-ray tube†† and a triple-tube projection system using optical combination of primary-colour images. Most observers agreed that the tri-colour tube gave the better pictures, both in colour rendering and definition. This was in spite of the fact (mentioned by Mr. Jesty) that in the R.C.A. tube the pattern of mask-holes and dots is liable to cause an interference pattern when interacting with our 405 scanning lines. Moreover, it seems that R.C.A., in order to avoid this beat effect with their 525-line structure, have made the pattern of holes and dots a good deal coarser than would otherwise be desirable, and as a result the definition of the tube is limited to about 250 lines.

The live scenes in the demonstration were televised by a new type of camera which uses only two pick-up tubes as compared with the three tubes in the R.C.A. colour camera. This represents an important step towards the ultimate aim of a single-tube camera. The principle of operation takes advantage of the fact that the eye is not able to see colour in fine detail, and in this way the camera is well adapted to the transmission systems (Fig. 1), which both make use of the same peculiarity. One pick-up tube produces a normal-definition monochrome picture of 3-Mc/s bandwidth while the other is arranged to give two low-definition colour signals, actually the red and blue primary-colour components. These are obtained by means of a filter consisting of alternate red and blue stripes arranged at right angles to the scanning lines. The green component is not required because it is not transmitted separately in the Fig. 1 systems but derived at the receiving end by subtracting the red and blue signals from the monochrome signal (which, of course, contains all three colour components).

This arrangement is obviously more economical than the three-tube type of camera, which produces red, green and blue colour-component signals of normal definition and combines them to form the monochrome signal, using only the red and blue outputs to provide the information for the transmitted colour signal (which does not need the full definition in any case). It also has advantages over the single-tube type of camera, which uses a very fine-pitch colour grid on the pick-up tube with red, green and blue stripes at right angles to the scanning lines. With this the pitch of the colour grid has to be about three times the definition of the equivalent monochrome picture, so that red, green and blue colour-component signals can be obtained for each individual picture element. By contrast, the two-colour grid in the Marconi camera is much coarser and gives exactly half the definition of the equivalent monochrome picture (1.5 Mc/s) since this is all that is required for colour information in the transmission system. Another advantage of the two-tube arrangement is that because the two-colour image is of low definition it does not have to be so accurately registered with the green image (contained in the monochrome picture) as in the three-tube camera, where all three images are of normal definition.

** *Wireless World*, Nov. 1953, p. 509.

†† *Wireless World*, May 1954, p. 242.

Monochrome Television Camera

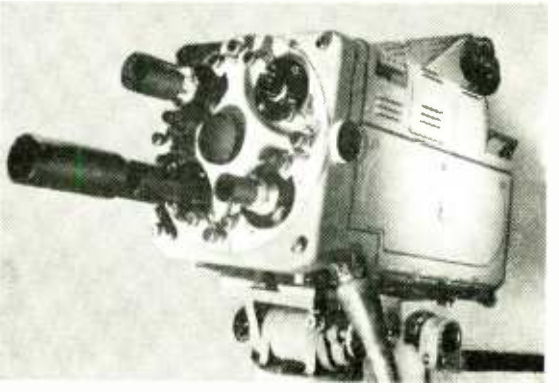
AT another recent demonstration by Marconi's a new camera for monochrome television, the Marconi Mark III, was shown in operation on a closed circuit. It can be used with either the 3-in or the new 4½-in English Electric image orthicon,* and in the demonstration the latter was employed.

As shown in the photograph, the camera has a four-lens turret, the lens in the lower left corner being the operative one. A control of light intensity is provided by means of discs in the turret, one of which carries a number of fixed filters and the other of which provides a continuous control of light transmission. Partly because of the placing of the tube and its coils to one side of the apparatus, and partly because of the use of electronic temperature control of certain windings, it has been possible to dispense with a blower for cooling.

The viewfinder is of the electronic type and is in a separate unit pivoted to the top of the camera. It is possible, therefore, to tilt the camera to any angle and yet keep the viewfinder in a position convenient to the operator.

The camera is designed for the 405, 525 and 625-line systems and with the 4½-in tube is claimed to give an output signal/noise ratio of better than 40 db. The sensitivity is such that for the best picture an incidental illumination of 10—20 ft candles is needed with an *f*/5·6 aperture. The power consumption is 1.5 kVA and the camera weighs 140 lb and measures only 17¼ in. high by 15¼ in. wide by 26½ in. deep.

A new flying-spot film scanner was also demonstrated and is suitable for 50- or 60-c/s frame frequencies. Scanning is effected with the film stationary and the film is pulled down during the frame flyback period of some 1 msec. It is the ingenious mechanical arrangement which permits this extremely rapid pull down that constitutes the main new feature of the scanner. The present model is for 16-mm film and for standard 2-in. by 2-in. miniature slides.



* *Wireless World*, May 1954, p. 225

WORLD OF WIRELESS

European Television Exchange • Earl's Court Plans • Increased Radio Exports • Cable & Wireless Jubilee

International Television

A FURTHER STAGE in the organization of the series of eighteen relays of television programmes between eight European countries for June and July was reached in Brussels early in May.

At the invitation of the European Broadcasting Union, which is co-ordinating the relays, the engineers and programme officials of the various broadcasting authorities met the technicians of the telecommunications administrations who will be responsible for the provision of cable links. The temporary radio links and the standards conversion centres will be the responsibility of the broadcasting authorities.

The telecommunications administrations have to provide a complicated network of international telephone circuits for: (1) programme sounds and commentaries in different languages; (2) operational instructions between administrations; and (3) connecting the national control points with the international co-ordination centre being set up at Lille.

Show News

THE DEMAND for space at the National Radio Show to be held at Earl's Court, London, from August 25th to September 4th, has been greater than at any time since the war, with the result that it may be necessary to reduce the amount of space devoted to combined electronic demonstration stands. All three Services will be participating this year and the scope of the Technical Training Display—introduced two years ago—will be enlarged. Incidentally, the Radio Industry Council has issued a booklet on careers in radio and electronics which is available on request.

With seven different sources of television programmes available for piping to the stands, receivers will be able to be demonstrated outside the normal B.B.C. transmitting hours. In addition a signal will also be available for demonstrating Band-III receivers and convertors.

Increased Exports

RADIO EXPORTS set up a new record in March with a total value of just over £2,800,000. Direct exports of communications equipment, broadcast transmitters, radar and other navigational aids and electronic equipment for industry accounted for £1.3M. This figure does not include equipment installed in exported ships and aircraft.

The March figure brought the total for the first quarter of the year to £6.9M.

C. & W. Jubilee

"THE cable engineers and the wireless engineers of the past have been replaced by a new generation of telecommunication engineers, conversant with the strong points of each method," writes Maj. Gen. L. B. Nicholls, chairman of Cable & Wireless, Ltd., in a booklet entitled "World-Wide Communication" issued to mark the company's silver jubilee. Brief explanations are given in the 40-page booklet of the methods employed to send messages and illustrations over the company's 114 W/T circuits, 85 R/T circuits, 18 radio phototelegraphy circuits and 150,000 miles of submarine cable.

In the section dealing with development and production work carried on at Radio House, reference is made to the development of the double current cable code (DCCC). This system enables two separate channels of communication to be sent over a single radio path. The signals of the two tape transmitters are fed alternately into a common sending unit and converted to DCCC. It can also be used as an automatic repetition system in bad operating conditions.

Patent Office Library

AN EXTENSION to the Patent Office Library in Chancery Lane, London, W.C.2, recently opened to the public, provides immediate access to over 3,500 scientific and technical periodicals published since 1920. Hitherto, much of this material has been available only on request. Another important addition to the library is the provision of a section for bibliographies and extracts.

The library remains open to the public until 9 p.m. on Mondays to Fridays and until 5 p.m. on Saturdays.

OPERATIONAL TRAINING. To provide radar training for Merchant Navy navigation officers under operational conditions the Sir John Cass College, London, has put into commission this 112-ft. motor yacht. It has classroom accommodation for 20 students and is equipped with Marconi and Decca radar, Decca navigators, Kelvin-Hughes echo-sounders and Marconi d.f. and radio-telephone gear. The radar observer courses in "Sir John Cass" last a fortnight.

Radio Expedites Goods Collection

AN interesting experiment is being conducted in Leicester by British Road Services with the object of improving the collection of goods from traders' premises. Three parcels vans are equipped with v.h.f. radio telephones and messages and instructions reaching the depot from traders requiring urgent collection can be passed on to the radio-equipped van nearest the premises concerned. This obviates the delay in waiting for a van to become available or of sending one specially from the depot.

Vans are equipped with 3-watt Pye sets and the traffic control station, which is located on a tall building and remotely controlled, has a 15-watt set. Amplitude modulation is used.

PERSONALITIES

The new post of chief engineer of the Communications Division of Marconi's W.T. Co., has been accepted by **C. Gillam,** who has been with the company since 1930. In 1942, he took over responsibility for aerial designs and became chief of the Aerial Design and Systems Planning Group on its formation in 1948, in which capacity he was responsible for the design of aerials and associated equipment for communications, broadcasting and television. His contributions to *Wireless World* include articles on the Wrotham aerial system.

N. C. STAMFORD.

C. GILLAM.

N. C. Stamford, M.Sc., M.I.E.E., recently appointed education officer of the Institution of Electrical Engineers in succession to W. H. Taylor (see below), was lecturer in electrical engineering in the University of Manchester from 1933 to 1944. In that year he was appointed principal of Marconi College, with additional responsibility for education and training in Marconi's W.T. Company. He subsequently became deputy education and training officer to the British Electricity Authority.

W. H. Taylor, B.Sc., A.M.I.E.E., recently appointed controller of Education and Personnel Services to the General Electric Company, was education officer of the Institution of Electrical Engineers for six years from 1947.

Dr. Alfred N. Goldsmith, a co-founder and director of the Institute of Radio Engineers, has relinquished the editorship of the *Proceedings of the I.R.E.*, which he has held since 1913. In recognition of his services he has been appointed Editor Emeritus and given the Founder's award. He is succeeded by John R. Pierce.

Richard Arbib, managing director of Multicore Solders, is on a two-months' tour of the U.S.A. and has visited the Chicago Radio Parts Show (May 17th-20th). The British Industries Corporation, distributors for a number of U.K. manufacturers, including Multicore, had a stand at the Chicago show.

Sir Arthur Fleming, C.B.E., D.Eng., Hon.M.I.E.E., who was director of research and education with Metropolitan-Vickers for many years before assuming a similar position with the parent company, Associated Electrical Industries, has received the honorary degree of Doctor of Law of Manchester University.

Col. J. Reading, M.B.E., B.Sc.(Eng.), M.I.E.E., an assistant engineer-in-chief, Post Office, has been appointed chairman of the council of the Institution of Post Office Electrical Engineers and of the board of editors of the institution's journal. He was for many years secretary of the institution. Col. Reading joined the equipment branch of the Engineering Department of the Post Office in 1925 and returned to the Post Office in 1946 after war service. He was for some time chief signals officer at the War Office.

E. D. Hart, M.A., A.Inst.P., A.M.I.E.E., who was for many years with Marconi Instruments, and, since 1952, has been head of the Technical Department of Mullard's equipment division, has been appointed deputy director of the Scientific Instrument Manufacturers' Association. He is chairman of the Joint Advisory Committee on Radio Communication and Radar Measuring Instruments set up by R.C.E.E.A., R.E.C.M.F. and S.I.M.A. The new secretary of S.I.M.A., following Mr. Peacock's resignation (see below), is Miss G. E. Moss, B.A., formerly clerk to the council.

A. G. Peacock, B.Sc., A.Inst.P., has resigned the secretaryship of the Scientific Instrument Manufacturers' Association and has joined the board of Mervyn Instruments, manufacturers of scientific and industrial electronic equipment, of St. John's, Woking, Surrey. He is perhaps best known as the honorary exhibition secretary of the Physical Society.

P. A. Thorogood, G4KD, has accepted the invitation of the Radio Society of Great Britain to organize the eighth Amateur Radio Exhibition which is to be held at the Royal Hotel, Woburn Place, London, W.C.1, from November 24th to 27th. Mr. Thorogood, who has organized the Electrical Engineers' (A.S.E.E.) Exhibitions, is chairman of the London u.h.f. group of the R.S.G.B.

C. E. Hay has been appointed by Communication Systems, Ltd., to fill the newly-established post of technical director. He has been transferred from the parent organization, Automatic Telephone and Electric Company, which he joined in 1945 from the Ministry of Aircraft Production.

G. W. Cussans, flying radio officer with the British Overseas Airways Corporation, has been elected chairman of the Radio Officers' Union for 1954. He was a sea-going operator with Marconi Marine before joining Imperial Airways (predecessor of B.O.A.C.) in 1936. From 1945 to 1948 he was senior instructor at Hythe, Southampton.

OUR AUTHORS

D. N. Corfield, whose article on valves for Bands III, IV and V appears in this issue, spent a short period in the research laboratories of Ericsson Telephones before going to Standard Telephones and Cables in 1927, where he was concerned with carrier telephones and repeater equipment. He was for four years chief engineer of the subsidiary company Kolster-Brandes and since the war has been in charge of the Brimar Valve Application Department. Mr. Corfield is a member of the committee responsible for building the Television Society's u.h.f. 405-line transmitter installed at Norwood. He has been active as an amateur transmitter, G5CD, since 1923.

Charles B. Bovill, who reviews in this issue the development of the French 819-line television system, has been working in France for some time on the Decca Navigator chain of stations. He has been with Decca since 1946. His radio career began in 1933 when he joined the Gramophone Company on the development of broadcast

receivers. In 1936 he went to the Air Ministry Aeronautical Inspection Directorate Radio Department and two years later joined Marconi's Aircraft Division acting as liaison engineer between the company and Coastal and Bomber Commands of the R.A.F. In 1942 he was commissioned in the R.A.F.V.R. and was officer in charge of the Air Operational Research Group of the Inter-Services Research Bureau.

H. G. M. Spratt, contributor of the article in this issue on magnetic recording tape, was, until recently, manager of the Magnetic Tapes Division of the Minnesota Mining and Manufacturing Company. Prior to that he was for a short time assistant chief engineer at Marconi Instruments and during the war was engaged on radio and radar in the Ministry of Supply. For seven years before the war Mr. Spratt worked on the development of high-definition television at E.M.I. and Philco. He started his career as a heavy engineer designing motors and generators.

OBITUARY

J. E. Nickless, M.I.E.E. (G2KT), who was for fifty years with Bullers, Ltd., and was the company's technical adviser on radio components (he retired in 1948), died at the age of 75 on May 2nd. He was well known in amateur circles and was a vice-president of the Southend and District Radio Society.

IN BRIEF

Broadcast Receiving Licences current in Great Britain and Northern Ireland at the end of March totalled 13,436,793, including 3,248,892 for television and 226,667 for car radio. The month's increases were 75,868 for television, 7,631 for sound only and 3,158 for sets fitted in cars.

Physical Society Show.—Both exhibitors and visitors to the Physical Society's annual exhibition will welcome the proposal to hold next year's exhibition in a larger hall. In spite of the co-operation of the governors of Imperial College, the growing interest in the show has made the space available at the college inadequate. It is expected that the 1955 exhibition will be held in the Royal Horticultural Hall, London, S.W.1, towards the end of April.

1954 Amateur Show.—It has been decided by the Radio Society of Great Britain to hold the eighth Amateur Radio Exhibition at the Royal Hotel, Woburn Place, London, W.C.1, from November 24th to 27th. The emphasis will be on "transistors and emergency equipment for portable and mobile use."

Electrical "Noise."—A five-day summer school on the theory of electrical conduction and noise will be held at the Centre for Continued Studies, Primrose Hill, Selly Oak, Birmingham, 29, from September 27th to October 1st. Particulars of the course, for which the fee is £5 (excluding meals and accommodation), can be obtained from the Director of Extra-Mural Studies, The University, Edmund Street, Birmingham, 3.

Electronics in Industry.—Some typical applications of electronics to mechanical handling equipment will be shown and, in some cases, demonstrated by a few of the 200 exhibitors at the Mechanical Handling Exhibition, which opens at Olympia on June 9th for eleven days. Among the organizations known to be featuring electronic control gear are:—The British Electrical Development Association, B.T-H., English Electric and Goring Kerr. A preview of the exhibition will be given in the June issue of *Mechanical Handling* which is organizing the show.

Home Service Coverage has been further improved by the installation of two permanent 2-kW transmitters at Scarborough, Yorks (1151 kc/s), and Ramsgate, Kent (1484 kc/s). They replace temporary transmitters which have been in use for some time.

Wireless Dinner Club.—At the annual general meeting and dinner of the British Wireless Dinner Club, which has a membership of 500, Maj. Gen. C. H. H. Vulliamy, C.B., D.S.O., was elected president in succession to A. V-M. C. W. Nutting, C.B.E., D.S.C. The new vice-president is H. Bishop, C.B.E., director of technical services, B.B.C.

Ten-Year Index.—The annual indexes to the four parts of the *Proceedings of the Institution of Electrical Engineers* for the years 1942-1951 have been collated and published as a collective index by the Institution. In addition to indexing every author, speakers in discussions and every key word in the titles of papers, the ten-year index includes a subject index in which titles of papers are collected under forty broad headings. The 500-page index costs 25s.

INDUSTRIAL NEWS

Transmitters for three television stations (both vision and sound), with associated aerial systems, have been ordered from **Marconi's** by the Danish broadcasting authority. They are to be installed at Copenhagen, Odense and Aarhus. The 625-line vision transmitters are to be amplitude-modulated while f.m. will be used for sound.

Cable Ship Radio.—The new cable ship *Recorder* (3,300 tons) for Cable & Wireless, Ltd., which was recently launched at Newcastle-upon-Tyne, will be equipped with Kelvin-Hughes radar and echo-sounders and Marconi radio-communication and sound amplifying gear.

B.B.C. and British Movietonews used **Leevers-Rich** magnetic recording gear when covering the Royal Australasian Tour. The recorders used by Movietonews are fitted with a synchronizing device, which, by means of a pulse recorded on the tape during the filming, ensures that when the tape is transcribed to the film perfect synchronism with the picture will be maintained.

"Navigator," the demonstration motor yacht of the Decca Company, is on a two-months' cruise of North European ports. She is equipped with the three types of radar (45, 12 and 159B) and the latest Decca Navigator (Mark V), which is capable of receiving the transmissions from nine chains working on different frequencies. Some 3,200 radar installations for 780 shipowners plus installations in vessels of the Royal Navy and 25 Commonwealth and foreign navies, have been undertaken by Decca. Navigator installations now total over 2,200.

South African Enquiry.—W. L. Procter (Pty.), Ltd., of 63, Strand Street, Cape Town, distributors of high-fidelity radio and audio equipment and components would like to receive catalogues from British manufacturers. Their London representatives are: William Dunn & Company, Ltd., 12-15, Finsbury Circus, London, E.C.2.

Clare Instrument Company, of Rickmansworth, Herts, which was recently formed by J. de Gruchy, has opened a London office at 39, Victoria Street, S.W.1 (Tel.: Abbey 1816). A multirange instrument incorporating the principles of protection described by Mr. de Gruchy in our September, 1953 issue, will be produced by the company.

The Engineering Division of **International Aeradio, Ltd.,** has moved from Bovingdon Airport to new premises adjoining the I.A.L. Printing and Publishing Division at Hayes Road, Southall, Middlesex (Tel.: Southall 2411).

Aerialite, Ltd., has opened a sixth depot—at 19, Blythswood Street, Glasgow, C.2. (Tel.: Central 2299.)

Radio-communication equipment and navigational aids are to be installed by **Marconi Marine** in the six vessels being built for the fleet of the Sugar Line, Ltd. Marconi equipment is also to be installed in the Union-Castle Line's new 7,450-ton motorship *Tintagel Castle* and the 9,000-ton motor tanker *Regent Royal* of the Regent Petroleum Tankship Company.

French Television Progress

Plans for Extending the Service

By CHARLES BOVILL.
A.M.I.E.E., M.Brit.I.R.E.

The 819-line test card used by La Radiodiffusion Television Française.

SOME three years ago it was unusual to see a television aerial in France, although there were regular broadcasts from stations in Paris and Lille. To-day, however, aerials are to be seen on the roof-tops of very many houses, both in the towns and in the country, and even the smallest radio shops display television sets for sale.

The sudden increase in the popularity of this form of entertainment is generally considered to be largely due to the success of the Coronation relay, which was seen by millions of French people, very many of whom had never seen or been previously interested in television. Another factor which has stimulated interest is the very good quality of the 819-line system, which is now the established French standard. French people have appreciated the fact that this is a very high definition system which cannot be superseded for some years to come, and they feel that a receiver can be invested in without danger of it becoming out of date. Moreover, the close spacing of the lines enables very pleasing pictures to be obtained from large-screen tubes.

When the 819-line system was first proposed it was looked upon as a dangerous step to take and technicians were apprehensive on account of the many problems which its use incurred. One of the main difficulties anticipated was serious phase distortion in the system due to the wide bandwidth which the high-definition system employs. This can occur in many parts of the chain between the studios and the transmitter aerial. It is therefore greatly to the credit of the engineers concerned, both in the Radiodiffusion Television Française and in the French radio industry, that the difficulties have been largely overcome by the use of ingenious phasing networks, negative feedback arrangements and other techniques, many of which have their origin in radar engineering. In the latest transmitters being built in France, correction is applied at the final modulator stage of the transmitter, an M-derived filter being used for the purpose.

Probably the most critical part of a wide-band television system is in the coaxial cable from the studio to the transmitter. In the case of the Paris station this is relatively long and undoubtedly some phase distortion occurs in it. French television experts state that the best way of judging the amount of phase distortion which occurs in the coaxial, and also the best way of seeing how good the 819-line system can be, is to view from signals transmitted from the Lille station. At this station, a Lille studio broadcast, which involves negligible coaxial cable transmission, can be compared with a relayed programme from Paris which must pass through the long coaxial cable from the studio to the transmitter. This comparative test indicates that if the coaxial cable technique can be improved there is very little wrong with the 819-line system.

Frequency Sharing Troubles

An unexpected problem was met last winter as a result of anomalous propagation conditions which caused interference to reception on the 185.25-Mc/s frequency shared by the Paris and Lille transmitters. This was overcome by using the offsetting technique which detunes the two transmitters by half the line frequency, here about 10 kc/s. The technique was originally developed in the U.S.A. and is now in general use for overcoming the difficulties of operating television stations on common frequencies. To understand the principle of the system, consider first the situation that occurs with perfectly synchronized transmitters. Under these conditions, when there is zero frequency difference between the carriers, there will appear at many reception points a second picture which will resemble the well-known "ghost image." The appearance of the unwanted picture must clearly depend upon the relative phase of the two signals at the receiving aerial, Thus, even with perfect synchronization of carrier frequencies, there will be many localities where reception must be unsatisfactory.

Under practical conditions it is almost impossible to achieve perfect frequency synchronization as there must be some wandering of the frequencies of the two carriers. At the receiver detector this frequency

Pair of 30-cm relay aerials with electromagnetic lenses, built by Cie Generale de Telegraphie Sans Fil.

Television relay station in the Paris-Strasbourg chain at Dabo la Hoube in the Jura, constructed by Cie Generale de Telegraphie Sans Fil.

wandering is translated into a heterodyne effect which appears on the screen of the receiver as a series of horizontal bars moving up and down. This effect takes place under conditions of a much greater ratio of wanted-to-unwanted signal and at ranges from the unwanted signal transmitter which are far in excess of those where the form of ghost image is seen. It is therefore an effect which can be most objectionable when even a very small interfering signal is present, such as occurs with abnormal propagation conditions. Furthermore, it cannot be eliminated by such simple expedients as orientation of the receiving aerial.

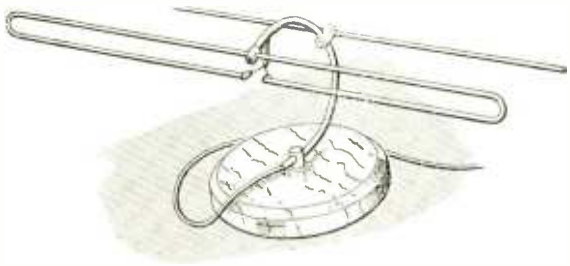
The problem of the "venetian blind effect," as it is so aptly called, led to the development of the offset system in the following way. Under conditions of a small frequency difference between two carriers there are only a few horizontal bars and the cycles of the beat between the two carriers appear as positively and negatively interfering pictures. As the difference between the carrier frequencies is increased the beat interference pattern becomes one of thin lines which is very much less annoying to the viewer. At the same time the odd and even lines have interfering images of opposite polarity which are cancelled out by the integrating effect of the eye at normal viewing distance. The critical offset frequency will be half the line frequency (10 kc/s with the 819-line system) to achieve the best all-round result. In order that the offset system can function correctly, it is of course necessary to maintain highly stable frequency control at the transmitters, which are working on what is virtually a common wavelength. Practical tests have indicated that a total frequency excursion of up to 2 kc/s, inclusive of both transmitters, is permissible without objectionable interference effects at the receiver. In the case of the Paris and Lille transmitters this means that a frequency stability to within one part of 200,000 is required.

Eiffel Tower Installation

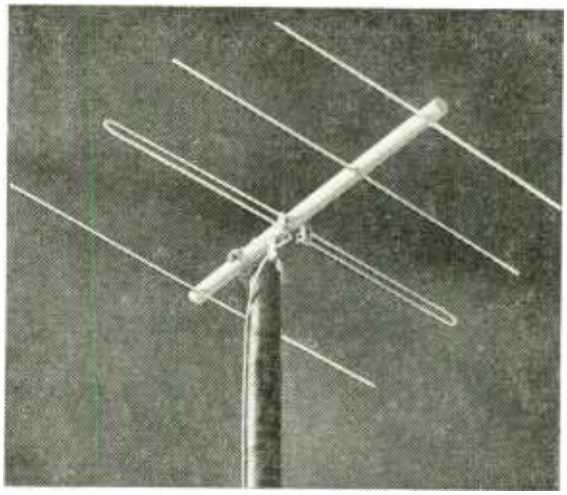
The value of the famous Eiffel Tower to radio has always been considerable from the time that Ducretet sent the first message from its summit in 1898. The massive aerials which for so many years hung from its top gallery to anchor points on the Champ de Mars, and which were used for time signals, have now been removed, and the Eiffel Tower is almost exclusively used for television work, for which it is an ideal transmission site. The 1,000ft elevation of the aerials is unique and enables the signals radiated to have an unobstructed path over a very large area. Not only does it allow the outside broadcast vans to work from considerable distances away, but it also enables relays to be installed which feed the subsidiary stations at Lille and at Strasbourg.

The Paris-Lille relay has been in operation for some time now, but the one to Strasbourg is more recent. It begins with a 3-cm link to Meudon, where the first of ten relay stations is located. From here the remainder of the links operate on a wavelength of 30 cm. The total length of the relay to Strasbourg is about 280 miles.

At present the Eiffel Tower transmitter radiates 12 kW and the equipment is housed in the top of the tower. A new transmitter is now being installed which will enable 150 kW to be radiated, and this will be housed at the base of the tower. The output of this transmitter and also that of the sound transmitter will be connected to a "diplexer," and thence through



Simple indoor television aerial with folded dipole and adjustable director on a marble base.



Typical television receiving aerial for the 819-line system made by Radio Industrie.

a single balanced feeder, over 1,000ft long, to a turnstile aerial on top of the mast, which will radiate both vision and sound signals. The total loss in the feeder will be of the order of 30 per cent. The existing transmitter is modulated at the final stage, but the high-power equipment will be modulated at low level. When the new transmitter is installed the old one will be removed from the top of the Tower and set up as a standby at the base.

These changes to the station will doubtless be welcomed by the engineers who operate the equipment, as throughout the winter they have to mount the last 570ft of the tower on foot to the transmitter room, since the hydraulic lifts, installed many years ago, become unserviceable in cold weather.

Following upon the success of the present high-definition transmitters, further expansion is being carried out, and in the near future new stations will be put into service at Lyon and at Marseilles, and a 200-kW station is being planned for Alsace. In the meantime the aerial mast at the Strasbourg station is being doubled in height in order to increase the field strength in the fringe areas.

The expansion of French television is intended to be in two stages. In the first stage more small relays will be built to serve thickly populated districts, such stations being satellites to the main stations. It is intended to have "branch lines" off the main relay chain from Paris to Strasbourg which will feed relays at Nancy, Reims and Amiens. The main station at Lyon will have a satellite to cover the lower part of the Rhône Valley, and the Marseilles station will have satellites at Toulon and at Nice to cover the south-east coast of France, where the population is relatively dense.

The ultimate plan, which was agreed upon in principle at the international conference at Stockholm in 1952, is for almost complete coverage of France. Owing to the topography of the country, which includes two major mountainous regions, there will be a requirement for a total of 45 stations. The implementation of this plan must depend largely upon funds granted by the Government and from the revenue from licences. At present the French television licence costs 4,350 francs, which is the equivalent of slightly more than £4 6s.

The French television authorities are fully aware of the geographical importance of France for international television relays, and their plans are centred round Strasbourg as the hub of European television relays. In the plan proposed, transmissions from Germany, Switzerland and Italy would enter France at Strasbourg and from there be relayed on to Paris and London. A radio link from Strasbourg to Paris is already being built, and the "inward" relay stations will occupy the same sites as the "outward" relay stations from Paris to Strasbourg.

In eastern France there are many localities where several programmes can be picked up, including the local programme. As there is a difference between the French standard and the European standard, as used in Germany and Switzerland, special receivers are needed—not only for the difference between the 819- and 625-line transmissions and their attendant variation in black-level percentage, but also the sound section of the receiver must be capable of receiving a.m. or f.m. signals. One manufacturer is marketing a receiver of this type aptly named the "Strasbourg," since in this town the Baden Baden transmitter can provide adequate signal strength. On the other hand, the first privately owned television station in Europe, at Saarbrücken, is using the French 819-line standard.

The station to be built for Monte Carlo, which will also be privately owned, will naturally use the French standard, and will probably be providing a regular programme for the Riviera by the end of the year. Both the Monte Carlo and Saarbrücken stations will transmit on frequencies in the 200-Mc/s band.

Indoor Receiving Aerials

Reception of the high-definition programmes has not presented many difficulties, and the normal folded dipole with a reflector and one or two directors is the most popular type in use. This aerial provides the 10-Mc/s bandwidth required and it is coupled to the receiver by a 72-ohm unbalanced coaxial cable. Very many receivers now operate from indoor aerials in the Paris region, and such aerials are becoming increasingly popular since on the 1½-metre wavelength a dipole aerial is of small enough dimensions to be made up as an attractive ornament. For the fringe areas these aerials are supplied with a self-contained pre-amplifier which gives 20 db gain. Interference from motor cars is markedly less on the 185-

Mc/s transmissions than on the 46-Mc/s transmission, which puts out the programme on the old 441-line standard in Paris.

Although France was criticized very strongly by other countries in Europe for adopting the 819-line standard and breaking away from the so-called European standard of 625 lines, recent events and rebroadcasts, such as the epoch-making Coronation relay, have shown that definition conversion can be carried out very satisfactorily and without noticeable detriment to picture quality. Once such techniques are perfected the international exchange of programmes becomes possible, and the question of standardization becomes of secondary importance, since, by the very nature of the wavelengths used for television, international reception must always depend upon local rebroadcasts, except in isolated cases, for which "multi-standard" receivers of the type already described are available. However, this raises the delicate matter of the necessity for standardization for television systems, which is better left alone, not only by the French.

Let it suffice to conclude with a word of admiration for General Leschi, the Technical Director La Radiodiffusion Television Française for having the courage to adopt and to try the high-definition system, and for the French radio industry for supporting it by technical development and making it a success.

Magnetic Recording Tape

Measurement of Coercivity and Remanence

By H. G. M. SPRATT, B.Sc., M.I.E.E.

IN a recent paper[1] on magnetic-tape recording it was clearly shown that, despite the use of h.f. bias, which subjects the tape to several magnetization cycles as it passes the recording head, a truly symmetrical hysteresis loop is seldom, if ever, reached before the tape has left the field. At the same time confirmation was provided of the fact, well known in practice, that the optimum bias current lies well below the saturation level. A valid measurement of coercivity or remanence, however, implies the use of a hysteresis loop which is both symmetrical and extends up to complete saturation in both directions of magnetization. Indeed, quite apart from the standard definitions of these quantities, measurements made under any other conditions would be difficult to repeat and useless for comparison purposes. It might therefore be assumed that such measurements were not only irrelevant but actually misleading when attempting to assess tape quality. Experience shows, however, that knowledge of these quantities is of considerable value in predicting performance, while the curves from which they are obtained may yield additional pointers to behaviour.

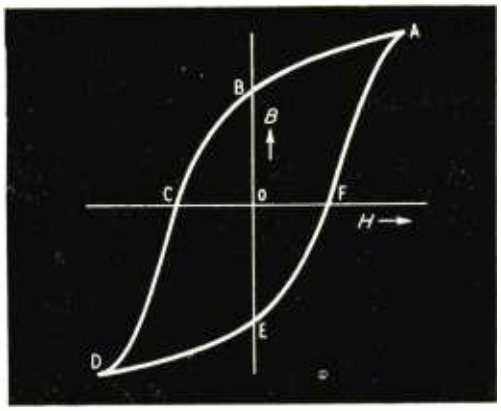
In what follows it is proposed to describe the most convenient method of measuring coercivity and remanence and to indicate the additional information to be derived from the curves. Before doing so, however, the practical importance of these two quantities will be briefly discussed.

In the sphere of magnetic recording the term "coercivity" is undoubtedly the better known of the two. This is because it is common practice for manufacturers to describe their tapes as of low, medium or high coercivity, an excellent idea, marred unfortunately by some confusion as to what constitutes medium and what high. Low-coercivity tapes, rather less popular now than in the past, have values extending up to 150 oersteds and are characterized by low optimum bias currents, easy erasure and relatively poor frequency response. High-coercivity tapes, with coercivity values extending from about 320 oersteds upwards, have exactly the opposite characteristics and are in little demand except for special purposes. Medium-coercivity tapes have coercivities ranging from 220 to 320 oersteds and combine most of the virtues of the other two types without their drawbacks. In practical usage other variables such as mechanical defects and differences in the performance characteristics of recording equipments can easily mask the slight but definite difference resulting from a 10 per cent change in coercivity, e.g., from 230 to 255 oersteds. Nevertheless, an accuracy of measurement within this percentage is essential for comparison purposes.

Remanence values have far less significance for the user than those of coercivity. This is slightly illogical since he is certainly interested in sensitivity and undistorted output capacity, quantities which are dependent upon remanence. Actually knowledge of the remanent flux is more useful still, since total flux, not flux density, determines sensitivity and coating thickness does vary from tape to tape. The bulk of tapes have remanence values lying within the range 400 and 900 gauss.

The necessity for a symmetrical hysteresis loop when measuring coercivity or remanence rules out completely the use of a static or point-to-point plotted B-H curve and demands a dynamic test obtained by applying a steady alternating magnetizing force to

[1] "An Investigation into the Mechanism of Magnetic-Tape Recording." P. E. Axon, *J.I.E.E.* Vol. 99, Pt. III, pp. 109-126 (May, 1952)



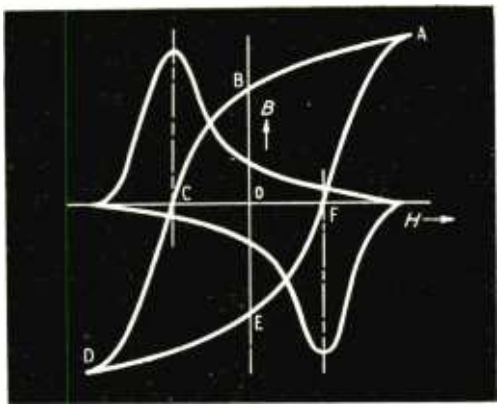


Fig. 1. Typical hysteresis loop under steady state a.c. conditions and (right) Fig. 2. Hysteresis curve together with the time differential curve of flux density (dB/dt).

the tape specimen. The resulting hysteresis loop will then be of the form shown in Fig 1 where the significant values are the magnetizing force OC or OF (the coercivity) and the flux density, OB or OE (the remanence). Obviously in a dynamic test these quantities can be determined only by reading them off a presentation of the loop on a cathode-ray oscilloscope.

To provide such a presentation we must clearly have available a voltage proportional to H for applying to the X-plates and one proportional to B for the Y-plates. As will appear later the first is easily obtained, the second not so easily. There is, however, no difficulty in providing a voltage proportional to dB/dt, the time differential of B, and one recognized procedure, which will be followed here, for obtaining a voltage proportional to B is to take the dB/dt value and integrate it. The integral is, however, less accurate than the differential from which it was obtained as will appear later. Apart from that, the coercivity value can be read off the differential curve —if it is shown—equally well and, moreover, this curve will reveal variations and abnormalities completely hidden in the integrated curve.

In Fig 2 are shown both the integrated curve, i.e., the hysteresis loop again, and the differential curve. The pronounced peaks appearing in the latter obviously correspond to the points of greatest slope in the hysteresis loop. Visual inspection shows, however, that these points of greatest slope are the points where the loop cuts the H axis, i.e., the points giving the value of coercivity. Experience shows that the greatest slope always coincides with this point for a homogeneous ferromagnetic material and is entirely unaffected by increasing the maximum value of H once that value has been raised to the saturating point.

The design of equipment for obtaining both differential and integrated curves will now be considered. If we have an air-cooled solenoid whose length is large and whose winding depth is small compared with its diameter and feed it from an a.c. source, say the 50 c/s mains, the instantaneous flux density in the neighbourhood of the centre will be uniform and proportional to the magnetizing current. A small search coil placed in this region with its axis parallel to that of the solenoid will accordingly have an output voltage which is proportional to the rate of change of this flux density and hence to that of the magnetizing current. If now we place a sample length of magnetic tape inside the search coil, the output voltage will increase as a result of the magnetization of the tape. This voltage value is of little use to us as it stands since we require, not the total voltage, but the increase only. To extract this difference a second identical search coil is placed near, but not too near, the first and connected in series opposition to it. In the absence of the tape the combined output of the two coils will be zero. This balance will, however, be upset by the insertion of the tape, the resulting voltage being that due solely

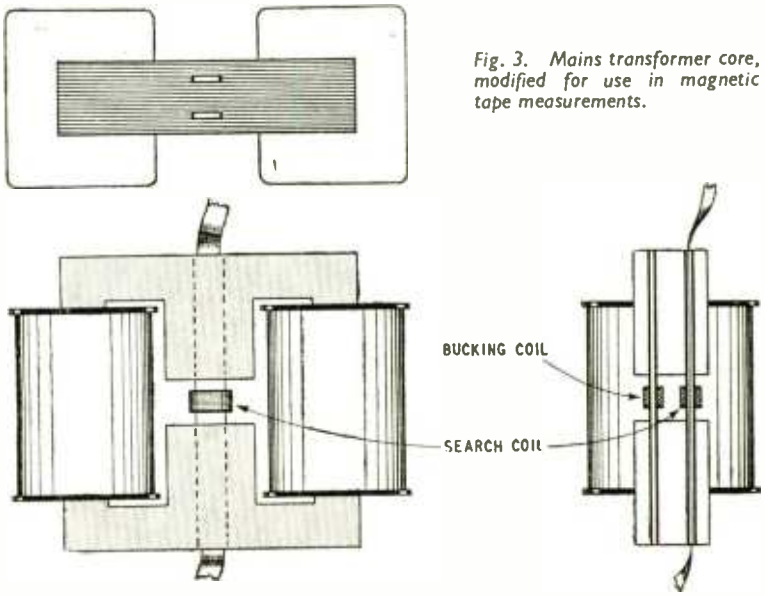


Fig. 3. Mains transformer core, modified for use in magnetic tape measurements.

to the induction in the tape. Theoretically, therefore, in order to present the differential curve on a cathode-ray tube, all that is needed is to apply this voltage to the Y-plate amplifier while a voltage proportional to the magnetizing current, obtained from the voltage drop across a resistance in series with the magnetizing winding, is applied to the X-plate amplifier.

Practical Precautions

In practice it is extremely difficult to design an air-cored solenoid to provide continuously the necessary alternating H of 1,000 oersteds maximum without overheating, but the use of an iron core with a large air gap will solve this problem. A core corresponding to the larger size of radio-receiver mains transformer is quite suitable provided the centre limb is cut away sufficiently to give the necessary gap and some of the inner laminations clipped back to form an aperture down which the tape can be threaded as indicated in Fig. 3. A tube of non-magnetic material of correct cross-section to accommodate three or four samples of standard ¼in-wide tape is introduced into this aperture and the search coil, located in the air gap, surrounds it. The compensating or bucking coil is also placed in the gap but separated slightly from the first. If the closest possible symmetry is desired, two identical apertures can be provided, equidistant from the centre line of the core, one for the tube and search coil, the other for the bucking coil. The magnetizing winding is wound on the two outside limbs of the core.

The search coils should be as small as possible to ensure intimate linkage with the tape flux and uniform flux density across the coil. As, however, they must be wound with several hundreds of turns to provide adequate sensitivity—and probably even then require the help of a pre-amplifier—a wire gauge of 48 to 50 is essential. The leads from the coils must be closely twisted together to prevent stray pick-up and taken to a terminal panel some few inches away from the core.

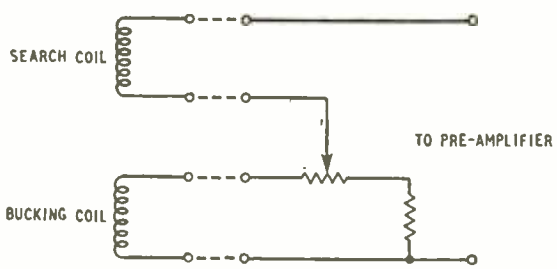
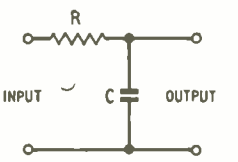
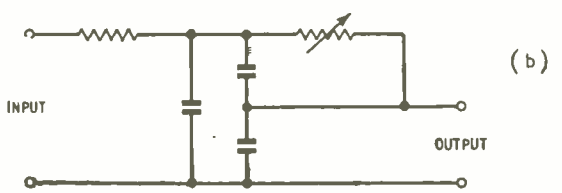


Fig. 4. Circuit showing position of the balancing potentiometer.



(a)



(b)

Fig. 5. (a) Basic integration circuit, (b) circuit giving zero phase error at the fundamental frequency.

It is too much to hope that, even if initial balance between the coils is achieved by adjustment of turns, this balance will be maintained permanently. Accordingly, the leads from the two coils should be taken separately to the pre-amplifier, where a small adjusting potentiometer is provided as shown in Fig. 4. Adjustment for balance is made by raising the magnetizing current from zero to maximum with no tape in the unit and full gain in the Y-plate amplifier. Under these conditions there should be no vertical deflection of the trace. Actually, this is likely to prove a council of perfection, even with the help of the potentiometer, owing to slight deviations from 180 degrees of phase between the coils. Final balance will be achieved either by adjustment of coil position or earthing point or the insertion of a piece of lamination into the gap near the compensating coil.

As implied above, provision must be made for full control of the value of the magnetizing current, and this is best effected by driving the magnetizing coils from a Variac transformer. In order to permit earthing of these coils, an isolating transformer should also be included.

The oscilloscope and its amplifiers should be checked for phase error, which will almost inevitably exist to some extent in the low-frequency range employed. A satisfactory test is to apply a 50 c/s voltage to the X-plates and at the same time a small fraction of the same voltage, derived from a resistance potentiometer, to the Y-plate amplifier. The appearance of a closed loop on the screen indicates phase shift in the amplifier and this must be reduced as far as possible by such means as increasing the values of bypass and coupling capacitors. The same procedure should then be carried out on the X-plate amplifier. As regards the type of oscilloscope, a double-beam tube is recommended because of the advantages to be gained by using the second trace as a marker.

Integrating Networks

As already explained, the hysteresis loop is obtained from the differential curve by integration and accordingly all that would appear necessary would be the insertion of an integrating network somewhere between the junction of the search coils and the Y-plates. In fact, care is needed in the choice of the network and as some loss of grain will certainly be involved, an additional stage of amplification will be required. The basic integrating network is the well-known RC combination shown in Fig. 5(a) but if it is used, the value of C will have to be made so large relative to R in order to avoid undue phase error that the insertion loss will exceed 40 db. This network, too, has the particular drawback of introducing a greater phase error for the fundamental frequency than for the harmonics, whereas the reverse is the lesser evil. The rather more elaborate network of Fig. 5(b) can be designed to give zero error at the fundamental frequency and only 0.3 degree at the 3rd harmonic for an attenuation not exceeding 25 db, and is therefore much more suitable for our purpose. Obviously the most convenient place for the integra-

(*Continued on page 267*)

tor and the additional stage of amplification is in the pre-amplifier, where arrangements can easily be made to switch both in and out as required.

It now remains to discuss briefly the two curves which should, of course, be similar to those shown in Fig. 2. Provided $H_{max.}$ is sufficiently high to take the tape up into saturation, both remanence, OB or OE, and coercivity, OC or OF, can be read directly off the hysteresis loop. The coercivity can also be determined, and somewhat more accurately, from the differential curve by measuring the distance between the peaks and the B-axis. Provided all mains pick-up has been removed from the trace and the centring is frequently checked, no difficulty should be experienced in reading to an accuracy within 5 per cent.

As suggested right at the beginning, the values of coercivity and remanence do not strictly apply to the conditions under which tape is normally used: nevertheless they prove in practice extremely useful for comparison purposes. In much the same way the height of the peaks in the differential curve is worth noting. It represents the maximum value of the slope of the hysteresis loop and would accordingly be a direct measure of sensitivity if the operating curve extended to saturation as this does. Even so, in comparison tests a high peak can infallibly be associated with a high sensitivity. It might also be expected that the degree of flatness of the top of the peak would indicate the undistorted output capacity of the tape. Unfortunately, on the normal cathode-ray tube the peaks are never sufficiently wide to show any sensible flatness on the top.

Perhaps the most striking feature of the differential curve is its sensitiveness to inhomogeneity of the magnetic material in the coating. If this coating contains two magnetic materials of different coercivities, it is very unlikely that the hysteresis loop will betray the fact. On the other hand it is equally unlikely that the differential curve will not. The presence of more than one component will be revealed by either asymmetry of the peak or even possibly a subsidiary peak as shown in Fig. 6.

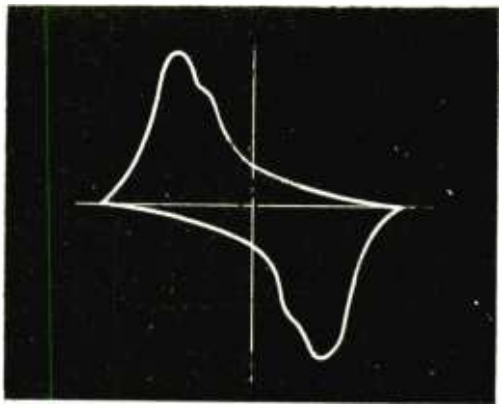


Fig. 6. Distortion of the differential curve due to inhomogeneity of the magnetic material.

It is doubtful whether all useful information extractable from the curves has been covered in this article. That must be left to the user's experience and own particular interests. It only remains to point out that, the more elusive the detail sought, the greater the care needed in balancing the coils and eliminating the last traces of phase error and mains pick-up when the apparatus is finally set up.

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A Textbook of Radar, by the Staff of the Radiophysics Laboratory, C.S.I.R.O., Australia. Second edition, edited by E. G. Bowen, Ph.D., M.Sc. Broad survey of fundamental principles and their practical realization. Chapters are devoted to the applications of radar in navigation and surveying, and to meteorology and the physical sciences. Pp. 617+XIII; Figs. 352. Price 45s. Cambridge University Press, 200, Euston Road, London, N.W.1.

L'Ionosphère, by G. de Maximy. Treatise on the principles of forecasting frequencies for optimum propagation in telecommunications. Pp. 54; Figs. 23. Price 750 Fr. Editions Chiron, 40, rue de Seine, Paris, 6.

Automatic Voltage Regulators and Stabilizers, by G. N. Patchett, Ph.D., B.Sc., A.M.I.E.E., A.M.Brit.I.R.E. Wide survey of electro-mechanical and electronic methods of regulation, including a bibliography of more than 600 references. Pp. 335; Figs. 196. Price 50s. Sir Isaac Pitman and Sons, Parker Street, London, W.C.2.

Television Engineers Pocket Book. Edited by E. Molloy and J. P. Hawker. A compendium of data for dealers and servicemen, including chapters on current practice in television receiver design and fault diagnosis. Pp. 228, Figs. 104, and numerous tables. Price 10s 6d. George Newnes, Tower House, Southampton Street, London, W.C.2.

Introduction to Colour TV, by M. Kaufman and H. Thomas. Description of N.T.S.C. (American) colour television system and analysis of typical receiver circuits. Pp. 140; Figs. 74 Price $2.10. John F. Rider, Publisher, 480, Canal Street, New York, 13.

Highlights of Colour Television, by John R. Locke, Jr. Introduction to principles of colour television as exemplified by the American National Television System Committee's recommendations. Pp. 44; Figs. 29. Price 99 cents. John F. Rider, Publisher, 480, Canal Street, New York, 13.

TV Manufacturers Receiver Trouble Cures. Edited by Milton S. Snitzer. Volume 5 of a series dealing with American commercial receivers. Pp. 109; Figs. 47. Price $1.80. John F. Rider, Publisher, 480, Canal Street, New York, 13.

Specialized Home and Portable Radio Manual. Volume 8. Service data covering R.C.A. receivers issued between June, 1951, and December, 1953. Pp. 96 with numerous illustrations. Price $1.65. John F. Rider, Publisher, 480, Canal Street, New York, 13.

Thyratron Inverter
A Correction

In the circuit of Fig. 7, p. 240, May issue, the top end of the 3-Ω, 1-W resistor in the switching circuit should go to the moving arm of the switch, and not to the "on" contact.

Further Notes on the Midget

Details of Chassis Layout and Circuit Additions for Long-wave Reception

By J. L. OSBOURNE

THIS article gives constructional details of the receiver, theoretical aspects of which were described last month. Details are also given of a method of adding a long-wave band to the receiver, such a band being necessary because there are large areas of this country in which best reception of the Light Programme is provided by the B.B.C. long-wave transmitter on 200 kc s. The photographs illustrating this article show the cabinet and method of chassis construction adopted by the author for the single and two-band versions and the full circuit diagram of the two-band receiver is given in Fig. 1.

It was originally intended to use a long-wave bandpass filter employing two LC circuits coupled as on medium waves, but such an arrangement has a number of disadvantages. For example, it is necessary to have a tapping point on the second long-wave inductor to feed the crystal, and a change over switch is necessary to select the medium- or long-wave tapping point as desired. One would be extremely fortunate to obtain a commercial inductor with a suitably positioned tapping point and in general hand-wound coils would be used. Moreover, to give a pass band of approximately 10 kc s at 200 kc s, a coupling coefficient of the order of 1/30 is necesssary and, if the long-wave inductors have a value of 2.2 mH, the coupling transformer requires primary and secondary inductances of approximately 70μH. Though not impossible, it is difficult to wind by hand two inductors of this value on a small former although, of course, it would be fairly simple to do so using a dust-iron core of the type used for medium-wave tuning inductors. If the long-wave coils have Q values of 100 (a typical practical value) a coupling coefficient of 1/30 is more than three times critical coupling and the frequency response has pronounced " rabbit's-ears." To avoid this, the coils can be damped by parallel resistors, but this reduces the gain. Thus, as pointed out in last month's issue, the addition of the long-wave band is by no means as straightforward as might be imagined.

It was considered unnecessary to go to the lengths detailed in the previous paragraph to obtain reception on a band containing so few signals, and a simple circuit was therefore sought which would permit the use of untapped commercial coils and would not require a coupling transformer. After some experimenting, the method finally adopted is that shown in Fig. 2. The long-wave coils L_5 and L_6 are simply coupled by a small capacitor C_{20} between their " hot " ends ; although this circuit has the appearance of a bandpass filter it would be flattery to call it so.

The inductor L_6 is very heavily damped by the detector which is effectively in parallel with it. This damping is more serious than on medium waves because, for a given Q, a long-wave coil has approximately five times the dynamic resistance of a medium-wave coil. In fact the effective Q of L_6 is probably less than 1/6th of its nominal value because of detector damping. On the other hand L_5 is relatively undamped, having only the anode a.c. resistance of V1 (1 MΩ) across it. When two coils of markedly different Q values are coupled, the resulting response

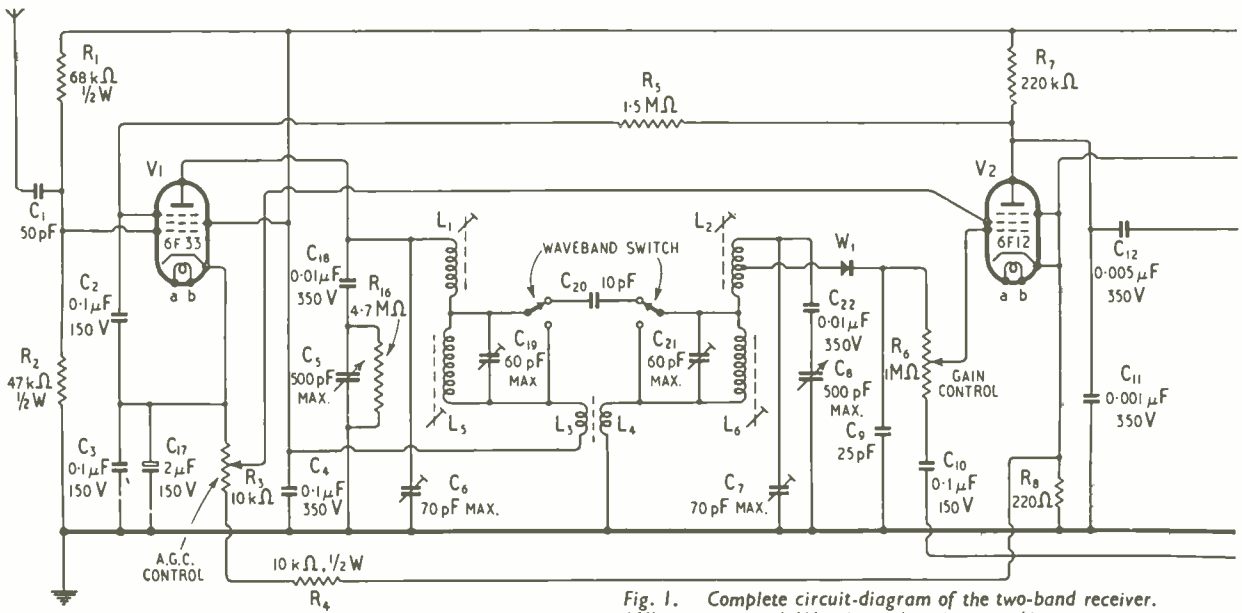


Fig. 1. Complete circuit-diagram of the two-band receiver. (All resistors are ¼-W unless otherwise stated.)

Sensitive T.R.F. Receiver

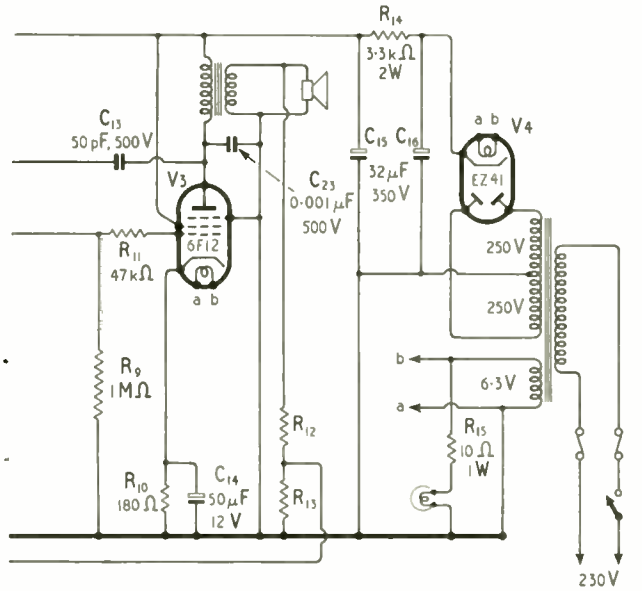
bears little resemblance to the wanted flat-topped curve. The capacitor C_{20} is in effect a matching component and is used in much the same way as the coupling capacitor in the "Modern Crystal Set" described by B. R. Bettridge in the September, 1951 issue of *Wireless World*.

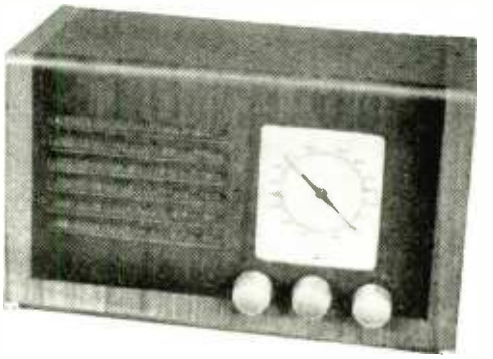
The optimum value for C_{20} was found by experiment to be approximately 10 pF. With this value the sensitivity of the receiver on long waves is of the same order as on medium waves and in the London area it was found possible to receive three signals including the Light Programme at good entertainment level.

The method of waveband selection can be followed from Fig. 1; the long-wave coils L_5 and L_6 are connected in series with the medium-wave coils L_1 and L_2 respectively. In one position of the 2-pole 2-way switch L_5 and L_6 are short-circuited to give medium-wave reception; in the other position the switch connects the coupling capacitor C_{20} between the "hot" ends of L_5 and L_6. The coupling transformer L_3L_4 is in circuit on both wavebands, but it has negligible effect on the long-wave performance because the mutual inductance between the windings (of the order of 1 μH) is so small compared with the inductance of L_5 and L_6 (approximately 2 mH).

A minor modification found necessary in the long-wave receiver is the addition of a 0.001-μF capacitor C_{23} from V3 anode to earth. This is necessary to prevent instability at high settings of the volume control, the r.f. filtering being less effective than on medium waves. The trouble is due to the proximity of the anode lead of V3 to the tuning inductors and can be cured alternatively by screening the lead.

In the original circuit the fixed vanes of one section of the tuning capacitor are at h.t. potential and, with the close vane spacing used in modern components, it was found that sparking tended to occur between





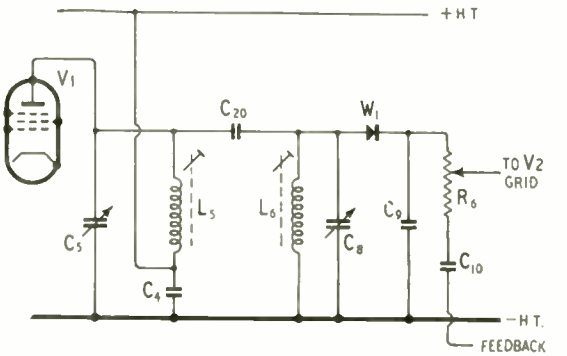


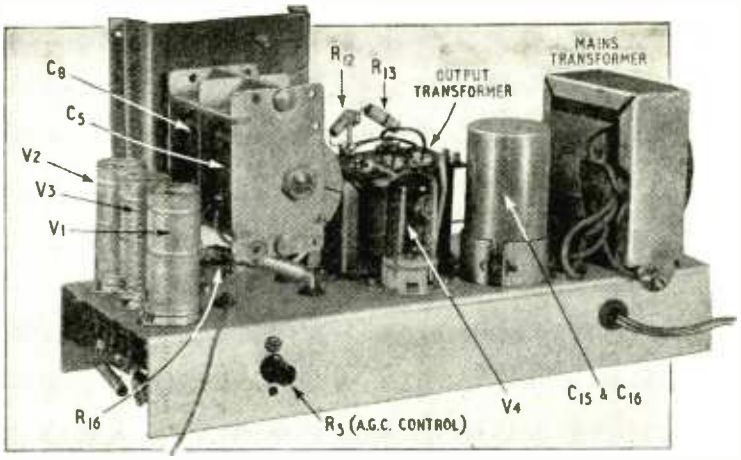
Fig. 2. Essential features of long-wave tuning arrangements.

fixed and moving vanes at certain settings of the tuning capacitor, particularly when it was briskly rotated. This is avoided in the circuit of Fig. 1 by the inclusion of a 0.01-μF capacitor C_{18}, the fixed vanes being earthed by the 4.7-MΩ resistor R_{16}, which is too high to give appreciable damping of the tuned circuit. To prevent misalignment a similar component C_{22} is connected in series with the detector section of the tuning capacitor. These additional series capacitors cause approximately 5 per cent. reduction in the maximum capacitance of the tuning capacitors and increase the lowest frequency receivable on medium waves to approximately 580 kc/s. If the full frequency coverage is required, it can be obtained by increasing the number of turns on L_1 and L_2 to 60. Alternatively, curtailment of the band can be avoided by using larger capacitors (say 0.1-μF) for C_{18} and C_{22} but the smaller capacitors were used by the author to conserve space.

A tendency has been noted in a receiver constructed to the circuit shown last month to oscillate at a very low frequency when tuned to a very strong signal and with a high volume control setting. The receiver does not always exhibit this behaviour and, when present, it occurs only on the strongest signals, disappearing on slight mistuning and on reducing the output volume. This has been traced to the variations in h.t. voltage which occur at high volume settings (the maximum undistorted output of the receiver is less than 1 watt). These variations affect the gain of earlier stages and set up steady oscillation. This

effect can be eliminated by connecting a small electrolytic capacitor (C_{17}) from V1 cathode to earth. Any capacitance greater than 2 μF is adequate and the voltage rating need not exceed 150 volts.

The dial lamp is a 6.3-volt 0.3-amp. type operated from the l.t. winding of the mains transformer via a 10-Ω, 1-W resistor R_{15} which drops the voltage available at the lamp to approximately 4. This reduces the brightness of the bulb, but the tuning scale is still adequately illuminated. The series resistor was included to give the bulb a long life; the author has used this technique for some time and has some bulbs which are still giving satisfactory illumination after more than five years' operation.

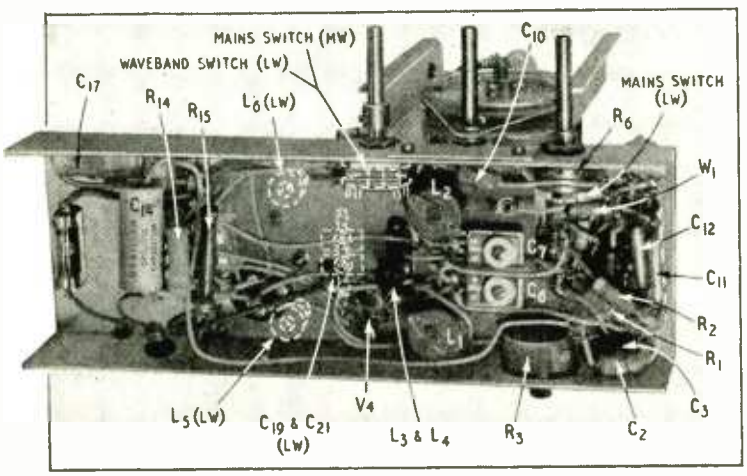


Principal components mounted above the chassis.

The accompanying photographs illustrate the method of construction used by the author for the single- and two-band models, the additional components required for long-wave reception being indicated in dotted lines. The receiver is housed in a cabinet measuring 5in × 5¾in × 11½in (outside measurements). The chassis measures 3½in × 1⅝in × 10½in, the front-to-back measurement being 1 inch smaller than the corresponding internal measurement of the cabinet, to leave room for the loudspeaker and the tuning drum drive. The chassis is spaced from the front of the cabinet by a folded piece of aluminium which supports the tuning capacitor, the tuning scale and the indicator lamp.

To keep hum at a low level, the three valves are grouped at one end of the chassis and the mains transformer is mounted at the other, the intervening space on the top of the chassis being occupied by the rectifier, smoothing capacitors, output transformer and tuning capacitor. Under the chassis, almost all the components associated with V1, V2 and V3 are mounted on the valve-holder tags or on two 5-way tag strips mounted on either side of the line of valves. The 50-μF cathode decoupling capacitor C_{11} is, however, rather bulky and is secured to the tags of a 7-way tag strip underneath the mains transformer. This tag strip also serves to terminate the l.t. winding and to support the resistor R_{15}. All the inductors and trimmers are located in the centre of the chassis near to the waveband switch. To facilitate alignment these are all adjustable from underneath the chassis. The a.g.c. control is mounted on the rear flange of the chassis and, when the chassis is in position in the cabinet, the adjusting screw projects through a hole in the back of the cabinet. A.g.c. can therefore be adjusted without removing the back from the cabinet. Once set, however, the a.g.c. control needs very little attention. The author's receiver has been in use for several months and during that time there has been no need to touch this control.

In the single-band model the three knobs control the volume, tuning and a rotary mains on-off switch, but in the two-band model the on-off switch is combined with the volume control and the third knob controls the miniature Yaxley-type waveband switch. This is a 3-pole, 2-way type of which two poles are used. The additional coils and trimmers required for long-wave reception are accommodated under the chassis near the waveband switch as shown in dotted lines. Fairly small components are necessary to fit into the space available and the trimmers are a pair of miniature compression-type capacitors of 60-pF maximum capacitance mounted on a steel strip attached to the chassis by stand-off pillars. The long-wave coils are Osmor Type QA6.



Underside of chassis showing modifications and positions of additional components for long-wave reception.

Long-wave alignment should be carried out after the receiver has been aligned for medium-wave reception as described in last month's issue. Long-wave alignment should then be carried out in the following way. Adjust C_{19} and C_{21} for maximum output with a modulated input at 350 kc/s and the tuning capacitor set to maximum capacitance, and adjust L_5 and L_6, for maximum output with a modulated input at 150 kc/s. Finally repeat the initial adjustment at 350 kc/s.

The quality of reproduction of this receiver is extremely good and, in fact, the excellent response to frequencies above 5 kc/s is an embarrassment during medium-wave listening after

dark, each heterodyne whistle being reproduced with uncomfortable clarity. Constructors with an interest in experimenting might care to try the effect of increasing the value of C_{13} to reduce the high-note response; it might even be anadvantage to use a 300 or 500-pF variable capacitor to act as a variable tone control.

Radio Receiver Measurements

International Recommendations on Methods of Testing Sound-broadcasting Receivers

PUBLICATION 69* of the International Electrotechnical Commission, like others in its series, expresses "as nearly as possible, an international consensus of opinion" on its subject, and the national committees represented on the I.E.C. are pledged to bring their own countries' rules into harmony with the recommendations "in so far as national conditions will permit."

Comparing the scope of this document with the British Standard Glossary of the same subject, recently reviewed†, one observes that it includes a number of characteristics omitted from BS.2065—notably hum, square-wave tests, stability of tuning, automatic frequency correction, acoustic feedback and radiation—and in the single matter of frequency response characteristics it even specifies conditions for acoustical measurement; in spite of this, the treatment is on the whole simpler. It owes a great deal to the American I.R.E. "Standards on Radio Receivers," a number of clauses being almost word for word. But there are some rather surprising differences; for example, the standard dummy aerial, which, although based on the form that has long been familiar, shows some changes in component values. This, however, is only the beginning of the section on dummy aerials, which are dealt with much more thoroughly than usual. Not only is provision included in the type shown here for correcting the output resistance of one signal generator, and for two-signal tests with 1:1 and 10:1 ratios, but additional units are specified for simulating indoor aerials over two ranges of frequency, car aerials, and pick-up by mains. Procedure for frame-aerial receivers is laid down in detail.

The standard 30 per cent modulation at 400 c/s is retained, and so is the 50 mW standard output, but 5 mW and 500 mW are allowed as alternatives to meet special conditions.

The method of hum measurement provides data from which behaviour on supply mains of different waveforms can be predicted: along with pure d.c. or sinusoidal a.c. is applied 2 per cent audio frequency varied over the whole of the a.f. range, and a curve is drawn of hum output against this frequency; mains-frequency harmonics in the output are also noted, and tests are repeated with different levels of unmodulated carrier wave present, to show modulation hum.

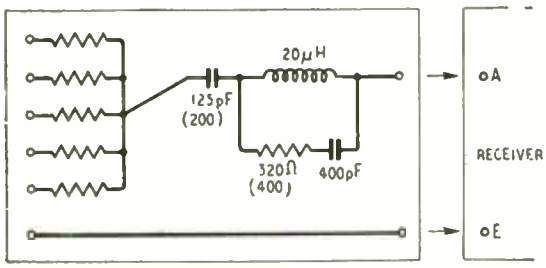
In contrast to the considerable amount of detail on these and other subjects, the methods of measuring harmonic distortion (total and individual) are dismissed in five lines, with no diagram. It might be expected that this brief treatment would provide room only for broad principles, so it is surprising to read that "During the measurement the loudspeaker has to be in its normal position."

The two common methods of intermodulation measurement are indicated, along with a note that disagreement among the principal workers in this field precludes rigid standards at the present time.

It is a pity that the wording of this international technical document should sometimes be so slipshod. For example, in Clause 21.3: "In the case of a loudspeaker for which the magnetic field is produced by a D.C. current, only the current in the speech coil should be considered for hum measurements." One might ask, what if the loudspeaker has not got a case? And, seeing that "D.C." presumably stands for "direct current," what is the significance of "D.C. current"? Wherever the words "the case of" occur (which they do frequently) the sense would be improved by striking them out. But these details apart, what exactly does this particular instruction mean? The French version fails to supply a clue, for this sentence is omitted from it! Unfortunately, badly expressed and ambiguous instructions are by no means rare.

Nevertheless, this publication does bring together a series of measurements well calculated to determine the practical capabilities of receivers within the terms of reference, with due regard (except, possibly, in the acoustic measurements) for what is reasonably practicable in equipment; and it is to be hoped that it will help to eliminate unnecessary differences in the basis of reckoning receiver performance. The fact that we have had to wait until now for an international recommendation on a.m. broadcast sound receivers emphasizes the need, as regards f.m. and vision receivers, for early and close collaboration between workers in all countries, so that differences can be eliminated before they have become too firmly rooted.

M. G. S.



The I.E.C. standard artificial outdoor aerial for 0.15-26.1 Mc s differs from the American I.R.E. specification by two component values (I.R.E. values shown in brackets) and by the addition of five resistors for matching to one or two signal generators. Their values are such as always to bring the total generator output resistance to 80 Ω, regardless of whether one or two generators are in use.

* "Recommended Methods of Measurement on Receivers for Amplitude-Modulation Broadcast Transmissions" (First Edition). Central Office of the I.E.C., Geneva, Switzerland. 1954. Price: S.Fr.10.

† BS.2065:1954. See *Wireless World*, April 1954, p. 188.

Valves for Bands III, IV and V

Half Way Between Ordinary Electrode Structures and Disc-Seal Techniques

By D. N. CORFIELD* D.L.C., A.M.I.E.E

RECEIVING valves for Bands III, IV and V generally differ from those used in lower frequency bands because it is essential for the r.f., mixer and i.f. stages to give more gain in order to achieve a similar signal-to-noise ratio. Television receivers for Band I generally have an i.f. not exceeding 20 Mc/s, a pentode mixer and a single pentode r.f. stage, and a signal-to-noise ratio between 6 and 8 db is achieved in good designs. This figure may not be obtained, however, on all channels in Band I unless a modern type of r.f. pentode is used. Earlier types of r.f. pentode such as the 8D3, 6F12, Z77 and EF91 developed during the war have a single cathode connection, with the result that their input impedance is about 8.9 kΩ at 45 Mc/s but only 3.8 kΩ at 67 Mc/s. This value is below the critical damping necessary for the bandwidth required, so the gain is lower and the noise worse for Channel V than for Channel I.

Modern r.f. pentodes such as the 6BW7, 6BX6 and EF80 have two separate connections from the actual cathode to the circuit, one being used for the input circuit and the other for the output circuit. This avoids a common cathode impedance in both circuits (inductance of the single lead) which normally couples them together and has the effect of lowering the impedance of the input circuit. As a result of this technique the input impedance of the 6BW7, for example, is 18 kΩ at 45 Mc/s and 6.5 kΩ at 67 Mc/s. These figures are twice as high as those of the earlier types.

Current television receivers designed for use on both Bands I and III use a higher i.f., usually around 34-35 Mc/s, and the improved input impedance of modern r.f. pentodes is desirable here also. This is because it is not a good thing for the circuit damping (necessary for bandwidth requirements), to be provided wholly by the valve, since replacing a valve could change appreciably the i.f. response characteristics.

These points are mentioned because the use of multiple connections is a feature of valves designed for the higher frequencies, although such connections are not necessarily always to the cathode.

The front end of receivers for Bands I and III usually takes the form of a multiple-position tuner comprising an r.f. stage and a mixer/oscillator, the tuned circuits being switched by ganged switches and

* Standard Telephones and Cables.

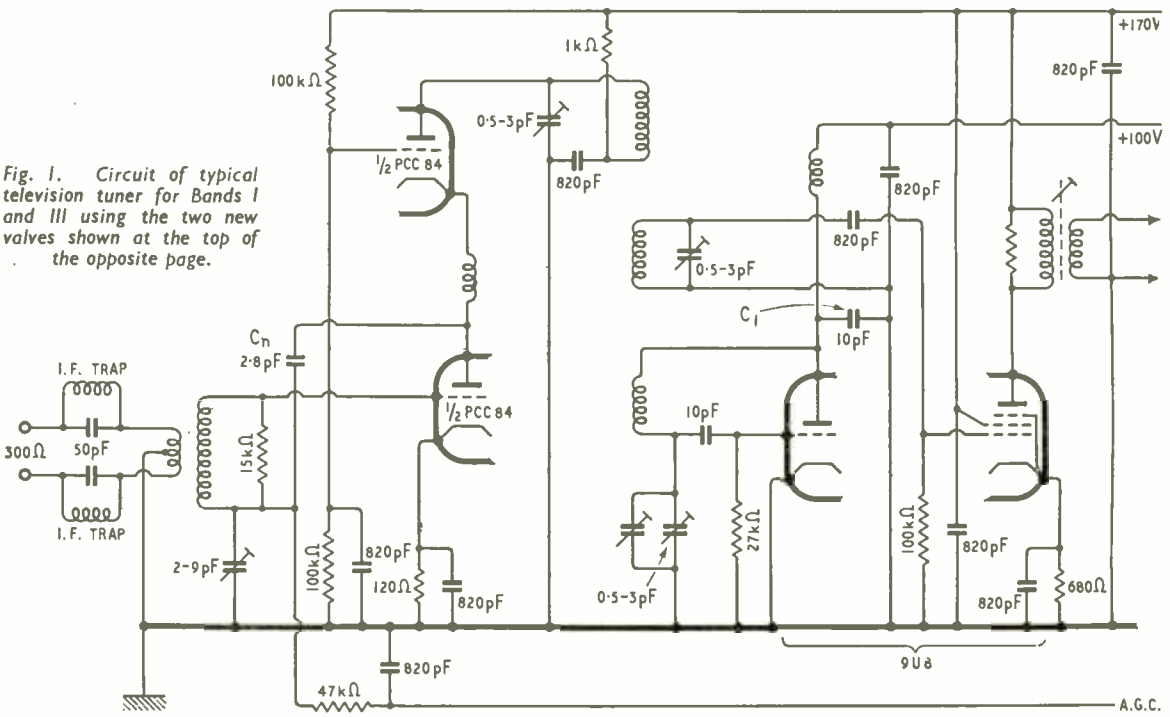


Fig. 1. Circuit of typical television tuner for Bands I and III using the two new valves shown at the top of the opposite page.

rotated on a turret. In order to conserve space and obtain improved performance new mixers have been designed, and these are generally triode pentodes. Typical examples are the 6U8/ECF82 and ECF80 with their a.c./d.c. versions 9U8/PCF82 and PCF80. These valves have much higher triode and pentode slopes than the types of triode pentode with which we are familiar. The 6U8, for example, has a triode slope of 8.5 mA/V and a pentode slope of 5.2 mA/V. The high triode slope ensures ready oscillation and the high pentode slope good conversion conductance as a mixer. Apart from the heater the two units are quite separate and this tends to reduce the possibility of oscillator radiation *via* the mixer portion.

The r.f. stage for such tuners does not use an r.f. pentode but a double triode in a "cascode" circuit. Triodes will always give lower noise than pentodes because of what is known as partition noise. The cathode current of a pentode comprises two portions, the anode current and the screen current, and both contribute to the noise but only the anode current to the useful signal. A pentode has, as a first approximation, three times the noise it would have if used connected as a triode. There are, of course, some snags in using triodes as r.f. amplifiers and they normally need to be neutralized in order to achieve stability. The cascode system is a trick which creates a stable circuit from two triodes.

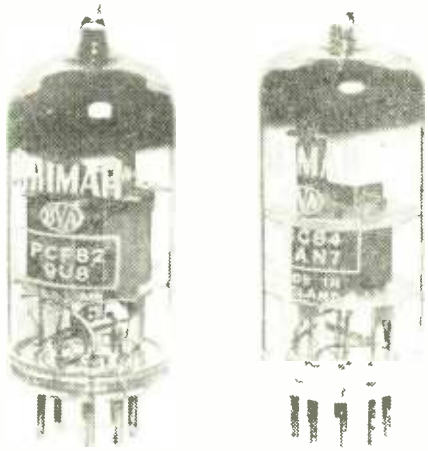
Fig. 1 shows a typical tuner circuit for Bands I and III. The lower triode of the first valve is used with an earthed cathode and the upper one with an earthed grid. The lower section has a fairly high input impedance but gives little gain except for the step up in the input transformer because it is working into the cathode impedance of the other section, which is very low. This upper section gives quite a good gain and the overall result is a gain from the aerial input to the mixer grid of about ten times (23 db). There is often a small coil between the anode of the first triode and the cathode of the second one, and this is for peaking the frequency characteristic of the circuit above 200 Mc/s to improve the gain. A small neutralizing capacitor is connected from the anode of the first section to the series-tuned grid circuit; this is not primarily for the purpose of obtaining stability but for improving the signal-to-noise ratio. Valves suitable for this circuit are the PCC84/7AN7, 6BQ7A, 6BK7A and 6BZ7; these give a noise ratio of about 7 db.

The mixer circuit is conventional except that a negative temperature-coefficient capacitor C_1 is required across the oscillator tuned circuit, otherwise the frequency drift is excessive. The maximum drift on Band III allowable in this country is rather less than in the U.S.A. and on the Continent because we use a.m. sound as against interchannel f.m. A proposed B.R.E.M.A. figure is 50 kc/s maximum.

Conventional British multi-channel tuners use very tiny coils for the circuits; some, in fact, are just straps across adjacent switch contacts. Their Q is, therefore, poor and so is the L/C ratio, the C being mainly valve capacitance and strays. As a result the frequency stability is not very good.

Oscillator Drift Problem

One possible approach to the oscillator drift problem is exemplified in a Band III to Band I convertor designed by the author. The oscillator uses a trough tuned line, electron-coupled oscillator fashion. The triode grid is tapped two-thirds of the way up the line



New valves for Band III television tuners. On the left the 9U8 PCF82 triode-pentode frequency changer and on the right the PCC84 7AN7 double-triode cascode r.f. amplifier.

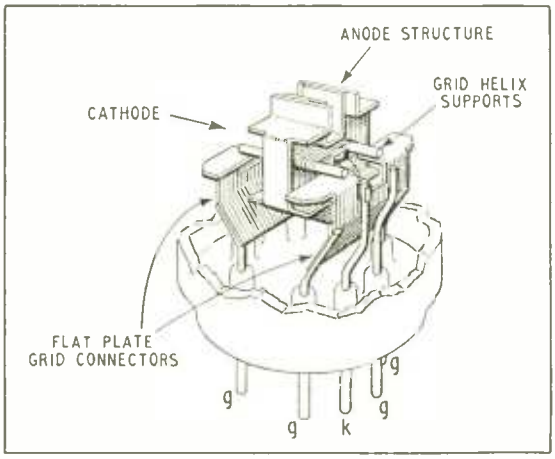


Fig. 2. Electrode structure of the 6AM4 triode, intended for earthed-grid operation up to 1000 Mc s. The grid is connected to five base pins (one not shown) through two flat metal sheets, which not only provide a low-inductance path to earth but shield the cathode and heater connectors from the anode. Flat strip is also used for the anode and cathode connectors.

and the cathode one-third of the way up, the heater lead being taken back inside the line. The two tuning capacitors, one variable (bandspread) and one fixed (bandset), are across the hot end of the line and the mixer is coupled to the oscillator cathode. Such a tuned circuit has a drift of 20 kc/s from cold and a drift of 100 c/s per volt for h.t. variations. Lines of this type need not be of any particular shape or size and can be bent, and if they are not required to be continuously tuned the capacitors can be switched in discrete steps. The author has used this type of tuned circuit for years in a receiver covering both the 2-metre amateur band and the 90-Mc/s f.m. band, and in fact it is not difficult to arrange this form of circuit to cover a frequency range of 3 to 1.

Valves for Bands IV and V require higher slopes and lower noise factors than for Band III. This can only be achieved by closer electrode spacings and

multiple connections to the essential electrodes. An example of such a valve is the 6AM4 which is an earthed-grid r.f. amplifier or mixer for use up to 1,000 Mc/s. Since the common electrode is the grid this uses five separate grid connections. In order to reduce the lead inductance the structure is mounted horizontally right down on the glass base (see Fig. 2). The slope of the valve is 9.8 mA/V.

Table I gives some idea of the increased difficulties of manufacture resulting from attempting to obtain similar performance at higher and higher frequencies. A quite modern type, the 12AT7, is given for comparison purposes. The 6AM4 has a grid-cathode clearance of only one-thousandth of an inch and the grid is wound with 1¼-thou' wire with a gap of two thous between turns. The reduction of grid-cathode spacing is necessary in order to maintain the required value of mutual conductance, and the grid-anode spacing has to be similarly reduced to keep the amplification factor in proportion. More turns per inch and thinner wire on the grid helix are an outcome of the generally smaller electrode structure. The valve will give a noise factor of about 6 db as an r.f. amplifier in Band IV and about 9 db as a mixer, and Fig. 3 at the bottom of the page shows a circuit including both these applications.

The corresponding oscillator valve is the 6AF4, which has a slope of 6.6 mA/V. It has two grid connections and three anode connections, as it is normally used with the cathode choked and the grid or anode earthed. More expensive valves, because of their construction, are the disc-seal types also known as lighthouse, planar, pencil or rocket valves. The grid, anode and, in the case of tetrodes, screen grid are brought out to discs or rings which can be clamped into the circuit and thereby provide a continuous and therefore infinite number of connections. These give even better performances than normal valves but in their present form are unlikely to be used in Bands IV and V for domestic television.

Crystal Mixture

A type of mixer commonly used for these bands is the crystal mixer, the most popular being the silicon type although germanium ones are also available. These mixers are somewhat critical of heterodyne voltage and give a conversion loss of about 6 db. A convertor can be made for Band IV with a noise factor of about 7 db if considerable care is taken. This figure can only be achieved if the first stage of the i.f. amplifier has very low noise, and this is usually obtained by using a cascode or neutralized triode for the first i.f. stage. It is also essential that the heterodyne voltage is free from noise and spurious frequencies. Since the noise output from the crystal is proportional to the crystal current generated by the applied heterodyne voltage, the presence of anything other than the frequency required (± a few cycles ideally) merely increases the noise without improving the signal. This is one effect responsible for poor noise figures in crystal mixers, particularly when the oscillator is operating at harmonic frequency or is generated by a lower frequency crystal, but it can be reduced by the insertion of a sharp filter or high-Q break between the heterodyne source and the mixer.

On all high frequency bands care must be exercised in the coupling between stages, particularly that between the aerial feeders and the first stage, and it should be remembered that the coupling that gives the maximum gain rarely gives the best signal-to-noise ratio. The lowest noise is usually obtained when the coupling is tighter than that required for normal gain.

Mention was made earlier of the importance of a low-noise r.f. stage to reduce the effect of mixer noise, and here it is worth noting the effect on noise factor of adding r.f. stages in front of a receiver in Band IV. With a noise factor about 6 db in the receiver, the addition of a disc-seal pre-amplifier of 20 db gain reduces this to 3 db while a further pre-amplifier brings it down to 2 db.

This article is based on a lecture recently given by the author to the Television Society.

TABLE I.—CRITICAL DIMENSIONS IN U.H.F. AND V.H.F. TRIODES

Valve Type	grid-cathode clearance	grid-anode clearance	grid turns per in.	grid wire size
12AT7 (double triode)	0.003in	0.015in	156	0.002in
PCC84/7AN7 (double triode)	0.00275in	0.013in	147	0.0015in
6BQ7A (double triode)	0.002in	0.017in	200	0.001in
6AM4 (single triode)	0.001in	0.008in	295	0.00125in

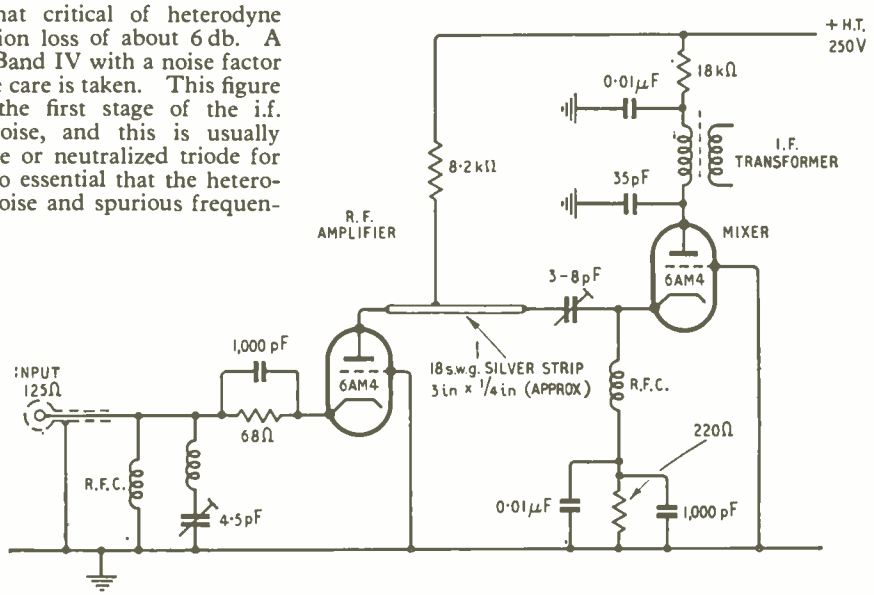


Fig. 3. The 6AM4 triode used as an r.f. amplifier and as a mixer in a Band IV receiving circuit (70 cm). The oscillator (not shown) is coupled inductively to the silver-strip line.

Piezoelectric Crystals

Survey of Physical Properties and Their Practical Exploitation

By S. KELLY*

BEFORE 1939 only two types of piezoelectric material were generally available; these were quartz and Rochelle salt. Quartz plates were used principally as resonators and oscillators, and Rochelle salt was the activating unit in crystal gramophone pickups. Since the end of the war an increasing number of piezoelectric materials have been made available, usually accompanied by cryptic initials which often mean less than nothing to the practising radio engineer unacquainted with chemical jargon; and he should not be blamed for misconceptions, especially when the various claims for different types of crystals appear to be mutually contradictory. Most of these new crystals have been developed with specific engineering applications in view and can be divided into two major classes: (a) as resonators, (b) as electromechanical transducers.

The underlying physical principle of these two types of crystal is identical, and the differences are of degree and application rather than fundamental. It is the purpose of this article to try to sort the sheep from the goats and at the same time establish some form of pedigree of the crystals used as electromechanical transducers, in particular those which are used in the manufacture of gramophone pickups.

Crystal Materials.—Quartz is still the major source of plates for precise control of frequency. It is interesting to note that bimorph† construction, at present extensively used on electromechanical crystal devices, was first introduced by the Curie brothers in their classic investigation of the piezoelectricity of quartz about 1880.[1]

Tourmaline is at present of little more than academic interest, although it has been used as a sub-standard for pressure calibration of microphones.

Ethylene diamine tartrate (E.D.T.) and dipotassium tartrate (D.K.T.) are used as resonators in crystal filters for carrier telephone systems. Their stability is sufficient for this application, and it is possible that they may replace quarts.

Lithium sulphate (L.H.) is used principally as a volume expander in high-frequency (ultrasonic) applications, but is largely being supplanted by ammonium dihydrogen phosphate (A.D.P.). Apart from A.D.P., none of the foregoing crystals finds any commercial use as transducers in gramophone pickups or microphones.

There are, therefore, only three general types of crystal available for use in commercial transducers. These are:—

(a) Sodium potassium tartrate (Rochelle salt),
(b) Ammonium dihydrogen phosphate (A.D.P.),
(c) Polycrystalline barium titanate (Ceramics).

There is a fundamental difference between the first two crystals and the third in that the former are single crystals grown from a solution, whereas the latter is an aggregate of micro-crystals sintered to shape. By virtue of the asymmetry of the basic crystal structure a voltage will be generated across two electrodes of a correctly oriented slab when a force is applied to it (usually but not always perpendicular to the faces which are furnished with electrodes). In the case of barium titanate ceramics in which the crystals are completely randomly oriented, the charges on the individual micro-crystals will cancel. By subjecting the fired and "electroded" slab to a high potential gradient the domains of favourably oriented micro-crystals grow at the expense of the others, and ultimately approximately 7 to 10 per cent of the domains are aligned in the correct direction.

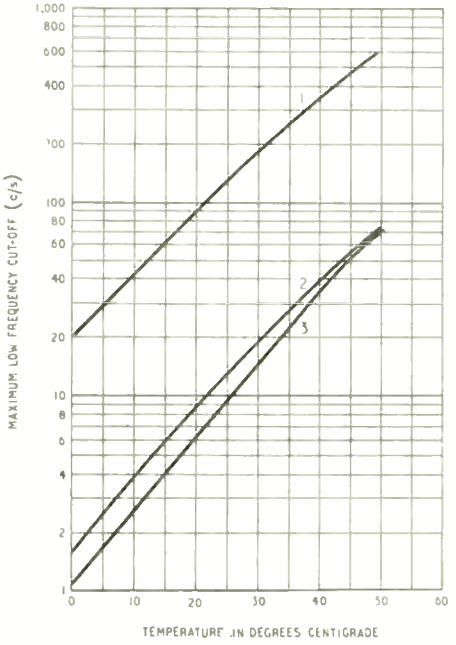


Fig. 1. Variation in low-frequency cut-off due to change of conductance with temperature in three grades of ammonium dihydrogen phosphate.

A.D.P.—Ammonium dihydrogen phosphate was developed at the beginning of the war to meet the need for high-power under-water transducers. It has a higher voltage sensitivity ("*g*" coefficient, discussed later) than Rochelle salt, but a very low dielectric constant, with the result that most A.D.P. crystal units are designed to work into a 5-MΩ load. This high value of load resistance can be reduced to a value of 1 MΩ and still maintain a satisfactory low-frequency

* Cosmocord, Ltd.

† A bimorph is essentially a mechanical transformer, consisting of two slabs of crystal material cemented together, with electrodes connected so that one element expands (for a bender type of crystal) or shears (for a torsional type) in one direction, while the other element contracts or shears in the opposite direction. The amplification of movement is $(L/T)^2$ where L is the length and T the thickness of the bimorph.

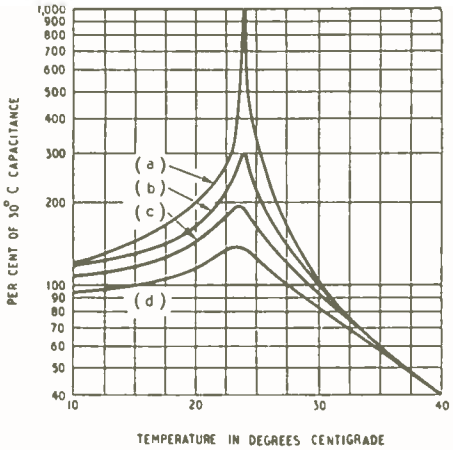


Fig. 2. Change of capacitance in Rochelle salt element with temperature. (a) X-cut plate, no restraint ; (b) torque bimorph, no restraint ; (c) bimorph mounted in pickup ; (d) bimorph set in casting resin.

response by shunting the pickup with a condenser of about four times the crystal capacitance; but the voltage sensitivity of the pickup will also be reduced by the same factor ($\times 4$). The capacitance is quite stable with temperature and pickups have successfully withstood the test of immersion in boiling water for half an hour with no apparent deterioration in performance.

There is, however, a snag! At frequencies below resonance, the crystal transducer behaves as a generator in series with a capacitance terminated with a resistance. In the case of Rochelle salt and barium titanate the conductance, G, is sufficiently small for it to be neglected, but in the case of A.D.P. the value is relatively high and variable, being a function of the purity of the crystal and the temperature. It is usual to express this conductance in terms of the low-frequency cut-off rather than an absolute value, and the cut-off frequency is that at which $G=\omega C$. This is the familiar -3 db point on RC-coupled amplifiers.

The graph, Fig. 1, shows the variation of low-frequency cut-off (-3 db point) with temperature for three different grades of A.D.P. These curves are taken under open circuit conditions and because of this disability and the low dielectric constant, A.D.P. is not often used as a transducer in pickups.

Rochelle Salt.—This compound has the highest electro-mechanical coupling coefficient of any commercially available piezoelectric material. It has a reasonably high dielectric constant, a low density and a fairly low Young's modulus, all of which combine, as we shall see later, to make a highly efficient wide-frequency-range bimorph. The capacitance versus temperature anomaly which occurs at the Curie point of 23.8 deg C can be a nuisance for some applications, but is not very important for gramophone pickups. Fig. 2 shows the variation of capacitance with temperature for Rochelle salt under four conditions; curve (a) is for a single shear plate, as cut from the virgin crystal, with no restraint, (b) is for a torsional type bimorph, again with no restraint, and curve (c) is the same crystal fitted into a gramophone pickup with correctly applied viscous damping and restraining members, and curve (d) is with the crystal firmly clamped. In the latter case the crystal was cast in a block of cold-setting Araldite "D" of approximately 1 inch cube. The above graph shows that the effect of the capacitance anomaly is strictly a function of the conditions under which the crystal is used.

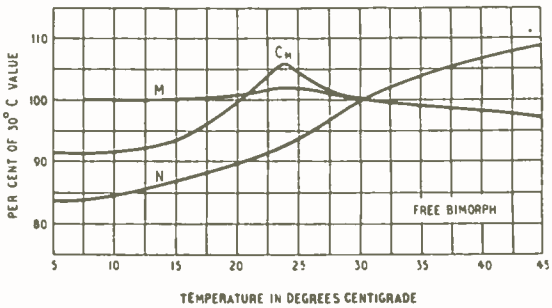


Fig. 3. Variation with temperature of effective mass (M), compliance (Cm) and the equivalent mechanical-electrical transformation ratio (N) in a free bimorph of Rochelle salt.

Fig. 3 shows the variation of the other constants with temperature; M is the effective mass, C_m compliance, and N the transducer ratio, all referred to 30 deg C. Except at very low frequencies the load impedance is considerably greater than the crystal impedance. The average value of the crystal used in present-day gramophone pickups is 1,500 ρF at 80 deg F (27.5 deg C) and this corresponds to a capacitive reactance of about 1 MΩ at 100 c/s. The crystal capacitance will be greater than nominal between 55 deg F (14 deg C) and 80 deg F, and the variation of low-frequency performance will be within 3 db over this temperature range.

Humidity does not present any serious problem with present-day commercially available pickups, although a limiting temperature of 45 deg C is imposed from practical considerations. At a temperature greater than 55 deg C the Rochelle salt will disintegrate in its own water of crystallization. The life of a crystal at 45 deg C can be considered infinite. At 55 deg C it is of the order of 18 months, at 60 deg C it is about 14 days and at 65 deg C it is about 30 minutes. The above figures were taken with normal production crystals fitted into hermetically sealed production type pickups. The ultimate life of a Rochelle salt pickup under normal used conditions is determined by the care and control exercised in the initial fabrication of the crystal to the point when it is hermetically sealed. If the crystal is not hermetically sealed, the life is only a few hours under humidity conditions of 95 to 99 per cent relative humidity and if the crystal contains any excess moisture at the time of sealing, its life will be reduced. Normally, in the crystal fabrication shops, temperature and humidity are controlled at 21 ± 1 deg C, 45 ± 2 per cent r.h. Under these conditions plain unprotected crystals can be stored indefinitely. Fig. 4 shows the relation between temperature and humidity for onset of dehydration, and beginning of solution, these being determined by (1) the point at which dehydration can be observed after 168 hours subjected to the conditions shown in the graph, and (2) in which the insulation resistance drops below 10,000 MΩ under the conditions specified. These curves are for unprotected, uncoated crystals.

Barium Titanate.—All the foregoing crystals (including quartz) can be grown from solution under carefully controlled conditions at temperatures between 25 deg C and 400 deg C, according to the type

of crystal.[3] The melting point of barium titanate is of the order of 1,500 deg C, and to the present date it has not been possible to grow pure barium titanate monocrystals larger than 1 or 2 mm side in commercial quantities. Barium titanate elements are, therefore, produced by a sintering process in which the carefully prepared primary materials (usually barium carbonate and titanium dioxide), together with various admixtures, are either slip-cast as in traditional pottery manufacture or mixed with a binder such as Bentonite and pressed to form on a tableting machine. The "green" slab is then fired in a sintering furnace at a controlled temperature which results in the material becoming a homogeneous solid mass. The consistency of the barium titanate at the sintering temperature is little stiffer than jam, and unless care is taken considerable distortion usually takes place especially if elements are of large area, unsupported, or of thin cross-section: the shrinkage is large and where precise dimensions of the finished product are required the fired slabs must be ground to size. (Part of the secret of successful manufacture of barium titanate is in obtaining the correct temperature for the correct length of time, the rest being careful chemical control, applied force and classic learning.) The resultant slab is an aggregate of micro-crystals of barium titanate randomly oriented. Whilst each individual crystal is piezoelectric they mutually cancel and the material behaves as a dielectric of high permittivity, but if the plate is subjected to a high unidirectional potential gradient for a period and this potential is then removed, the material will appear to be piezoelectric, and the magnitude of this phenomenon will be a function of the polarizing potential gradient and time.

Fig. 5 shows the variation of coupling coefficient versus polarizing potential gradient for pure barium titanate when applied for about 1 hour at room temperature, the polarizing voltage may be reduced to about half of this value if applied at just above the Curie temperature (about 120 deg C) and allowed to cool to lower than 50 deg C with the potential still applied: but it is usual to apply the maximum field consistent with the elements not breaking down during the polarizing process.

Above the Curie temperature (120 deg C) the crystal has a cubic form, the eight corners of the cube being barium atoms (each barium atom is shared between eight adjacent cells). One oxygen atom occupies the centre of each of the six sides, and since each is shared with the adjacent cell there are three oxygen atoms. The titanium atom is in the centre of the cell and is relatively free to move within it. It will normally be in a "potential well" adjacent to one or other of the oxygen atoms, but if the thermal energy is sufficient it may jump from the neutral position of one oxygen atom to any of the other five in a completely random manner. At temperatures below 120 deg C, the titanium atom will move permanently towards one of the oxygen atoms, the cell will assume tetragonal form (actually the length will increase by about 1 per cent in the direction of the titanium atom movement). If the titanium atoms in sufficient adjacent cells are locked in the same direction a domain will be formed and will be ferro-electric. The crystals (and therefore the domains) are randomly oriented in the sintered aggregate and no residual polarization will occur, application of a unidirectional bias will result in more and more domains aligning themselves in the direction of the electrical field as it is increased. At maximum field strength (just below the breakdown point) about 10 per cent of the domains are aligned in the direction of the field, and the plate has expanded by about 6 parts in 10,000 in that direction. On removal of the polarizing field it will be found that the majority of the domains remain aligned in the preferred direction.

Application of alternating potential to the plate will cause it to alternatively expand and contract, the absolute value of this mechanical variation being proportional to the applied voltage. The mechanical movement is probably caused by the growth and contraction in the preferred direction of the aligned domains at the expense of their neighbours, rather than any reversal in the domains themselves. The mechanical strain is quite considerable and can be well in excess of the elastic strength of the material. It is interesting to note that crystals firmly cemented (with a thermo-setting resin) to a heavy metal support and then polarized inevitably shatter when the polarizing field exceeds about 20-25 volts per 0.001in.

Various additions are made to the pure barium titanium oxide to improve its properties. The addition of strontium will reduce the Curie point, whilst the addition of lead will increase it. One particular artifice is to add zirconium, which increases the low-temperature transition point to a limit of approximately 45 deg C and which will give an enhanced "g" coefficient. This can be very important to gramophone pickup manufacturers, because it will result in a

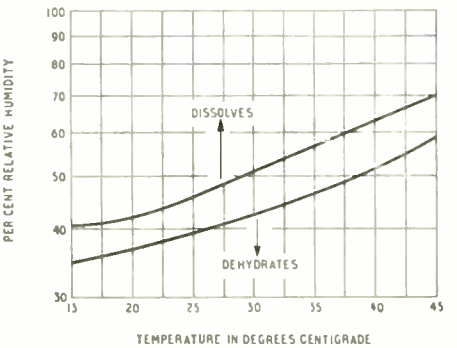


Fig. 4. Temperature and humidity in relation to the onset of dehydration and solution in Rochelle salt.

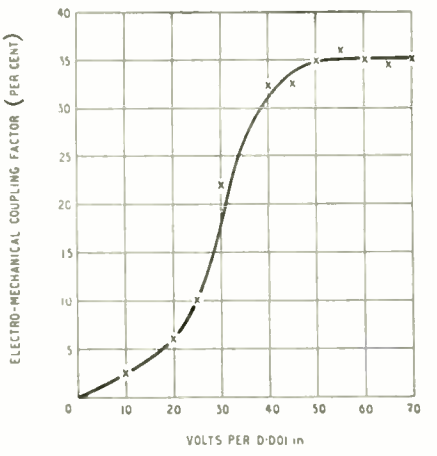


Fig. 5. Relation between potential gradient of polarization and electro-mechanical coupling factor in barium titanate.

sensitivity gain of approximately 3 db at temperatures below 45 deg C, but if the crystal is subjected to temperatures above this limit the coupling will revert to the lower value.

As stated before, the asymmetry of barium titanate disappears above the upper Curie point (about 120 deg C) and if a pre-polarized barium titanate aggregate is subjected to temperatures above about 80 deg C it will tend to lose its polarization. It has been found that minor quantities of impurities adversely affect the life of barium titanate, in some cases reducing the sensitivity by 50 per cent in a matter of weeks or months; the effect is quite unpredictable and to eliminate it requires most careful chemical control. The addition of lead or calcium has the effect of "locking" the domains so that the stability of the crystal is considerably improved, especially when used as a driver. The manufacturers will usually guarantee the sensitivity of the element to deteriorate by not more than 10 per cent over a period of one year.

The maximum coupling coefficient figures for pure barium titanate of 0.35 measured under laboratory conditions are not realized in practice, a value of about 0.2 being usual. This is due to two causes: (a) an admixture of lead or calcium, and (b) either by reversed polarizing or subjecting the crystal to elevated temperature for a short while, in order to stabilize the element. Fig. 6 shows the temperature dependence of barium titanate. The anomaly at about +5 deg C shows up as a hysteresis loop of the dielectric constant, dissipation factor and voltage output ("g" coefficient). It will be seen from the middle curve that if the unit is polarized at a temperature lower than the discontinuity (Y) and the temperature is increased, the "g" coefficient will decrease to some value, and then if the temperature is reduced below the discontinuity point the lower value of "g" will be obtained (Z). The the addition of zirconium will increase the temperature of discontinuity to a maximum of approximately 45 deg C, whilst the addition of lead will reduce it to about −20 deg C. Calcium will reduce the discontinuity temperature to still lower values.

Unlike Rochelle salt and A.D.P., ceramic bimorphs at present available are in bender form only. The coupling coefficient (and hence the conversion efficiency) is much lower than Rochelle salt and A.D.P. but barium titanate has the advantages of a higher working temperature than Rochelle salt, a high permittivity (about five times that of Rochelle salt and 100 times A.D.P.) resulting in a lower electrical impedance than other crystals for a given size of plate, and a stable capacitance temperature performance together with improved humidity resistance characteristic. It is not by itself completely proof against humidity, in that the insulation resistance of the bimorph will be reduced under conditions of high humidity due to absorption of water vapour, although the crystal can easily be dried out.

Crystal Coefficients.—Crystals are anisotropic, that is the various electrical and mechanical properties are different in different directions of the crystal and are not constant in all directions as are those of isotropic materials. Of the 32 known crystal classes, 20 will show piezoelectric effects (which are due to lack of symmetry of the crystal), and depending on the crystal asymmetry they may have from 3-21 elastic constants, 0-18 piezoelectric constants, and 1-6 dielectric constants.[1] Crystallographers refer these constants to the X, Y, and Z rectangular axes, and where crystals are cut at oblique axes (for instance, zero temperature coefficient cuts of quartz, etc.) transformation equations have been evolved by means of which the new constants can be calculated in terms of the standard constants."

TABLE 1

Comparative Table of Electromechanical Materials

Crystal and Mode	Strain out / Field in d	Dielectric Constant[1] κ	Field out / Stress in g	Elastic Modulus Y	Coupling Coefficient $k = \sqrt{d.g.Y}$	Specific Gravity	Frequency Constant[2] $\sqrt{Y}\,4\sqrt{\rho}$	Maximum operating temp. °C.
Rochelle salt (30°C.)								45
X-cut expander ..	165	200	0.093	31.0	0.69	1.77	2100	
Y-cut expander ..	27	9.2	0.33	10.0	0.30	1.77	1180	
A.D.P.								120
Expander	24	15.3	0.177	19.3	0.29	1.80	1630	
Quartz								550
Expander and thickness	2.3	4.5	0.058	80	0.10	2.65	2700	
Lithium sulphate								75
Thickness	16.0	10.3	0.175	46	0.36	2.06	2360	
D.K.T.								110
Expander	11.0	6.5	0.192	25	0.23	1.99	1770	
E.D.T.								100
XY-cut expander ..	11.3	8.2	0.156	26	0.22	1.53	2050	
Tourmaline								1000
Thickness	1.93	6.6	0.033	160	0.10	3.1	3600	
Barium titanate								100
Thickness	190	1700	0.0125	110	0.56	5.7	2200	
Expander	78	1700	0.0052	110	0.22	5.7	2250	
Multipliers—								
M.K.S.	10^{-12} m, V		V.m / Newton	10^{9} Newton / m²			c s. m.	
c.g.s..	10^{-10} cm, V		V.cm. 10^{-3} / dyne	10^{10} dyne / cm²			kc s. cm / 10	

[1] Relative to vacuum.

[2] The density ρ should be given in kg m³ in the M.K.S. system and is obtained by multiplying the specific gravity by 1000. The frequency constant is then obtained in c.s. m = kc s. mm.

Note: Expander units are used for making bimorphs.

The various constants have now been more or less standardized and are shown on Table 1, which lists the major piezoelectric crystals currently available for commercial use. This table relates only to expander modes, expansion and compression of crystal elements taking place either parallel or at right angles to the applied electric fields, and covers only the more useful expander modes of these crystals.

The dielectric, piezoelectric and elastic constants are interrelated and are given below; in order to prevent misunderstanding of the terms "stress" and "strain," the following definition is used in this article: —

When a solid body is in equilibrium under a given system of externally impressed forces, its state of deformation is called a "strain," while the forces, which necessarily occur in equal and opposite pairs, give rise to a "stress."

"d" Coefficient, Column 1.—This expresses the strain obtained for an applied electric field strength and practically is the ratio of expansion of the plate for the voltage applied. The direction of the expansion (i.e., a contraction is a negative expansion) is directly dependent on the sign of the applied field. It is usually in a direction perpendicular to the applied field although in special cuts such as the "L" cut in Rochelle salt it can be parallel to it. This condition holds whether the applied voltage is direct or alternating. The instantaneous increase in length of the crystal will be directly proportional to the instantaneous applied voltage. In the case of ferro-electric crystals such as Rochelle salt at temperatures between the Curie points of −18 deg C and +23.8 deg C, and barium titanate, it is not strictly true because of the phenomenon of ferro-electric hysteresis, but for a practical application, especially at low field strengths, this can be neglected.

Permittivity (Dielectric Constant) κ, *Column* 2 is the dielectric constant referred to a vacuum, and is independent of the intensity of the electric fields normally encountered, except in the case of Rochelle salt between the Curie points of −18 deg C and +23.8 deg C where the material is ferro-electric and is voltage sensitive. The Rochelle salt values given are for weak fields and are applicable where the crystal is used as a voltage generator such as a gramophone pickup or microphone.

"g" Coefficient, Column 3. This coefficient represents the open circuit voltage per unit applied force. If a unit step function of force is applied the instantaneous voltage developed will be proportional to this force, but this voltage will then decrease in an exponential manner, with time, dependent on the leakage resistance across the terminals and the capacity of the crystal (see Fig. 7). As a matter of interest, under conditions of very low humidity and extreme care being taken with the insulation and mounting of the crystal, Rochelle salt bimorphs have still shown 60 per cent of their peak voltage several minutes after the step function has been applied. When an alternating force is applied, the instantaneous open circuit voltage is proportional to the instantaneous applied force. This is one of the most important coefficients in the design of transducers, because it specifies the maximum available voltage under known working conditions.

In the case of a gramophone pickup the maximum available force is of the order of a 5×10^{-2} Newtons and for a microphone is usually about 10^{-5} Newtons (a Newton is 10^5 dynes). This constant thus gives a direct comparison of the voltage sensitivity of the various materials, always assuming, of course, that the plates of the various materials being compared are identical in size.

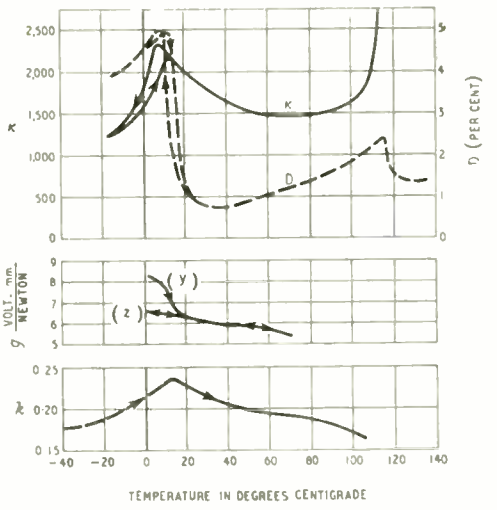


Fig. 6. Temperature dependence in barium titanate of dielectric constant (κ), dissipation factor(D), voltage output coefficient (g) and electro-mechanical coupling coefficient (k).

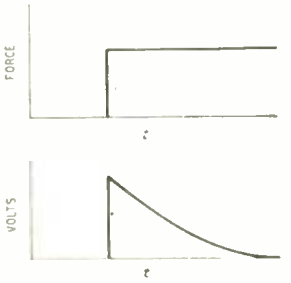


Fig. 7. The voltage developed by a step function of force will decay due to the finite resistance of the crystal.

Young's Modulus, Column 4. This is for the particular crystal cut stated. It is an important coefficient because it will decide the low-frequency impedance of the final crystal unit, in general a low value of Y is preferred.

Coupling Coefficient k, Column 5. By definition, a transducer is a converter of one form of energy to another and in the case of crystals the two forms of energy are electrical and mechanical. The electrical constants of the crystal will therefore be a function of the mechanical loading applied to it and *vice versa*. For example, if the crystal is firmly clamped so that it cannot possibly move and the dielectric constant of the crystal is measured, one obtains the minimum electrical capacitance of the crystal. If the tightness of the clamp is reduced some additional energy will be stored in mechanical form and the measured dielectric constant will have increased. Ultimately, where the crystal is completely free to move, the maximum quantity of mechanical energy will be stored and this is commonly called the free dielectric constant. The ratio of the clamped and free dielectric constants is determined by the coupling coefficient *k;* it is defined as the square root of the ratio of total energy stored in mechanical form to the total electrical energy absorbed by the crystal. The following equation gives the rela-

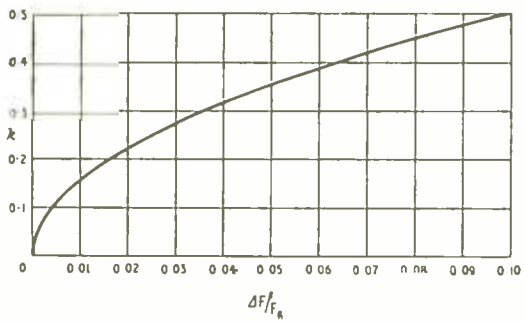


Fig. 8. Derivation of coupling coefficient from the relationship of the resonant frequencies of the freely suspended crystal.

tions where the values d, κ and Y are as defined above:—

$$k = \sqrt{\frac{d}{\kappa} \cdot \frac{}{4\pi Y}}$$

An alternative way of obtaining the coupling coefficient is:—

$$k = \sqrt{d.g.Y}$$

The simplest method of measuring this parameter is by measuring the resonant and anti-resonant frequencies of the crystal; and the relation between the coupling coefficient and these frequencies with an accuracy sufficient for practical purposes is:—

$$k = 1.58 \sqrt{\frac{\Delta F}{F_R}}$$

where F is the resonant frequency and ΔF is the difference between the resonant and anti-resonant frequencies. The graph of Fig. 8 plots this equation. Several precautions must be taken during the measurements. The crystal must be freely suspended, preferably at its nodal point and the source impedance of the electrical generator must be extremely high and preferably resistive in order that electrical loading effects be reduced to negligible proportions.

When comparing the "goodness" of two different crystal materials, this coefficient is usually the first to be considered. In the case of barium titanate, the final efficiency of the product is controlled to a large extent by the manufacturing processes rather than an inherent quality of the crystal, as in classic crystals such as Rochelle salt or quartz, and the coupling coefficient is the parameter often used for quality control of the various production processes.

Columns 6 and 7 show the density and the frequency constants, whilst Column 8 is the maximum operating temperature. The frequency constant relates the resonant frequency and length of the freely suspended crystal when in longitudinal vibration.

As before stated, the table relates to single plate units, but for pickup engineering applications the mechanical impedence of these plates is too great; the bimorph construction is usually used in order to achieve reasonably low working mechanical impedances.

(To be concluded)

References

[1] "Oeuvres de Pierre Curie." Gautier-Villars (Paris) (1908), pp. 200-205.
[2] "Piezoelectric Crystals and their Application to Ultrasonics." W. P. Mason (van Nostrand), pp. 165-189.
[3] "Crystal Growth." H. E. Buckley (Chapman and Hall), pp. 43-71.
[4] "Piezoelectricity." W. G. Cady (McGraw Hill), pp. 17-21.
[5] "Piezoelectric Crystals and their Application to Ultrasonics." W. P. Mason (van Nostrand), pp. 443-461.
[6] "The M.K.S. System of Units." T. McGreevy (Pitman.)

SMALL-CRAFT RADIO

The converted 60-ft lifeboat "Aries," which, with a crew of four, is making a double crossing of the Atlantic, has been fitted with Admiralty-type communication equipment. Sub. Lt. E. Skelton, R.N.V.W.R. (G3JOQ), is shown in this Wireless World photograph at the controls of the 15-W m.f. (330-550 kc/s) section of the Type 619 transmitter. The 40-watt h.f. section (1.5-16 Mc/s) is on the right and in the centre is the receiver, Type CAT, which covers 60 kc/s to 32 Mc/s in eight steps. The power pack is under the desk. The installation was carried out by Rees Mace who also fitted a Pye PTC117 a.m. radio-telephone transmitter-receiver operating on 121.5 Mc/s in the wheelhouse for communication with aircraft.

LETTERS TO THE EDITOR

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

Relaxation Oscillators

IT is pointed out to me by W. T. Cocking that I was in error in saying that a certain dynatron characteristic had d.c. negative resistance.* He reminds me that d.c. resistance can only be negative when the ratio of applied direct voltage to direct current is negative, as it can be in those dynatrons whose anode current is negative over a certain range of anode voltage (but not in the example I showed). Over this range of negative current, the a.c. resistance is first negative and then positive, and if the valve is operated in the positive-a.c. negative-d.c. region it delivers d.c. power to the load and anode-voltage source.

I entirely agree that this is the only strictly correct interpretation of "d.c. negative resistance," and it seems that I myself was caught in one of the meshes of the trap I have so often warned others about—the anomalous terms with which our craft is littered. As a sop to common usage (or perhaps through sheer forgetfulness!) I wrote "d.c." when I ought to have stuck to my principles and made it "z.f." Appeasement is a rotten policy!

The distinction I was trying to show between the dynatron and most other negative-resistance devices (transitron, back-coupled valves, etc.) is analogous to that between "d.c. amplifiers" and "a.c. amplifiers." "A.c. amplifiers" have reactive couplings which prevent them from holding indefinitely a changed steady output current or voltage caused by a similar but smaller change at the input. Transitrons and back-coupled valves likewise have reactive couplings that prevent a positive increase in steady potential from causing a steady negative increase in current. The negative resistance of a dynatron, on the other hand, is analogous to the amplification of a "d.c. amplifier." In the same way that my expression "d.c. negative resistance" was wrong, so is everybody's "d.c. amplifier." Apart from the fact that most so-called d.c. amplifiers are not *current* amplifiers at all, the ratio of steady output current (or voltage) to input is, in general, not equal to the amplification.

Even if no one was actually misled by my common but wrong use of "d.c.," I ought to have called the peculiar dynatron characteristic "z.f. a.c. negative resistance"—to signify a.c. negative resistance at frequency indefinitely close to zero. I hope that would satisfy even the rigorous mathematicians!

E. F. Good raises an objection to the last paragraph of the same article, in which I included sinusoidal RC oscillators in the relaxation category. While sharing with him and apparently other readers a feeling that this is not quite right, I am unrepentant. First, because in this matter I was following B. van der Pol, whom one would hesitate to contradict on the subject of relaxation oscillators; and, secondly, because if one denies that RC sinusoidal oscillators are relaxation oscillators one is faced with the awkward obligation of specifying precisely when they turn into relaxation oscillators as the negative feedback is progressively increased.

"CATHODE RAY."

* "Relaxation Oscillators," *Wireless World*, April, 1954, p. 195.

Marine V.H.F. Telephony

WITH reference to your Editorial in the February issue of *Wireless World*, may I call your attention to a letter written by me to the Editor of *Wireless Engineer* and published in October, 1940, on the use of double modulation on v.h.f. transmissions?

I suggest that it should be fairly simple to provide for marine v.h.f. transmitters to be modulated either in the f.m. or a.m. mode as required, and many receivers are now available which can be switched to receive either f.m. or a.m. as required.

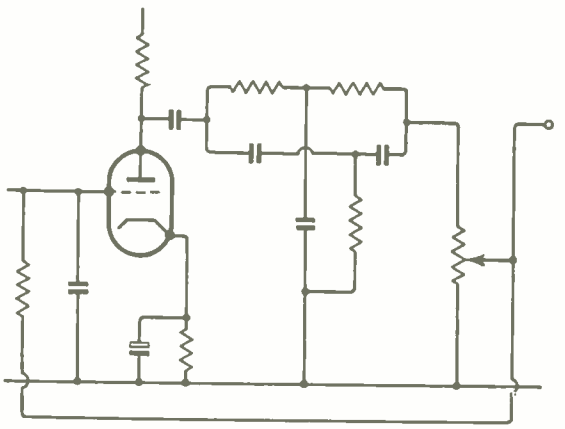
It is interesting to note that this double-modulation method of providing stereophonic or binaural broadcasting is now being used in the U.S.A., as reported in *Electronics*, February, 1954, issue.

I am rather surprised that the B.B.C. has not made use of this method to permit either binaural transmission from the Wrotham station or to enable receivers capable of receiving on a.m. only to sample the advantage of v.h.f. broadcasting.

Port Moresby, Papua. W. C. GEE.

Williamson Tone Compensating Unit

JOHN J. CLARK suggests (April issue, p. 177) that the slope can be varied by adjusting the loop gain, but as C. Robinson points out (May issue, p. 224), the suggested modification will affect the overall gain of the



amplifier. One way to overcome this defect is to take the output from the potentiometer tap, so that the proportion of the output fed back to the input remains constant, whilst the gain within the loop varies. This gives a constant overall gain for most settings of the potentiometer, but varies the rate at which the gain falls off near the "cut-off point."

Whitton, Middx. G. A. ASKEW

Undecoupled?

WHY should L. Bainbridge-Bell (May issue) pick on "decoupling to" for his criticism? There are hundreds of other equally offensive (to the grammarian) terms in the electronics world, let alone in others. He also infers that "decoupling to cathode" is somehow worse (grammatically) than "decoupling to earth." Indeed, if we have an h.t. supply of zero a.c. impedance, we could profitably decouple a screen-grid h.t. supply to h.t.!

The difference between "couple" and "decouple" is simply one of purpose. A coupling capacitor (*sic*; no steam engines in my equipment!) does not *remove* a.c. fluctuations from an anode, whereas a decoupling capacitor would (since we always make our measurements with respect to earth). Does Mr. Bainbridge-Bell's "grid leak" allow the inside of his valve to spill

all over the chassis? What memorandum about gramophones does a "gramophone record" contain? Would a "four-stroke" make a cat purr?

On another topic, with regard to "Cathode Ray's" helpful suggestions concerning baby alarms; why trouble the poor baby-sitter all the time. For most of the infant's needs, a "tele-film," shown on a screen near the cot, to be triggered by the baby-cry-analyser, of the infant's mother making suitable goo-goo noises is all that is needed. Only for very urgent needs would the baby-sitter's viewing be disturbed at all.

Cambridge. KEITH A. M. HARDISTY.

Plug-and-Socketry

MAY an overseas reader express an unavoidably delayed opinion on the article by C. Lister in your February issue? Party No. 1 seems to have the better system of names. The fact that the pins of some chassis or panel mounting plugs are recessed out of harm's way does not turn such plugs into sockets. The pins of others are not recessed and the mating cord socket remains wholly outside the panel when contact is made. Surely Mr. Lister has forgotten that household necessity, the "long cord," which comes out when an appliance is to be used at some distance from the nearest wall socket. In this case Party No. 2 would have a plug fitting into a plug. If Mr. Lister dislikes "*n*-pin plug" he could always say "*n*-contact plug," but one feels that objection to the former on the grounds of redundancy is rather like being horrified at every split infinitive.

Mr. Lister has my warm approval, however, in ventilating this matter. Though only an occasional buyer, I am often irritated at the inadequate or misleading descriptions of their wares given by some of your advertisers. One employs the term "motor" in two senses, (a) motor only, and (b) motor plus turntable, in the same advertisement. Again, if a meter or fuse-holder is not panel mounting, should it be allowed to hang freely from the chassis at the ends of its leads? "Surface mounting" or "flush mounting" gets rid of that uncertainty which is the real gravamen of my reproach. There is no way of knowing how many actual or potential customers in this country are affected but, doubtless, few would notice the redundancies were it not for the three weeks' wait and half-crown that it costs to find out by air mail what the advertiser really means. Manufacturers' catalogues are not always helpful even when they are available.

Dunedin, New Zealand. S. G. EMSLIE.

Television Convertors

THE Band III convertor described by G. H. Russell in your May issue offers an attractive solution to the conversion problem, but it seems doubtful if such a simple device could give an adequate performance in most areas. No amount of filtering in the convertor could cut out direct pick-up of a strong Band I signal by a sensitive receiver tuned to it, unless the receiver were very well screened. Few commercial sets are, and patterns due to beating between carriers would be inevitable.

Furthermore, with two local oscillators running, one in the convertor and one in the set, an almost infinite number of beats can be found to exist between their harmonics, sufficiently close to the carrier in Band III, Band I or the i.f., to cause patterning.

Oscillator stability is a big problem in Band III frequency changers, and if the two oscillator drift errors add, which is not unlikely, very poor tuning stability would result.

A far less hazardous conversion would be to change the Band III signal straight down to the receiver i.f. and to link-couple it into the first i.f. transformer of the i.f. strip, switching from Band I to Band III simply by switching the h.t. from one "front end" to the other. Some adjustment of the tuning of this transformer would be necessary to restore the i.f. curve to its original shape, but this should not prove difficult.

Salford, Lancs. R. WARD.

Die Castings

I WAS very interested to read your account of the B.S.I. Certification Scheme for zinc alloy die castings which appeared in the April issue. This scheme should encourage the wider use of high-quality die castings in industries such as your own.

Your comparison between zinc alloy die castings and cast iron may, however, give your readers a wrong impression, since the tables published in BS1004 give figures for the tensile strength of zinc alloy die cast test pieces ranging from 16 to 20 tons per square inch. These figures compare more than favourably with the average tensile strengths of ordinary iron castings, which range from 10 to 12 tons per square inch.

The value of zinc alloy die castings lies not only in the high strength of the material, but in the intricate shapes which can be mass-produced with high dimensional accuracy. The new Licence Scheme will no doubt encourage many manufacturers in the telecommunications industry to make further use of certified zinc alloy die castings. RONALD W. BAILEY,

Oxford. Zinc Alloy Die Casters Association.

"*Cascode*"

THE recently developed series-connected twin-triode r.f. amplifier which, with the advent of Band III frequencies has a particular application in television receivers, is repeatedly referred to, in and out of the literature, as a cascode circuit. This confuses with the original cascode circuit by Wallman, which used parallel-connected triodes to h.t.

The new circuit affords a distinct advantage to the original by the extended grid base obtained by series connection, minimizing cross-modulation of the vision and accompanying sound signals. Also the original cascode employed a frequency-selective neutralizing circuit, whereas the grounded cathode triode of the series-connected amplifier generally includes a neutralizing capacitive bridge, with balance independent of frequency.

These differences would indicate the need for a more positive identification of the new circuit. "Extended Base Cascode" would identify one merit, but does not embrace the second.

The American 6BQ7 when used similarly is identified as a "Driven Grounded Grid R.F. Amplifier" which is to be commended more than the loosely used cascode identity.

Colwyn Bay. S. L. FIFE.

Transistor Applications

THE exploitation of any new device is nowhere more rapid than in the U.S.A., and the transistor is no exception. According to the April, 1954 *Electronics* a transistor pre-amplifier is now embodied in a hand-type moving-coil microphone, its use lifting the output to about the level of that of a carbon type. It is said that the background noise is considerably reduced.

A carrier telephone system which employs some 300 transistors has been installed in a rural area. It covers 26 miles or so of country, includes three terminal units and, several repeater amplifiers, and the use of transistors is said to reduce the size of these equipments to 1/10th and the power requirements to 1/20th of that of valve equipment.

New Licence Regulations

Amending Transmitting and Receiving Licences

UNDER the 1949 Wireless Telegraphy Act, and its extensions covering the Channel Islands and the Isle of Man, the Postmaster-General is empowered to make such regulations as are necessary to licence transmitting and receiving stations. No such regulations regarding fees had been made until April 5th when two Statutory Instruments* covering broadcast receiving licences and sundry transmitting licences were laid before Parliament. They are scheduled to come into operation on June 1st. Co-incident with the introduction of these new fees the P.M.G. has revised some of the regulations covering the issue of licences.

So far as broadcast receiving licences are concerned the main changes are in the fees payable. As has already been announced in Parliament, television receiving licences are to cost £3 per annum. In the past an hotel has been licensed as a single household, irrespective of the number of rooms equipped for radio reception, but the new regulations provide for licences for hotels at £1 (sound) and £3 (sound and vision) for each room equipped.

On the transmitting licence side there have been many changes. In general the technical requirements are more stringent except that for amateurs there has been an easing of restrictions. There have been a number of changes in the charges for transmitting licences—both increases and decreases—which, incidentally, are based on the estimated administrative costs for the various classes of licence. It is the intention of the P.M.G. to issue the new licences on the first renewal after the introduction of the new regulations and charges on June 1st.

Mobile Radio

To ensure that these new Statutory Instruments are fully discussed in the House of Commons, Capt. L. P. S. Orr, M.P., who is chairman of the Mobile Radio Users' Association, has announced that he is putting down a Prayer for their annulment. The question of the legality of the original charge for mobile radio licences is, as already reported,† being contested by one user who has served a writ on the Post Office. It is also claimed that some of the regulations laid down in the licences are contrary to the provisions of the Wireless Telegraphy Act.

Now for the details of the new transmitting licences. Brief descriptions are given in S.I. 1954/439 of seventeen different types of licence, but this is not a complete list, for there are in addition a number of special licences; in fact there are some cases where there is only one licence in existence. In other cases, such as that for the radio control of industrial equipment and telemetering, new licence regulations are in course of preparation.

On perusing the provisions of the new "private mobile radio licence," which will supersede the business radio licence, the technical requirements appear to be more stringent. On investigation, however, it will be found that the technical limitations laid down, which were not included in the old licence, are, in fact, a reiteration of the P.M.G.'s specification issued to manufacturers for the type-approval of their equipment. The licence charges have been reduced from £5 to £3 per transmitter and a composite licence for all the stations in a network will be issued. It is something of an anomaly that whereas ambulance services come under the "private mobile radio" category and will pay the £3 fee, there is a separate "police and fire service" licence for which the fee is £2 p.a. for each fixed station, irrespective of the number of mobile transmitters used.

Amateur Sound and Vision

Instead of the previous arrangement whereby charges for amateur sound transmitting licences varied according to the power of the station (10 W, £1; 25 W, 30s; over 25 W, £2 p.a.) the new regulations provide for a uniform fee of £2 p.a. The initial charge of 10s or £1 according to the radiated power will no longer be made. Operators may not at present use portable equipment or operate from an alternative address without first applying to the Post Office and the charges for "P" or "A" operation have been 10s each. Under the new regulations operation from a temporary alternative address or location is covered by the main licence. Provided the periods of "P" or "A" operation do not exceed four consecutive weeks the Post Office will not need to be notified.

A "sound mobile licence" which is supplementary to the main amateur transmitting licence will in future be available for £1 and this will permit the licensee to operate in a vehicle or vessel. Amateur equipment, whether mobile or fixed, may not be used at sea or within any estuary, dock or harbour.

The P.M.G. is introducing the award of a certificate (Amateur Radio Certificate) which will be granted to those who pass the City and Guilds Radio Amateur Examination and a 12-w.p.m. morse test. Holders will be permitted to operate a transmitter under the supervision of a licensed operator without themselves holding a licence.

A licence to operate an amateur television station will in future cost £2 instead of £3, and as at present, it limits transmission to visual images. An operator may send his call in morse but to radiate sound he will also need an amateur sound licence.

A licence for the radio control of models is provided for in the new regulations. This costs £1 for five years. The operator will not have to pass a test.

There will in future be a "training establishment licence" (£2 for five years) which will permit the establishment of a transmitting and receiving station for "wireless telegraphy" which, within the meaning of the Wireless Telegraphy Act, covers radar.

* S.I. 1954/438 "The Wireless Telegraphy (Broadcast Licence Charges) Regulations" (4d) and S.I. 1954/439 "The Wireless Telegraphy (General Licence Charges) Regulations" (6d), H.M.S.O.
† *Wireless World*, March, 1954, p. 124.

The Diode Rectifier in Valve Voltmeters

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

Limitations of Use Imposed by Specified Maximum Error

THE majority of valve voltmeters for alternating voltages use a diode rectifier followed by what may be called a current amplifier or direct-voltage valve voltmeter. A previous article[1] reviewed the whole design of this rectifier circuit, including methods for dealing with its non-linearity, which of course is of chief importance at low voltages. The present article is confined to causes of error other than non-linearity, and has especially in view (though not exclusively) use at frequencies lower than r.f. At such frequencies one reasonably expects a fairly high standard of accuracy to be attainable. On the other hand, the sources of voltage being measured are unlikely to be low-loss tuned circuits, and, as was emphasized previously, when a non-resonant source is being measured the error due to diode loading is appreciable with much less source resistance than is often supposed, especially when one is accustomed to using the instrument across r.f. tuned circuits. For 1 per cent error, say, a diode voltmeter with a load resistance of 1 MΩ is actually worse than an ordinary 1,000-ohms-per-volt metal-rectifier meter on a 50-V or higher range!

With an ordinary voltmeter, the source-resistance error can be calculated from the voltmeter resistance. In one way of looking at the matter, this resistance and the resistance of the source of voltage form a potential divider as in Fig. 1, and the voltage actually read (assuming the meter otherwise free from error) is $\frac{R_m}{R_m + R_s} E$ instead of E. An error of x per cent is caused by R_s when it is x per cent of $R_m + R_s$, or (assuming x is reasonably small) very nearly x per cent of R_m. If R_m were 50,000 Ω, for example, and the maximum source-resistance error tolerated were 1 per cent, the maximum source resistance that need not be corrected for would be just over 500 Ω.

An alternative viewpoint that shows the same result is to suppose that the voltage to be measured is due to a constant current I flowing through the source resistance. It is therefore equal to IR_s. When the meter is connected, the resistance through which I passes is R_s and R_m in parallel, i.e. $R_m R_s/(R_m + R_s)$. The ratio of voltage read to voltage before the meter was connected is therefore $\frac{R_m}{R_m} \frac{}{R_s}$ as before.

If one seeks to apply this calculation to a diode voltmeter the question at once arises, where is R_m? And if the voltage being measured is across a tuned circuit there may also be doubt about R_s. One thing that must *not* be done is to work on the assumption that R_m is the load resistance of the diode, i.e. the resistance across which the rectified voltage is developed —R in Fig. 2. In general one cannot regard the rectifier as equivalent to an ordinary resistance, for during the greater part of each cycle of the input voltage the diode is non-conducting so that the rectifier as a whole is an open circuit and imposes little or no load on the voltage source, while during the remainder of the cycle it is conducting and passing a relatively heavy current into the capacitor C. Notwithstanding this, however, it is found that in the special case of the source of voltage being a resonant circuit the damping effect of connecting the rectifier across it is equivalent to that of an ordinary resistance. The reason is that the flywheel effect of the stored energy in the resonant circuit maintains its pure voltage waveform in spite of the great variability of the load across it.

[1] *Wireless World*, March 1952, pp. 89–94.

Effective Input Resistance

It is sometimes stated that the value of this equivalent resistance, which we shall call R_i—the effective input resistance of the rectifier, or the resistance which, if substituted for the rectifier, would draw from the voltage source the same amount of energy during each cycle—is half the diode load resistance (R). But it is not always made clear at the same time that this is not even approximately true if the input voltage is small or the source-resistance error is large, and that it applies only to the series-diode circuit, Fig. 2(a). R_i varies with input voltage, because at very small inputs a diode is far from being a perfect rectifier. Throughout this article, however, we shall assume that the input is sufficient (say at least several volts) for the performance of actual diodes to be not greatly different from that of an ideal diode having infinite resistance when the anode is negative with respect to the cathode and either zero or a constant small resistance when it is positive. If for the moment we also assume that the Fig. 2(a) circuit is used, with no source resistance, then V_r, the rectified output across R, is equal to the peak value of the sinusoidal input voltage. Since the forward resistance of the diode is assumed zero and its backward resistance is infinite, R is the only power-dissipating element in the circuit, the power being $V^2_r R$. This must be equal to the input power, which by definition of R_i is E^2_{rms}/R_i. Since the peak value, $E_{max} = \sqrt{2}\, E_{rms} = V_r$, $E^2_{rms} = V^2_r/2$, so $R_i = R\,2$. In practice this theoretical value is a reasonably good approximation when the input voltage is at least a few volts and there is no series resistance other than a low-resistance diode—in other words, conditions are such that V_r is not more than one or two per cent less than E_{max}.

In Fig. 2(a), R is shut off from E by the non-conducting series diode for almost the whole of every cycle, but in the shunt-diode circuit, Fig. 2(b), a.c. is driven through R by E all the time (the impedance of

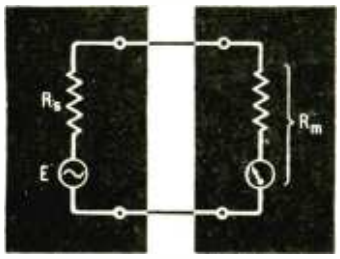


Fig. 1. Diagram representing a source of voltage as an e.m.f. E in series with internal resistance R_s, being measured by a voltmeter with resistance R_m.

C being assumed negligible), so R_i in this case is equivalent to R/2 in parallel with R; i.e., R 3.

To prevent the alternating voltage across R in the shunt circuit from being passed on, some kind of simple filter is usually employed, perhaps the commonest being as in Fig. 2(c) or (d). If the impedances of C_1 and C_2 are negligible in comparison with the resistances, it can easily be found in the same way—by reckoning the d.c. and a.c. resistances in parallel—that in Fig. 2(c) $R_i = \frac{R_1 R_2}{R_1 + 3R_2}$, and in Fig. 2(d) it is $\frac{(R_1 + R_2)R_2}{R_1 + 3R_2}$. In both circuits it is assumed that there is no current path between the output terminals other than those shown. To make the output in Fig. 2(d) equal to the r.m.s. value of sinusoidal E, $(R_1 + R_2)$ must be about equal to $\sqrt{2}\ R_1$, in which case $R_i = R_1/3.83 = R_2/1.59 = (R_1 + R_2)/5.42$. And if in (c) $R_1 = R_2$, $R_i = R_1 4$ $R_2/4 = (R_1 + R_2)\ 2$. All these, of course, are subject to the assumptions made; with large input voltages the actual R_i tends towards these figures, but around bottom-bend level the whole matter becomes far more complicated. In general, R_i is greater (loss smaller) at small input voltages in the series circuit (a), and less in the shunt circuit, than large-voltage values. At high frequencies the additional losses in the capacitances may be serious and would have to be taken into account in any accurate evaluation of R_i.

The importance of R_i is that when it comes across a resonant circuit it reduces that circuit's dynamic resistance (which we shall call R_r). The voltage developed across the circuit by a given e.m.f. or current is proportional to the dynamic resistance. So the ratio of voltage with the rectifier connected to the voltage without the rectifier is $R_i R_r\ (R_i + R_r)$ to R_i, or $R_i (R_i \quad R_r)$ to one. In other words, the calculation is exactly the same as for an ordinary meter, Fig. 1, R_i now taking the place of R_m, and R_r the place of R_s. For example, if a series-diode voltmeter with a load resistance R of 3MΩ were used to measure the voltage across a resonant circuit with a dynamic resistance of 80 kΩ, R_i would be 1,500 kΩ, so the factor by which the voltage was reduced by the meter would be approximately 1500 1580 - 0.95; i.e., 5 per cent error.

The desirability of making R_i large is especially great in the valve voltmeter used to indicate Q in the usual type of Q meter measurement, for this damping error directly affects the readings and is not cancelled out as in the reactance-variation method.

Peak Clipping

So much for measurements on resonant circuits. From now on we shall assume that the source of voltage can be represented, as in Fig. 1, by an e.m.f. E in series with a resistance—the source resistance R_s. Such a source has no stored energy to meet the relatively heavy demand at the positive peak of each cycle, when the diode is conducting; consequently the positive peaks—which are what the diode voltmeter measures—are clipped short and the readings are low. If R_s and the forward resistance of the diode (r_d) were nil, C or C_1 in all the circuits in Fig. 2 would charge up to the full peak value, E_{max}. To do this, the portion of each cycle during which the diode conducted would have to be infinitesimally small and the current infinitely great, so even a very small value of $R_s \quad r_d$ is sufficient to modify the situation considerably. If we restrict the error due to it to, say, 1 per cent, so that V_r is only 1 per cent less than E_{max}, the period of diode conduction cannot extend far each side of the positive peak; and since during this brief period C has to take in enough charge to feed R for the whole cycle, the charging current is bound to be relatively heavy. To restrict the voltage dropped in R_s by this heavy current to 1 per cent of E_{max}, it is

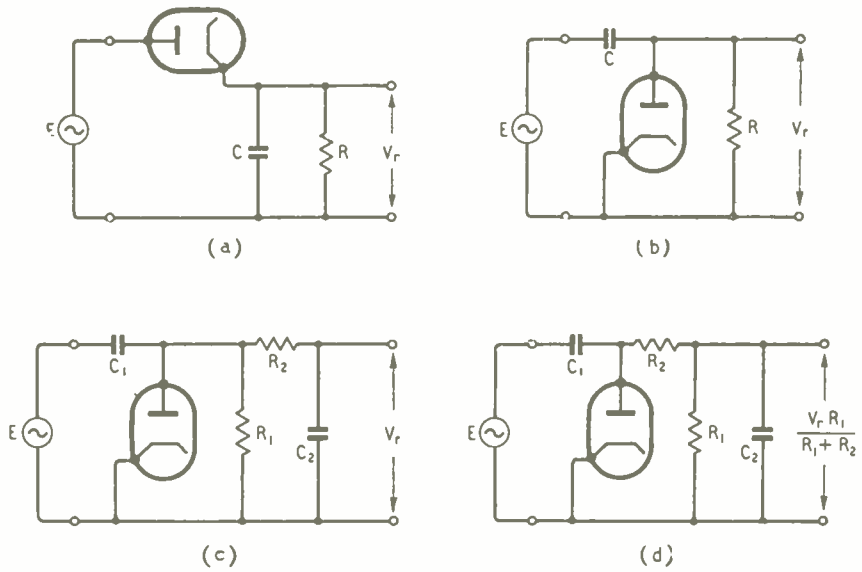


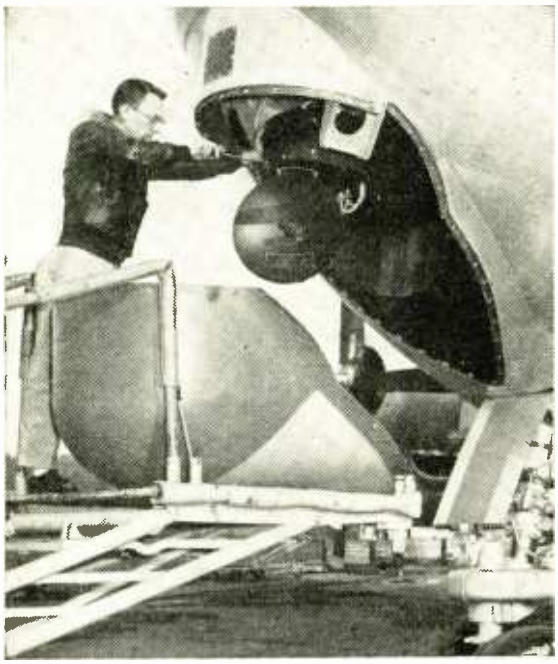
Fig. 2. The four types of diode rectifier considered. (a) is the series-diode type, (b) the simple shunt-diode, and (c) and (d) are shunt-diode circuits with two varieties of simple filter for removing the a.v. component from the output.

obvious that R_s must be very small compared with R, which carries a far smaller current.

In the article previously referred to there was a curve, due to D. A. Bell[2], showing how the "efficiency of rectification," V_r/E_{max}, varies with R_s/R. Although one could see from this curve that an efficiency of 99 per cent (i.e., error 1 per cent) necessitated R_s being a very small fraction of R, the scale was such that it was very difficult to see even roughly how small. One object of the present article will be to remedy this by showing the upper part of the curve on a larger scale. Another object is to take account of the value of C on the small errors. But the main object is to extend the information, hitherto available only for the series-diode circuit, to the shunt circuit and the variants shown in Fig. 2. While a very large amount of information has been published on the series circuit, the shunt circuit seems to have been almost ignored. Admittedly the series circuit performs better in nearly every respect, but for use in measuring instruments it is not generally so convenient as the shunt circuit. Even data about Fig. 2(b) do not really meet the need, because in order to keep the following amplifier from being overloaded by a.c. the circuits used in practice are more likely to be (c) or (d), and what then is the load resistance?

(To be Concluded)

[2] *Wireless Engineer*, Oct. 1941, pp. 395-404. Actually a similar calculation had been presented, slightly differently, by F. M. Colebrook eleven years earlier (*Wireless Engineer*, Nov. 1930, pp. 595–603).



Aerial scanner of R.C.A. lightweight search radar being installed in plastic nose radome of Boeing 80-ton "Stratofreighter." Now a standard fitting in these aircraft, it can be used to locate storm fronts, as a collision warning device and as a navigational aid, by showing up prominent land features. Two display indicators are fitted, one shared by pilot and co-pilot and the other for the navigator, who also controls the equipment's various functions.

News from the Clubs

Birmingham.—June meetings of the Slade Radio Society include a talk on "Receiver Design" by G. Nicholson (11th) and another on "Servicing Car Radio" by W. E. Lewis (25th). The second of the season's events for the Harcourt Trophy will be a midnight d.f. test on the 12th/13th. The society meets at the Church House, High Street, Erdington, on alternate Fridays at 7.45. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Brighton and District Radio Club continues to meet each Tuesday at 7.30 at the Eagle Inn, Gloucester Road, Brighton. The club transmitter (G3EVE) is on the air on 80 and 160 metres (phone and c.w.) on some Tuesdays. A quantity of components has been acquired and it is proposed to start an "assisted constructional scheme" to help young members in building their equipment. Sec.: T. J. Huggett, 15, Waverley Crescent, Brighton, Sussex.

Hastings.—The Hastings and District Amateur Radio Club will again be exhibiting at the Hobbies and Crafts Exhibition in the New Pavilion, Falaise Road, Hastings, during the town's Carnival Week (July 3rd-10th). The club station, G6HH/A, will be manned during the exhibition from 10.00 to 22.00 each day except Sunday, July 4th, and will operate in the 80-metre band. Amateurs are invited to arrange schedules. Sec.: W. E. Thompson, 8, Coventry Road, St. Leonards-on-Sea, Sussex.

QRP.—The QRP Society is organizing a campaign to encourage the use of low power by all stations participating in local nets. The society considers that there is no justification for stations to use 150 watts when 5W will adequately cover the neighbourhood. The society would like to hear from clubs interested in QRP with a view to organizing contests and trials. Sec.: J. Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.

Commercial Literature

Measuring Instruments, including signal generators, valve-voltmeters, Q-meters, frequency meters, bridges and microwave test equipment, described in a 1954 catalogue of 200 pages, handsomely bound and illustrated, from Marconi Instruments, Longacres, St. Albans, Herts. A functional diagram accompanies the description of each instrument.

Power Resistors, wire-wound, with values from 10 to 30,000 Ω and power ratings from 10 to 40 watts. Leaflet from R.M. Electric, Team Valley, Gateshead 11, Co. Durham.

Lead-through Capacitors, Hi-k miniature ceramic types, for Band III and IV television tuners. Also Hi-k ceramic disc capacitors for decoupling in television receivers. Two technical bulletins from The Telegraph Condenser Company, North Acton, London, W.3.

Slotted Angle Strips in steel for Meccano-type construction of racks, frames, etc. Leaflets from Dexion, Triumph House, 189, Regent Street, London, W.1.

Voltage Stabilizer with output voltage continuously variable between 200 and 240 volts and maintained to within 0.25%. Input voltage variation possible is −17½% to +6½%. Leaflet from Servomex Controls, Crowborough Hill, Jarvis Brook, Sussex.

Miniature Soldering Irons of the pencil type made by Oryx. One model, for 6-volt operation, gives a high bit temperature of almost 400°C; another, already supplied for 6-, 12- and 24-volt working, is now available for 50 volts. Leaflet from Anglo-Netherland Technical Exchange, 3, Tower Hill, London, E.C.3.

Encapsulation of small units in suitable potting resins: a service offered by Lion Switchgear and described in a leaflet from their Works at Hanworth Trading Estate, Hampton Road, Feltham, Middx.

Components and Accessories; an information folder for insertion in their catalogue from Webb's Radio, 14, Soho Street, London, W.1.

High-Fidelity Audio Amplifier of 12 watts output, substantially flat from 2 c/s to 160 kc/s, with negative feedback of 26 db and distortion of less than 0.1%. Also a pre-amplifier and remote control unit for use with it. Specifications on a leaflet from Pye, St. Andrews Road, Cambridge.

French Components Show, 1954

Preponderance of Electronic and Television Equipment

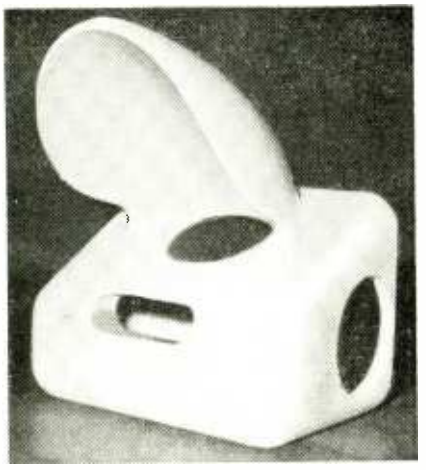
By E. AISBERG*

SINCE the world's first components exhibition was staged in Paris in 1934, the area covered by the "Salon de la Pièce Détachée" has grown from 600 to 6,000 sq. metres. Like its British counterpart, the R.E.C.M.F. show, the French Salon confines itself to components, accessories and measuring instruments produced by the home industry.

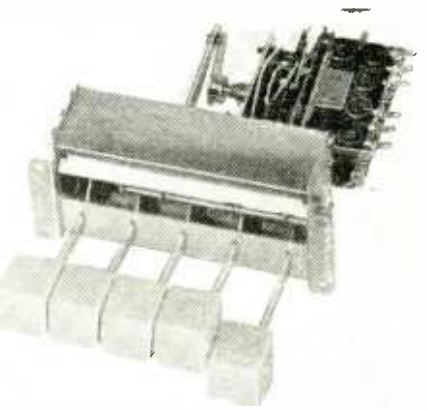
Three main tendencies were in evidence this year. First and foremost, equipment for professional and industrial use took pride of place. What was at one time essentially a radio show has become an exhibition of general electronics. No doubt the heavy demands imposed on the French industry by the armed Services are responsible for this tendency, and, as a result, technical considerations are becoming of greater importance than purely commercial ones. Now that supplies are plentiful, choice is determined largely by quality, but of course price is important in components for broadcast receivers, both sound and vision. Lastly there is a trend, more and more in evidence, towards the production of many new television components.

Sound Broadcast Equipment.—Since March 28th the Paris f.m. station, which had previously been conducting low-power experimental transmission, has been regularly at work on 96.1 Mc/s with a power output of 20 kW. The coming of f.m. has been responsible for some novelties amongst components. Several coil manufacturers have produced special assemblies for the 90-Mc/s frequency band, as well as wide-band i.f. transformers and windings for discriminator circuits.

* Editor, *Toute la Radio*.



"Rabbit's-ear" dual loudspeaker with one operative and one passive unit. (Elipson).

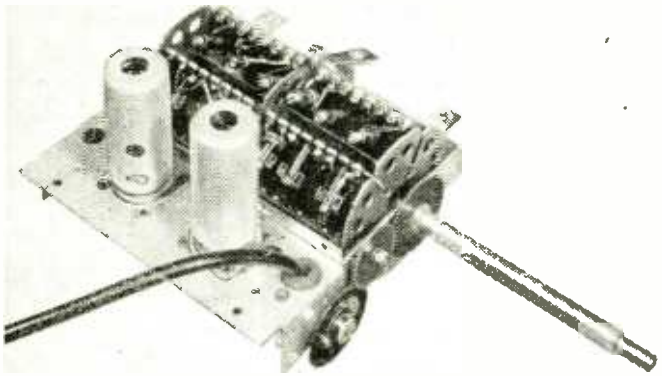


Device to enable a rotary switch to be push-button operated (S.T.A.R.E.).

Loudspeakers designed to handle a wide range of audio frequencies were well in evidence. Besides the usual electro-dynamic types several manufacturers have introduced dual units with concentrically mounted electro-static or piezo-electric units capable of reproducing audio frequencies up to 15,000 c/s. The coming of f.m. was not the sole cause of the development of such loudspeakers; they are required also for the reproduction of high-quality microgroove records. If the manufacturers of television receivers would only take the trouble to give proper attention to the a.f. portions of their sets, viewers could take full advantage of the wide-band sound transmissions which accompany the pictures. Most French televisors, alas, are provided with rather rudimentary a.f. amplifiers and small loudspeakers and so are incapable of reproducing more than a narrow band of audio frequencies.

Before we leave loudspeakers another interesting novelty must be mentioned. This is an instrument with a focusing baffle shaped like a rabbit's ear. In addition to a normal, energized reproducer there is a second one, exactly similar but mounted horizontally. The latter receives no audio input; actually, its speech coil is short-circuited. The purpose of the "parasitic" speaker is to absorb the resonance peaks of the other to some extent. Since it is precisely similar to the energized one, it has the same resonances and the currents in its speech coil serve to damp the movement of the cone.

Television Equipment.—The new television components show, on the one hand, a tendency to simplify manufacturing processes with a view to price reductions, and on the other a desire to enable the user



Dual moving-coil and piezo-electric loudspeaker. (Musicalpha) and (left) Six-channel television tuner. (Vidéon).

to receive several stations, possibly with different standards of definition.

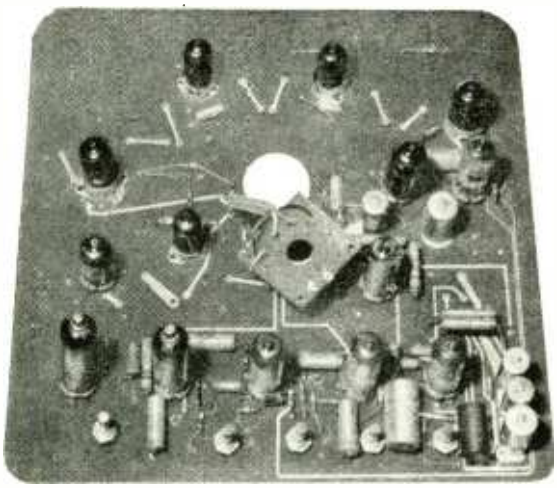
Printed-circuit technique has now for the first time been used in the manufacture of television receivers. The French term *circuits appliqués* is perhaps more accurate. Two manufacturers showed assemblies made by cementing a plate of copper, 0.03 mm to 0.05 mm thick, to an insulating backing and removing unwanted metal by chemical methods.

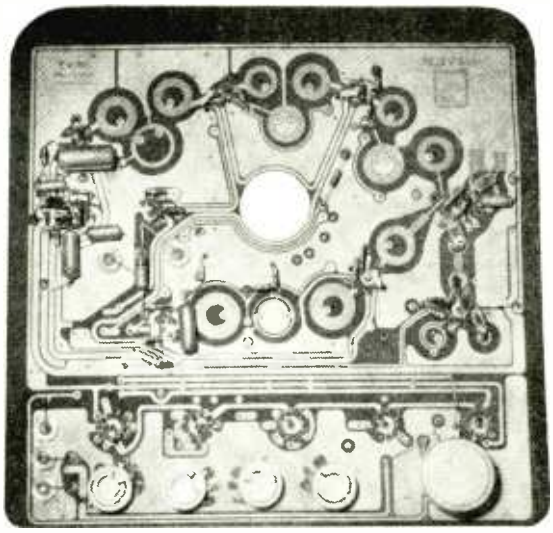
A complete TV receiver chassis constructed in this way may contain no more than a few dozen soldered joints, as against the thousand or so called for by ordinary wiring methods. Deflector coil assemblies are also made by the applied circuit method. Much use also is made of the new magnetic materials for TV purposes.

Cathode-ray tubes shown had screen diameters ranging from 36 to 66 cm, anything less than 36 cm being of no account. Tubes with 43-cm screens are already in mass production and the large-scale manufacture of 54-cm tubes will soon be under way. Wide-angled tubes with deflection up to 90 deg are becoming common.

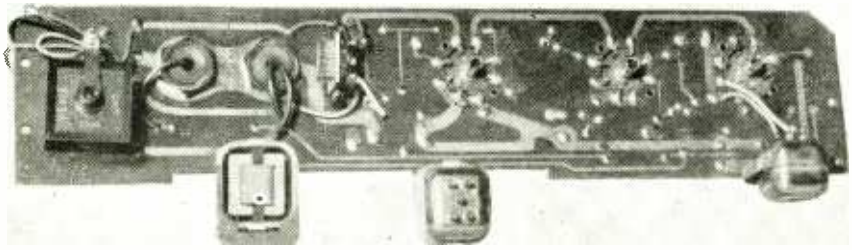
Two types of "rotactor" (rotary switching coil units) enabling reception to take place on any one of several channels were exhibited. They are equipped with readily interchangeable coils.

Several standards of definition have to be taken





Front and back views of printed circuit panel for a television receiver. (Visseaux).



Printed circuit amplifier panel for a magnetic recorder. (Aréna).

Servicing oscilloscope with 3-in. c.r. tube. (Centrad).

into account in France. In addition to the 819-line transmissions on the official French standard, 441-line transmissions will continue until 1958. Again there are many viewers in the regions near the eastern frontier who receive the German 625-line transmissions. One thus finds television measuring instruments, pattern generators and the like, designed to deal with this multiplicity of scanning systems.

Measuring Instruments.—Amongst these there is a large variety of new instruments designed to meet widely different needs. There are galvanometers so completely water-tight that they can be used submerged in several metres of water. More and more instruments are seen with scales of up to 270 deg. With the higher and higher sensitivity that is being achieved a microammeter with a full-scale deflection for a current of 1 μA comes as no surprise.

One ingenious means of improving the oscilloscope must be mentioned. It consists of a fluorescent scale engraved on a sheet of Perspex, which is placed in front of the screen. The screen is illuminated from the side and the brilliance can be varied at will.

Electronic Equipment.—In France, as elsewhere, the semiconductors are beginning to figure prominently in the field of electronics, germanium and silicon diodes being in common use. Several firms showed transistors, though these are not as yet generally available.

An ingenious device is a d.c. "transformer" which enables direct voltages to be increased or decreased at will. The appliance contains a 2-position switch. In one position the switch connects a bank of capacitors in series; in the other it connects them in parallel. The capacitors may thus be charged in parallel and discharged in series and the voltage increased. It can be decreased by charging in series and discharging in parallel. The principle is an old one; but this practical application is new and the device is completely reliable.

To sum up, the Salon must have made a very satisfactory impression on any technical visitor. Quality, reliability and ingeniousness were its outstanding characteristics, all of which serve to exemplify the liveness and virility of the industry.

HONG KONG HARBOUR RADIO

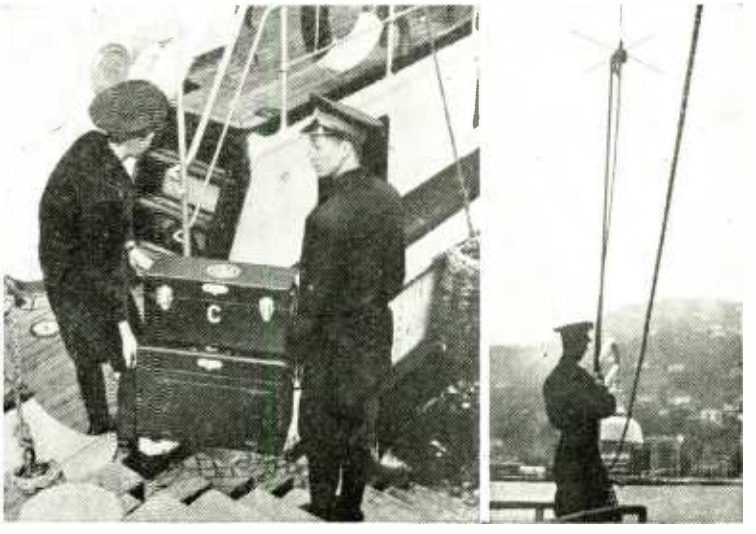
A V.H.F. radio-telephone system has been installed at Hong Kong to provide direct communication between ships in the harbour and subscribers on the Hong Kong telephone exchange. In addition to providing this facility the new system affords direct communications between moored ships and greatly assists loading and unloading operations.

The ship-to-shore radio link is provided by a portable battery-operated f.m. transmitter-receiver, which is taken on board from the pilot's cutter as soon as the ship enters the harbour and set up in some suitable position.

To facilitate operation the network is divided into several groups, each group being allotted two wavelengths, one for transmit and one for receive, and all groups work through a permanent land station linked by cables to the main telephone exchange.

Ship stations operate from a 12-volt battery and the equipment for each comprises a calling decoder, portable aerial mast, transmitter, receiver, desk controller and all necessary cabling; the gear can be set up on board and working in a matter of minutes.

All the equipment was made by the General Electric Company of England and the service is operated by Cable and Wireless.



One of the G.E.C. mobile radio-telephones being taken aboard the pilot's cutter for transference to a ship entering the harbour. On the extreme right is shown a ground-plane aerial set up aboard ship in Hong Kong harbour for ship-to-shore communications.

Cavity Resonators

Empty Boxes Instead of Coils and Capacitors

By "CATHODE RAY"

IN microwave equipment, the parts that correspond to wiring at lower frequencies are commonly referred to as "plumbing," from the obvious resemblance of waveguides and associated metalwork to the pipes with which builders in this country decorate the outsides of houses. The precision of manufacture and installation has to be a good deal higher than in domestic plumbing, however. After having been accustomed to making electrical connections from A to B by means of almost any old piece of wire, the constructor's graduation to microwaves comes rather painfully. Whether the same can be said of the theory side is perhaps a more open question. Anybody who has been brought up to think exclusively in currents and circuits probably finds it very difficult to imagine how electricity can be sent along a pipe. If, however, he had begun with microwaves, which would have meant thinking in fields from the start, the idea of currents travelling along wires might have appeared strange and difficult. Supposing I had a very limited time in which to do my best for someone who knew nothing at all about electricity, I think I might choose waveguides rather than wires. Even though speaking tubes are no longer standard equipment in the really modern home or office, so that an actual demonstration might be difficult to arrange, it is easy to imagine how they work. And if one can visualize sound waves going along pipes, why not electromagnetic waves? Communication by wire is a much more surprising phenomenon

Acoustic Resonant Cavities

It is the same with resonant cavities. We radio people are so used to our tuned circuits being made up of coils and capacitors that we are baffled when asked to accept an empty copper box as a tuned circuit. But if we could start again with no electrical knowledge at all, surely it would be the coil and capacitor that would be baffling, rather than the cavity? After all, everyone is accustomed to acoustical resonant cavities. Even the washer-up can hardly have failed to notice that while a bottle is being filled with water the sound, produced by the resonant cavity formed by the unfilled portion of the bottle being shock-excited by the impact of the water, rises in pitch as the cavity becomes smaller. And I suppose we have all played tunes by acoustically shock-exciting our mouths—another form of resonant cavity—by tapping our teeth with a pencil or blowing air between our lips and simultaneously varying the size of the cavity. By slightly modifying the blowing technique we can obtain much clearer notes, caused by continuous oscillation in the cavity, commonly referred to as whistling. To whistle a low note we have to make the mouth cavity larger than for a high note. If anyone asks about dental cavities, the answer is that in a well-kept mouth they should always be small enough for their resonant frequency to be above audibility.

Another example of acoustic resonant cavity, introduced to most of us at an extremely tender age—probably on first visiting the seaside—is a shell held to the ear, which, like an electrical tuned circuit, selectively amplifies the frequencies to which it resonates, causing otherwise barely audible sea noises to roar forth impressively. And when listening to speech or music, one can, by making a cavity with the hands close to the ear, distort the sounds in just the same way as a too-resonant audio amplifier or loudspeaker.

The classical example, which so far I have not been privileged to witness, is the famous tenor lifting his empty glass after dinner and shattering it with one strong sustained note sung at its resonant frequency. But in this country such behaviour, even by famous tenors, is probably considered bad form, and one would have to go abroad to stand any chance at all. However, with so many less spectacular but perhaps more instructive demonstrations right at hand, there is really no need.

Now of course the fact that enclosed or nearly enclosed spaces have acoustical resonance does not prove that they also have electromagnetic resonance, nor does it explain how such electromagnetic resonance (if any) takes place. But we do know that there is a very close analogy between the generation, transmission, propagation and reception of sound waves, and of electromagnetic waves, so at least our examples of acoustic resonant cavities should lead us to expect something corresponding in electromagnetics; and by tracing the analogy between sound and electromagnetic waves we ought to be able to get some idea of how electromagnetic cavities resonate. To make this approach it is necessary to have a fairly comprehensive mathematical knowledge of sound waves, and their differences as well as resemblances to electromagnetic waves. Anybody who has such knowledge will probably be able to follow this line for himself without the doubtful benefit of my assistance. The rest of us will be content with the general picture.

Another approach is from what we know about transmission lines, resonant stubs and waveguides. Anyone who has grasped the theory of these three items can go on to resonant cavities on the basis that cavities are to waveguides as resonant stubs are to transmission lines. One learns that long lines, made up of uniformly distributed inductance and capacitance, transmit electromagnetic waves, and that certain comparatively short lengths, either short-circuited or open-ended, resonate, and are equivalent to tuned circuits (but in general are much better, in terms of

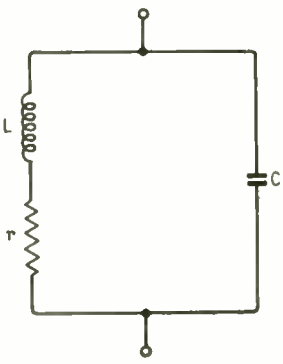
Q. Similarly, a pipe or waveguide, provided its diameter is large enough in relation to the frequency, transmits electromagnetic waves; and a certain length of waveguide (such as a half wavelength) acts as a high-Q resonator. A closed length of waveguide is one possible form of cavity. And, just as waveguides have different "modes" of wave transmission, so cavity resonators have different modes of oscillation. Cavities, then, are best considered as an extension of the study of waveguides, especially as regards the question of modes.

The shapes of cavities are by no means only the same as commonly used types of waveguide. One possible, and in fact highly efficient but not usually convenient, shape is spherical. A very usual one, again not related to waveguide shape, is the toroid or American doughnut; for example, in klystrons, where it is termed the rhumbatron.

Still another approach, short-circuiting the study of waveguides, is by way of ordinary inductance-capacitance or LC-tuned circuits. The rhumbatron just mentioned is sometimes introduced as a development of a tuned circuit consisting of a single-turn coil and a single pair of capacitor plates, as in Fig. 1(a). By putting together a sufficient number of turns in parallel around a circle, as at (b), one forms a rhumbatron. Although this view may be better than nothing if a knowledge of waveguides and wave propagation is lacking, it doesn't get us very far. And it may be misleading in that the inductance and capacitance are not really separate, even in this shape, and obviously are not if the shape is a sphere, cube or cylinder. It is therefore hopeless to try to analyse a resonant cavity, as one can an ordinary tuned circuit, by measuring L its inductance; C, its capacitance; and r, the resistance which, if connected in series with L, would account for all the losses (Fig. 2). On the other hand, it is quite easy to find a cavity's resonant frequency. Actually, it has many resonant frequencies, but "the" resonant frequency, if not more particularly specified, is taken as the lowest. And it is fairly easy, by means of the frequency-variation method, to measure the Q of a cavity. The one remaining item needed to specify its performance as a resonator is its impedance, measured at resonance, when it is equivalent to a high resistance—the "dynamic resistance." This is more difficult, but can be done if the points between which the resistance is reckoned are indicated.

(a) (b)

Above: Fig. 1. One way of looking at the toroidal-shaped resonant cavity (b) used in klystrons is as an extension of a single-turn coil and a single-pair-of-plates capacitor (a). In fact however the inductance and capacitance are not completely separate, even in this shape.



Right: Fig. 2. However a resonator is made up, it can be represented by this equivalent circuit. The values L, C and r usually depend on frequency and on what are reckoned as the terminals of the resonator.

These three things, usually written as f_o, Q and R_d respectively, together with the terminal points of R_d, are sufficient to specify any kind of tuned circuit, whether its inductance and capacitance are distributed or lumped. If lumped, then L, C and r can easily be found from f_o, Q and R_d, because

$$f_0 \simeq \frac{1}{2\pi\sqrt{LC}} \quad \text{(when Q is not small)}$$

$$Q = \frac{2\pi f L}{r}$$

$$\text{and} \quad R_d = \frac{L}{Cr}$$

If they are distributed, as in a stub or cavity resonator, the values of L, C and r found from these equations are the component values of the equivalent lumped tuned circuit.

Why we use Cavities

Just in case anyone may not be quite clear why people should bother with cavities instead of the good old coil and capacitor (or, alternatively, bother with a coil and capacitor when it seems that an empty screening can is sufficient) let us dispose of that point before going any farther.

The advantage of the coil and capacitor is that their construction enables a comparatively large amount of inductance and capacitance to be got into a small space. Thereby it is practicable to tune to Droitwich (200 kc/s) in even a "ladies' handbag" portable set. Theoretically it is possible to tune to Droitwich with a resonant cavity, but its dimensions would have to be of the order of half a mile, which would create some practical difficulties, notably in the matter of manual tuning control. Even at the London television frequency (45 Mc/s) a cavity-tuned receiver would resemble a battery of Lancashire boilers. The conventional tuned circuit meanwhile is still entirely convenient at this frequency. But at the much-discussed Band III frequencies (around 200 Mc/s) one is beginning to feel a shortage of turns when trying to arrange step-up or step-down ratios. And if we had to go to Bands IV or V, in the upper hundreds of megacycles, this difficulty would become so acute that a semi-distributed construction such as the "butterfly" circuit would probably be adopted. An alternative is the stub or short resonant line, already mentioned, but this is not particularly compact by present-day standards: at 600 Mc/s a quarter-wave stub is 12½ cm long—say 5in. A cavity is still less convenient, because it has to be wide and deep as well as long. It comes into its own in the thousands of megacycles, where lumped tuned circuits are right out of it, and stubs in turn are beginning to be difficult because their short-circuiting ends, which are supposed to be almost negligibly small compared with the length, no longer are.

The higher the frequency, the greater the tendency to radiate. Although radiation from a coil can be prevented from going far enough to cause trouble, by shutting it up in a metal can, it is not thereby pre-

vented from being a loss to the coil. Apart from the difficulty of getting few enough turns at very high frequencies, therefore, the coil is out of it because of excessive radiation losses. For the same reason tuning stubs always take the coaxial form, in which the outer conductor completely screens the inner*; not the parallel-wire type, which radiates. When the frequency is so high that the length of a coaxial stub is so short that its outer diameter cannot be incomparably smaller still and at the same time give adequate clearance between low-resistance conductors, then one might as well drop the inner conductor and make it a cavity, for the dimensions will not be unreasonably large.

And so we are left with an empty metal box. It acts as its own screening can, so the radiation loss is practically nil. The only dielectric concerned is the air inside, so the dielectric loss also is practically nil. (If we were really fussy we could pump the air out; sometimes this has to be done anyway, if the resonator is part of a valve.) The only conductor concerned is the metal of the box, which is nearly always copper; and since the currents flow only on the inner skin† the inner surface of high-class cavities is polished and silver-plated. All these things having been properly attended to, the losses are extremely small, and the Q values are fantastic by conventional tuned-circuit standards—30,000 and more is not unusual. Of course, a cavity is not usually made just for the sake of being set into oscillation; it is expected to work for its living, and the load to which it is coupled pulls down the overall Q. But for best results it ought not to be pulled down too much; in this respect the cavity is like any other tuned circuit.

Although Q is often expressed (as we have already done) as the ratio of inductive (or capacitive) reactance to equivalent series resistance, this is just a special case of the general definition, which takes the form of the ratio of energy stored to energy lost. The energy stored in a cavity resonator is stored in the electric and magnetic fields inside, so other things being equal is proportional to the volume. The energy lost is lost in the inner surface, so other things being equal is proportional to the area of that surface. One would expect, then, that the highest Q would be obtained in the shape that has the largest ratio of volume to surface area; which is the sphere. In practice the cylinder is little if any behind the sphere, and is obviously easier to make.

Field Patterns

In such a very introductory look at cavities I really don't think we had better delve deeply into the business of modes; it can all be found in the books on microwaves, which are full of diagrams looking like latitude and longitude lines on hemispherical maps of the world. The full lines are electric lines of force, and the dotted lines are magnetic lines of force, and all of them are as imaginary as lines of latitude and longitude. They just show the directions and roughly the relative intensities of the fields at chosen instants during the cycle of oscillation. In a conventional tuned circuit the electric and magnetic departments are kept almost completely separate, in the capacitor and coil respectively, but in a cavity they share the same space. The analogous fact in an organ pipe or other acoustic resonant cavity is that the air inside vibrates to and fro (velocity wave) *and* is alternately compressed and expanded (pressure wave). And just as an acoustic cavity resonates at one series of frequencies from end to end, and another from side to side, the electromagnetic cavity resonates at various series of frequencies depending on the mode. In both acoustic and electromagnetic kinds of cavity, a standing-wave pattern is set up at resonance, and the mode is the particular pattern. Hence all the pretty diagrams. Anyone who has studied loudspeakers knows that the cone can vibrate in a large number of different modes, at different frequencies. The modes of vibration of a flat plate can be shown visually by sprinkling it with fine powder, which is thrown off the vibrating parts on to the stationary parts, forming what are called Chladni's figures (Fig 3).

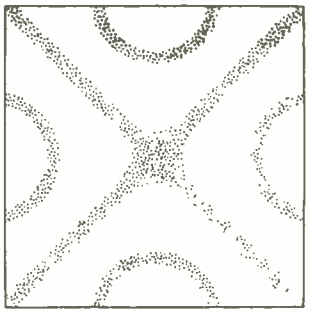


Fig. 3. One example of Chladni's figures, in which the pattern into which powder sprinkled on a plate forms itself when the plate is set into vibration shows the mode of vibration. The dark or powdery parts are the nodes, where there is no vibration.

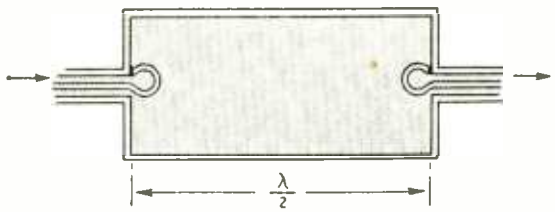


Fig. 4. Rectangular resonant cavity with input and output coupling loops.

Fig. 5. Circuit equivalent to Fig. 4.

In a two-conductor line, whether parallel-wire or coaxial, both electric and magnetic lines of force are transverse; that is to say, at right angles to the direction of travel. The electric lines stretch between the two conductors and the magnetic lines encircle them. But in a waveguide, where there is no second conductor, one lot of lines is partly along the pipe. The British custom is to divide all modes into two main classes, according to which lot of lines this is. In America they are classified according to which lot it isn't. Thus modes which have electric lines going along the guide are in the British system called E modes. In America they are called TM (transverse magnetic). Actually both lots of lines are transverse, but only the magnetic lines are exclusively so. The other class of modes is called H (for magnetic field) or TE (transverse electric). Individual modes in each class are distinguished by little numbers, e.g. H_{01},

* "Some Coaxial Problems," *Wireless World*, Dec., 1953, p. 571.
† "Skin Effect," *Wireless World*, Nov., 1953, p. 537.

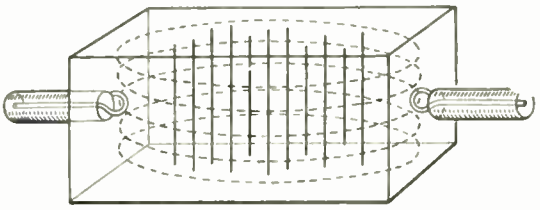


Fig. 6. The dotted loops are magnetic lines of force and the verticals within them are electric lines of force characteristic of the lowest-frequency mode of oscillation set up as in Fig. 4.

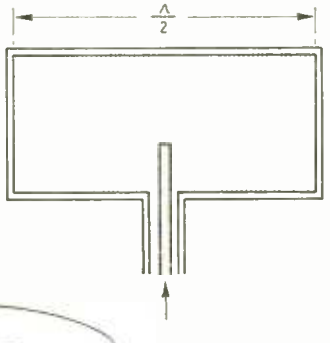


Fig. 7. Electric probe coupling for setting up the same mode of oscillation as in Figs. 4 and 6.

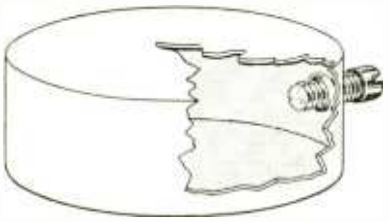


Fig. 8. Screw plug device for varying the resonant frequency of a cavity.

according to the number of half-waves in the field pattern across the main dimensions. This is where I refer you to the books for details.

Important Modes

Resonant cavities, unlike waveguides, do not have a continuous wave movement in one direction; there is a standing wave pattern, and these patterns or modes are classified in the same way as for waveguides, except that one more number is needed—to indicate how many half-cycles there are of standing wave. Although there are innumerable possible modes, it is only the very few of lowest "order" (and therefore frequency) that are used; the others are merely a nuisance. A good deal of the design of a cavity resonator is a matter of discouraging unwanted modes, so as to make sure that at any one time it oscillates with one intended pattern at one intended frequency. Here again there is the acoustical analogy. If you, like me, have a member of the family who is learning to play a wind instrument, you will know what I mean. Such instruments, it seems, require skill to ensure that the column of air therein does not vibrate in some undesired mode, instead of or in addition to what is wanted.

In both musical and electromagnetic instruments, a good deal depends on how the driving or exciting unit is coupled to the resonator. In microwave plumbing, one can place a probe (which is like a tiny rod aerial) in the direction along which the electric lines of force are wanted, or a loop in such a position as to encircle magnetic lines where they are wanted. Fig. 4 shows a rectangular cavity magnetically coupled to a source via a coaxial line at one end and to a load at the other, making a system equivalent (at the resonant frequency) to the circuit in Fig. 5. The input loop in Fig. 4 starts an electromagnetic wave with the magnetic lines going through the loop, and therefore at right-angles to the paper. The corresponding electric lines are from top to bottom. When the wave reaches the far end it is (except for energy taken out by the coupling there) reflected. The magnetic field is reflected without change of phase so the round trip is a whole wavelength and the reflected energy arrives back in phase with what is just being delivered by the loop. Most of it is reflected again; and so forth, until the build-up in the cavity is very large. Since some of the magnetic field at the outlet end passes through the loop there, it generates an e.m.f. and so starts a wave along the outlet line. The field pattern in the resonator is represented conventionally as in Fig. 6; the mode is H_{011} or TE_{011}. If the cavity were twice as long, or the frequency twice as high, it would be H_{012}, because there would be two half-wavelengths from end to end.

Because the electric lines are vertical, an alternative way of establishing resonance of the same mode is shown in Fig. 7. The total distance from the probe to the end walls and back is only half a wavelength, but the electric field is reversed in phase on reflection, so the reflected wave again arrives in phase. No load is shown here, so presumably the cavity is very sharply resonant indeed, and the input impedance would go through very violent changes of magnitude and phase if the frequency were varied through f_0.

There are two other methods of exciting cavities: through a slot, or little open window between the source and the cavity; and by shooting electrons through the cavity. This last method is very important, as we shall see.

An aspect of the subject yet to be mentioned is tuning. Obviously one way of tuning a cavity is to vary its length. One can think of a cylinder in a petrol engine as a resonator tuned rapidly to and fro over a wide range of frequency. We would be well advised to do no more than think about it, because as a practical arrangement it would not be very efficient. Steel piston rings, though no doubt excellent as a gas and oil tight joint, would not be conspicuously satisfactory for microwaves. However, suitable cylinder and piston combinations are in fact used as resonators for wide ranges of tuning. More often quite a small range is sufficient, and then a popular method is a screw plug (Fig. 8). The acoustic analogy might lead one to suppose that screwing the plug in, by reducing the volume of the cavity, would raise the resonant frequency. It might do so, but on the other hand it might lower it; all depending on whether it occupied space formerly dominated by electric or magnetic field. If electric field, then the result would be the same as if part of the space between capacitor plates were filled with metal—the capacitance would be increased and frequency lowered. Screwing a plug into the haunt of magnetic field, on the other hand, is like copper-slug tuning in coils—the inductance is reduced and frequency raised.

Applications

The uses of cavities? Obviously, for general tuning purposes. But there are one or two rather interesting special uses. Cavities can hardly be mentioned at all without bringing to mind the cavity magnetron,

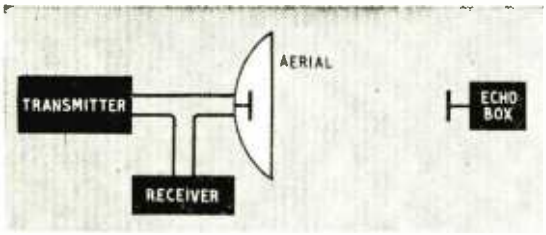


Fig. 9. Echo box method of checking the frequency and overall efficiency of a radar set.

which might quite well be called the valve that won the war. I gave some account of this last year,* along with the klystron,† which also incorporates one or more resonant cavities. In both of these the cavities are thrown into resonance by controlled electrons flying past or through them.

Another use is as a wavemeter. For rough tuning over a wide range there is the piston type, and for fine tuning the plug or plunger controlled by a micrometer movement. The enormously high Q enables the resonant frequency to be very precisely indicated. But, in contrast to the conventional absorption wavemeter, one must beware of responses at unwanted modes.

The high Q comes in very useful for testing radar sets. The higher the Q the longer the oscillations in the resonator take to die out after the power has been cut off. With a Q of the order of 30,000, they go on for quite a long time—at least several microseconds. That may not strike one as being an unendurably long time, but a wavelength of 3 cm means 10,000 cycles per microsecond. Briefly, the procedure is to set up a cavity resonator with a little dipole receiving aerial at a fixed distance from the radar aerial (Fig. 9). Each pulse from the radar, if it is working on the correct frequency (the frequency to which the cavity or "echo box" is tuned) sets the box into oscillation. At the end of the pulse the oscillations die away exponentially and are picked up by the radar receiver. Since each microsecond delay between pulse and received signal appears as a range of 164 yards on the receiver, the time taken for the oscillations to die away to the just-detectable level is known, and of course the longer this is the better the radar set as a whole, for it increases with transmitter power, receiver sensitivity, and efficiency of feeders, aerial, etc.

Speed of E.M. Waves

My last example of the use of a cavity resonator is a very special one. Some years ago, Dr. Essen of the National Physical Laboratory used a resonant cylinder about 7in long to measure the speed of electromagnetic waves in a vacuum with great accuracy. The dimensions of this cylindrical cavity were made correct within one hundred-thousandth of an inch, and the result of the measurement was given as 299,792.5 ± 3 km/s. Since there is no reason to believe that the speed of electromagnetic waves at the frequency of the measurement (10,000 Mc/s) is any different from those at 500,000,000 Mc/s, this is accepted also as a measurement of the speed of light. Certainly it agrees well with accurate direct measurements of the speed of light. The speed is so enormous that the early methods necessitated a distance of many miles. Now seven inches is enough.

* "Valves for Microwaves," *Wireless World*, Sept., 1953, p. 417.
† "More Valves for Microwaves," *Wireless World*, Oct., 1954, p. 479.

Transistor Stagnation

DEVELOPMENT of transistors is being held up by the unwillingness of possible users to co-operate with the manufacturers, according to B. R. Bettridge in a recent lecture to the Brit. I.R.E. Engineers were tending to sit down and wait for the super-device they felt was just around the corner, he said, instead of getting down to experimental work with existing transistors and making demands for specific improvements. Consequently the manufacturers were not very sure in which directions to guide their development work and the awaited improvements were slow in coming. The whole situation was a vicious circle which could only be broken by the users thoroughly exploring the potentialities of the transistor and pointing out the best lines of development.

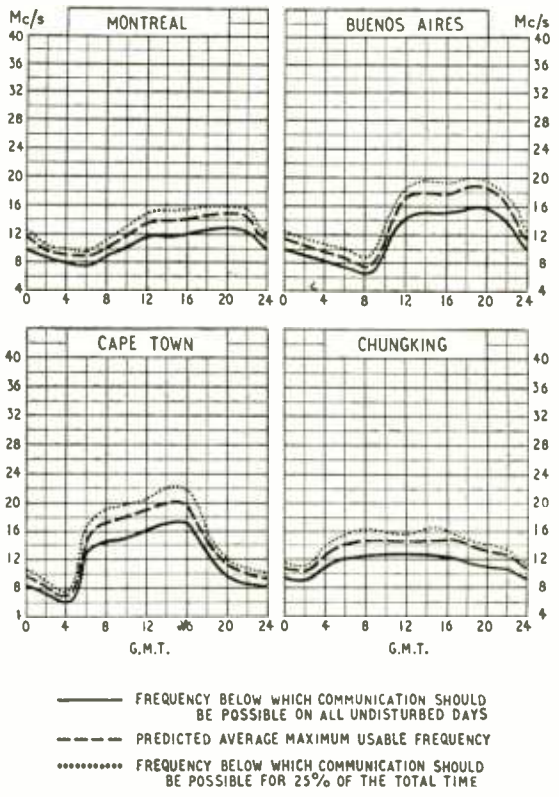
Mr. Bettridge spoke about the use of other materials besides germanium for transistors, but said there were difficulties in manufacturing them in the form of single crystals.

Short-wave Conditions

Predictions for June

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 June.

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



Physical Society's Exhibition

Electronic Techniques in Research and Measurement

This report is followed by surveys of recently introduced valves and allied devices; also of test and measuring gear. These surveys cover exhibits at both the Physical Society's and R.E.C.M.F. shows. Some products appeared at both, so no distinction is made in the surveys between the two exhibitions.

RESEARCH

THE transistor has stimulated research into semi-conducting materials and the possibilities of finding substitutes for or perhaps even better substances than germanium for this and other applications of solid-state electronics. Germanium belongs to Group IV of the periodic table of the elements with a chemical valency of 4, and on theoretical grounds it has been predicted that intermetallic compounds of elements from the groups above and below with valencies of 5 and 3, which solidify in a zinc-blende structure similar to germanium should exhibit comparable electrical properties.

One of the principal difficulties in making electrically significant compounds is the maintenance of exact molecular proportions during the alloying process. The Services Electronics Research Laboratory showed examples of miniature vacuum furnaces and methods of controlling the reaction, and also a series of representative specimen compounds.

Provisional constants for some of these compounds are as follows:—

	Energy gap (eV)	Melting point °C	Electron mobility cm²/sec per V/cm
Aluminium antimonide	1.65	1,060	100
Gallium arsenide ..	1.2	1,280	3,500
Gallium antimonide	0.71	725	700
Indium phosphide ..	1.2	1,050	—
Indium arsenide ..	0.48	950	14,000
Indium antimonide	0.18	525	50,000
Germanium ..	0.72	960	3,600

It will be seen that gallium arsenide has properties similar to germanium and may be expected to be less sensitive to temperature since the energy (gap) required to free an electron-hole pair from the crystal valency bond is greater.

The exceptionally high electron mobility and the low energy gap of indium antimonide suggest that it should be very useful as a thermoelectric generating material, and better than germanium as a material for measuring flux density by means of the Hall effect.* A demonstration was given with a small specimen of this material embedded in potting resin, which gave full-scale deflection on a Pye "Microvolter" when rotated in the earth's magnetic field.

An exhaustive study of the dielectric properties of ceramics formed by various proportions of the oxides of magnesium, silicon and aluminium has been made by the Research Laboratory of B.T.H. In the most favourable proportions the losses (tan δ) are as low as 0.0001-0.0005 at 3,000 Mc/s; the dielectric constant is about 6. Conducting glasses made with vanadium oxide and other admixtures and having resistivities at room temperature of the order of 10^1 were also shown by B.T.H.

A sensitive method of measuring frequency fluctuations is embodied in the "periodmeter"† which was shown by H.M. Underwater Detection Establishment. Time intervals between zero transits of the wave under examination are displayed on an arbitrary time base as successive vertical deflections, and the shape of the envelope gives useful information on the nature and components of any frequency irregularity. The resolution is 1 c/s in 10 kc/s and one oscillogram showed that the equipment is capable of giving accurate information on magnetic tape speed, well below the generally accepted limits for fluctuation in recorders. It has also been applied to the measurement of the mean frequency of noise in a narrow band, and to the detection of pulse signals in noise.

Apparatus for the measurement of very weak sounds (of the order of 7 phons) was demonstrated by G.E.C. Research Laboratories. It has been designed primarily for the investigation of hum produced by fluorescent lighting chokes. A soundproof double box, lead-lined, is used to contain the choke under test and a sensitive microphone, and a special pre-amplifier in which the anode current of the first valve is only 60 μA has been developed to reduce the electrical noise level. This amplifier is in tubular form so that it can be used for general measurement with minimum disturbance of the sound field.

The National Coal Board are investigating a method developed in the Physics Department of King's College, Newcastle, of detecting the presence of air in fire-damp drained from pit workings by measuring the velocity of sound through the gas by a pulse technique. The position of the pulse on a c.r. tube display is arranged to indicate all mixtures on a horizontal trace and an alarm relay is operated when the air content lies between 50 and 100 per cent. A commercial gas analyser working on the same principle is made by Sir Howard Grubb, Parsons and Company.

An unusual application of electro-acoustics methods is to be found in the "apidictor" shown by the research department of Wayne Kerr Laboratories. A microphone and switched selective amplifier are used to monitor the sounds made by bees in a hive and to give information on the health of the queen and the imminence of swarming without disturbing the life of the colony.

Other research items noted in passing were a d.c. mercury pump (A.E.R.E.) in which transverse current and a magnetic field at right angles force the liquid upwards in accordance with the classical "left-hand rule"; and an e.h.t. supply unit (A.S.R.E.) in which the valve heaters are energized by capacitive feed from the anodes through miniature r.f. transformers which can be suspended in the wiring in multiplier circuits

* See *Wireless World*, Nov., 1950, p. 415.

† *Wireless Engineer*, Nov., 1953, p. 274.

NON-INDUSTRIAL ELECTRONICS

THE counting and sizing of microscopic particles, such as blood corpuscles and dust, is a job which plainly calls for electronic techniques. The most popular method seems to be to place the particles on the slide of an ordinary microscope and scan them with a flying-spot cathode ray tube "looking" down through the eyepiece; a photocell on the other side of the slide then transforms the light modulated by the particles into pulses, and these are passed to an electronic counter during the period of one frame. Instruments working on this principle were shown by Mullard and University College, London. To avoid the possibility of a large particle being counted several times as a result of being on more than one scanning line, both instruments use a double scanning spot with an extra photocell. When the first of the two spots encounters the particle a pulse is counted in the normal way, but when, on the next scanning sweep, both spots encounter the particle the pulse from the second photocell is used to cancel the output of the first one, and so on. Size analysis of particles is accomplished in the University College instrument by a pulse-width discriminator which only accepts photocell pulses of certain durations, and in the Mullard instrument by increasing the separation of the two spots so that the second "inhibiting" spot only comes into action with particles of a certain size.

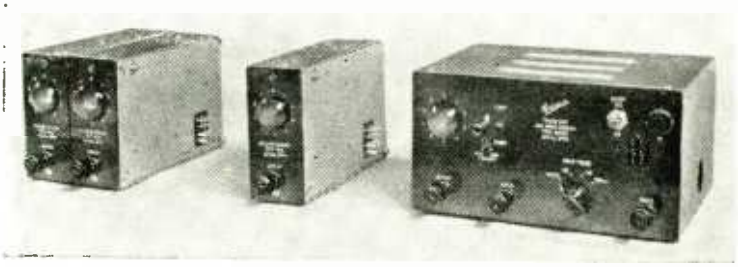
Another type of particle which can only be counted by electronic means is that produced by radioactive materials, and in this field the scintillation counter is becoming increasingly popular because of its great sensitivity—up to 80 times that of a Geiger-Muller counter. Burndept were showing an interesting example which was fitted with a lead collimator round the detecting crystal to give directional properties. With this the counting rate falls to one half of its peak value when the counter is moved as little as 5½ degrees from the source of radiation. For the actual process of counting, as distinct from detecting, Ericsson Telephones were demonstrating a versatile equipment based on their well-known Dekatron tube. This is designed on the "add-on" unit principle so that any number of decades, each incorporating a Dekatron, can be plugged together to count up to whatever figure the user requires.

A new method of displaying the electrical activity of the heart which is now becoming increasingly popular is the vectorcardiogram. This gives a two-dimensional picture by presenting on one diagram recordings made simultaneously across two planes of the heart. In the vectorcardiograph shown by the Cambridge Instrument Company the amplified signal from one set of electrodes is connected to the Y plates of a c.r. tube and the signal from the other electrodes to the X plates, the result on the screen being a complicated loop somewhat akin to a Lissajous figure. This trace gives the properties of magnitude, sense and direction of the heart voltage, while the time scale is provided by a recording camera. Ordinary electrocardiograms can also be displayed.

Another interesting Lissajous-type display on a cathode ray tube was given by a number and letter generator shown by the Admiralty Signal and Radar Establishment. This presented the face of a clock, with moving hands giving the actual time and with the letters A S R E in the middle. The basic generator waveform was an ordinary sine wave produced by an RC oscillator. From this four secondary sine waves were derived, each displaced 90° in phase, and from these in turn came eight sets of half sine waves (positive and negative) and four sets of sine waves of twice the original frequency, making 16 waveforms altogether With these it was claimed that all figures and all the letters of the alphabet could be produced.

(Right) Ericsson counter with "add-on" decades.

(Below) Vectorcardiograph with recording camera by Cambridge Instrument Company.



(Right) Mullard flying-spot particle counter.

INDUSTRIAL ELECTRONICS

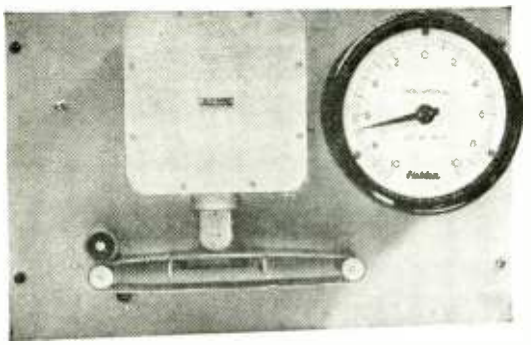
THE precision tachometer for measuring rotational speeds of aircraft engines, made by Plessey, is essentially an electronic counting device using Dekatron cold cathode tubes to give four decades. Electrical pulses from the engine shaft are registered on the counter tubes for a period of precisely 1 second, the marker pulses for which are derived from 4-kc/s quartz oscillator through two scale-of-two counting circuits followed by three Dekatrons. The display on the four counting Dekatrons is held for 0.7 sec for reading and then automatically set to zero for the next count. Alternatively the display can be held indefinitely until reset by push-button. The instrument is said to have an accuracy of 0.025 per cent.

In the Labgear (Cambridge) electronic tachometer (D4105) speeds up to 150,000 r.p.m. can be measured Normally the time datum is derived from 50-c/s mains, but terminals are also provided for an external 1-kc/s oscillator. Timing intervals of 0.1, 1 and 10 sec, and 1, 2, 10 and 20 minutes can be used, and the instrument is basically a combination of the D4102 automatic timer and D4104 Dekatron basic counter.

For the measurement of displacements, bridge methods involving change of capacitance or inductance are general. Wayne Kerr demonstrated applications of a 3-terminal a.c. capacitance bridge in mechanical engineering problems. Fielden were showing a rubber thickness gauge (continuous sheet micrometer) which makes use of a differential transformer with movable core, actuated by a spring-loaded roller. The bridge is balanced by the standard Fielden pointer servo mechanism and can be supplied as a simple indicator, as an error indicator or as a recorder. Salford Electrical Instruments demonstrated a differential electromagnetic transducer designed for operation from a.c. mains, which could be used for remote position control or for the measurement of displacement and is independent of supply voltage or frequency.

A self-contained industrial servo unit (Type R1219) shown by Ediswan, is mounted on a standard 19-in panel and contains a feedback push-pull amplifier, with provision for internal or external reference voltages, adjustable loop gain, etc., which feeds a total current of 80 mA to the centre-tapped field winding of a Type FA2 Evershed and Vignoles d.c. servo motor. The unit which provides a standing torque of 22 oz-in can be used to drive a variable-ratio transformer in voltage or current stabilizers, for process control or in machine tool pattern follower systems. It was shown connected to a model giving constant tension in a wire, irrespective of winding speed or direction.

Ultrasonic techniques are finding increasing applications in industry, and Mullard were showing, in addition to their high-powered ultrasonic drill, examples of work cleaned with the aid of high-frequency vibration. By irradiating the cleaning liquid with ultrasonic waves, generated with standard Mullard equipment, it was demonstrated that improved results could be obtained in less time. For removing the surface film from optical lenses a magnetostriction transducer working at 25 kc/s is satisfactory, while for intricate engine parts, ball races, etc., a quartz crystal using frequencies of the order of 1 Mc/s is most effective in dislodging dirt from confined spaces.

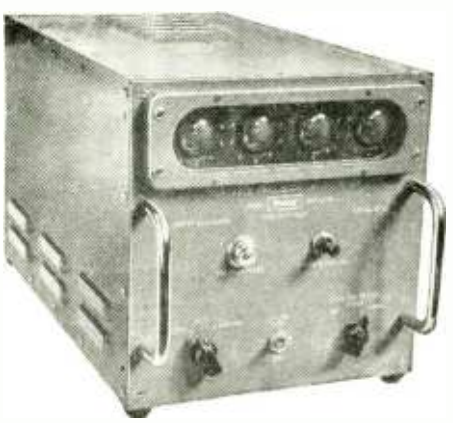


(Above) Fielden continuous sheet micrometer.

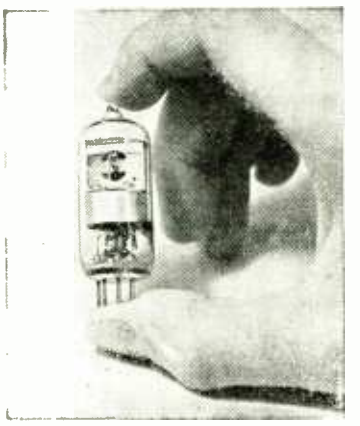
VALVES AND SEMI-CONDUCTORS

MOST manufacturers are now prepared for the coming of Band III television with new valves for the front end of receivers or tuner units. All assume the same type of circuit—cascode signal-frequency amplifier plus frequency changer, as described in our April issue—and all the valves are very similar to each other. For the double-triode cascode stage there are the Mullard PCC84, the Osram B319, the Brimar 7AN7/PCC84 and the Ediswan 30L1, all designed to operate at 90 V h.t. (each section) and with mutual conductances of about 6 mA/V. For the triode pentode frequency changer there are the Mullard PCF80, the Osram LZ319, the Brimar 9U8/PCF82 and the Ediswan 30C1. All eight valves have 0.3-A heaters for connecting in series heater chains.

Another sign of the times was the appearance of several ranges, or partial ranges, of valves for a.m./f.m. receivers. Amongst these were a number of multiple valves intended to serve several purposes. With the Brimar 6U8 triode pentode, Osram B309 double triode and Mullard ECC85 double triode, for example, one half would be an r.f. amplifier and the other a self-oscillating mixer. With the Brimar 6T8 and Mullard EABC80, both



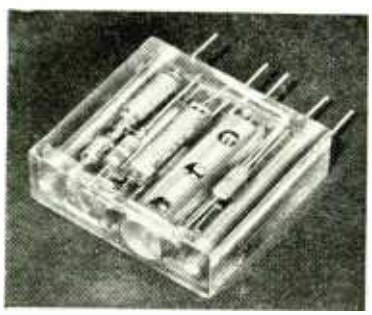
(Left) Portable precision tachometer (Plessey).



(Right) G.E.C. tunable magnetron showing form of cavities.

triple-diode triodes, two of the diodes would be used in an f.m. ratio detector, the third as an a.m. detector and the triode section as an a.f. amplifier.

The design of low-power tunable magnetrons of the conventional type for operation at frequencies of the order of 10,000 Mc/s becomes difficult because of mechanical complications. G.E.C. were showing that a simple type of magnetron can be devised to give adequate output for most low-power applications by the use of electron interaction with space harmonics of the resonator field. The valve (type VX3238) has a simple form of anode with two resonant cavities, mounted within a glass bulb through which it radiates directly into an output waveguide. It operates with the same voltage and magnetic field as a magnetron with ten to fourteen cavities of the usual type. By adjusting an external cavity coupled to the valve a tuning range of at least 400 Mc/s can be achieved with a single control and with a power of not less than 100 mW. Pulse operation is possible and a peak power of the order of 1W may be obtained at a peak current of about 50 mA. G.E.C. also had another low-power tunable magnetron (type VX3809) with an interdigital anode structure. It operates at an anode voltage of 700-800V and gives an output power of 4-8 watts over a tuning range of 8.8-11.6 cm.



Example of Wayne Kerr "potted" circuit element with provision for dissipating heat from encapsulated valve.

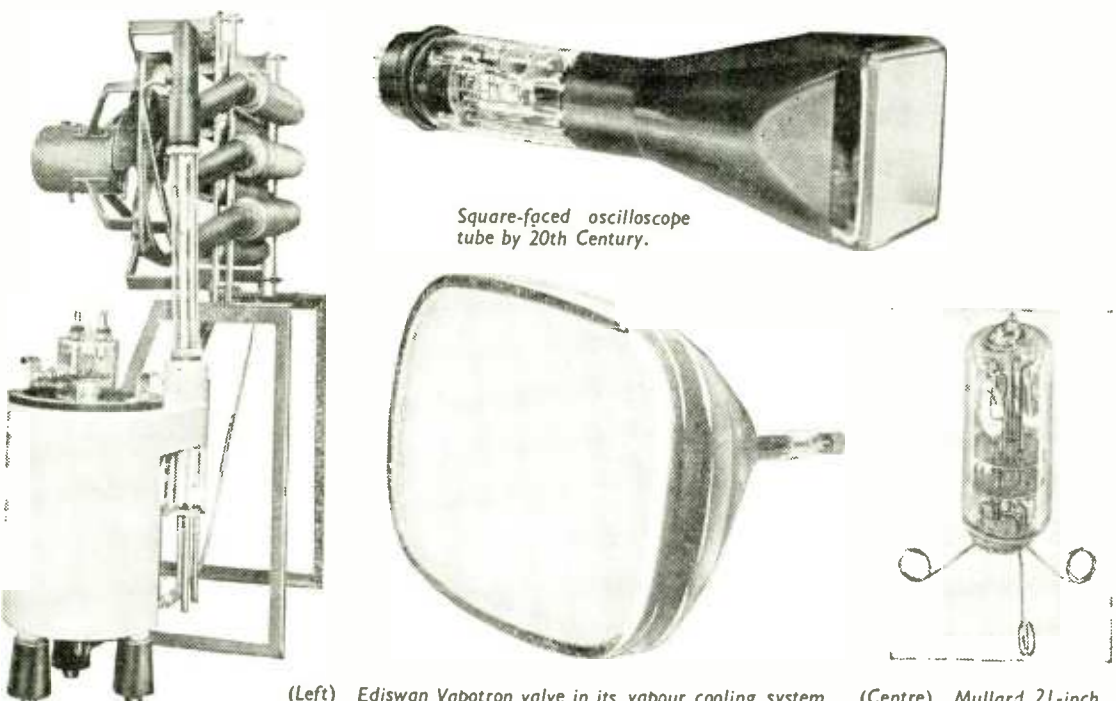
Cooling transmitting valves by water vapour instead of forced air or circulating water is claimed to give greater heat dissipation for a given size of valve. Ediswan were showing two of their "Vapotron" valves with special anode structures rather like copper pineapples for this type of operation. The valve is arranged to bring water to boiling point and advantage is taken of the loss of heat in evaporation. The water is self-circulating and no pumps are required.

In cathode ray tubes the most interesting exhibit was a 21-inch rectangular tube, type MW33-21, made by Mullard and intended for export receivers. It has a tetrode gun with an extra electrode at cathode potential for giving uniformity of focus over the whole screen. 20th Century Electronics were showing new versions of their single-beam oscilloscope tubes with the novel feature of square screens.

It goes without saying that the transistor field is expanding rapidly, and junction types were on view for the first time. Among these were the Mullard OC70 and OC71—high stability types with large current gains, hermetically sealed in glass and intended for use in hearing aids. They replace the OC10, OC11 and OC12 (also on show) which came out some time ago. Among point transistors, one of the latest types was the GET2, made by G.E.C. This is similar to the well-known GET1, but works at a lower voltage and has a higher current gain—3.8 as compared with 2.5. In addition the "knee" of the I_c—V_c characteristic is much sharper than in the GET1. This firm were also showing experimental p-n-p and n-p-n junction transistors in oscillator and amplifier circuits, one oscillator being powered from two dissimilar metal electrodes immersed in tap water! An experimental point type with electrode spacing of only one thousandth of an inch was capable of operating at frequencies as high as 40 Mc/s.

Turning to more prosaic semi-conductor devices, Brimar were showing a new metal rectifier, type RM5,

Square-faced oscilloscope tube by 20th Century.



(Left) Ediswan Vapotron valve in its vapour cooling system. (Centre) Mullard 21-inch rectangular c.r. tube. (Right) Two 20-Mc/s quartz crystals in evacuated glass envelope (S.T.C.).

intended for receiver h.t. supplies. With an input voltage of 250 volts r.m.s. it will give a maximum d.c. output current of 300 mA. It measures $1\frac{1}{8}$ in square by 6 in long. For e.h.t. applications Westinghouse had some small tubular rectifiers, types 39E and 39K, with wire ends and diameters of $\frac{5}{32}$ in. Individual elements are rated at 85 V maximum peak inverse and 100 μA mean d.c. output current. This firm were also showing hermetically sealed versions of their 36EHT and 16HT rectifiers.

Among the quartz crystals on show were some interesting overtone crystals by S.T.C. for operation at frequencies up to 200 Mc/s. They have a frequency tolerance of ± 0.005 per cent and an equivalent series resistance of 1 ohm per Mc/s. One example was a crystal working on a 9th overtone at 180 Mc/s.

One of the many problems associated with "potting" circuit elements is the dissipation of heat generated by encapsulated valves. The method adopted by Wayne Kerr is to enclose the valve (sub-miniature types are generally used) in a perforated metal tube with the closed end flush with, or very slightly proud of, the face of one side of the moulding. The assembly is then mounted so that this face makes contact with the metal chassis, or with a metal bracket of sufficient size, to carry away the heat from the tube.

Among the many activities of Wayne Kerr is investigating the qualities and characteristics of the various resins used in this potting, or encapsulating, process. This year they staged a demonstration showing, by means of polarized light, the strains and stresses set up in certain mouldings on solidification and it was shown also how such stresses can be avoided by using suitable mixtures.

Makers*: Brimar (V, C, G); Ediswan (V, C); English Electric (V, C); Ferranti (V, C); Mullard (V, C, G, T); Osram (V, C, G, T); Pye (Q); Salford (Q, R); S.T.C. (Q, R, G, T); Westinghouse (R, G).

**Abbreviations*: V, valves; C, cathode-ray tubes; G, germanium diodes; T, transistors; R, metal rectifiers; Q, quartz crystals.

TEST AND MEASURING GEAR

Apparatus Shown at the R.E.C.M.F. and Physical Society's Exhibitions

AMONG the very few new meters to be seen at either show was the "Duo Meter" (British Physical Laboratories) which, as its name suggests, incorporates two meter movements, each with its own range switch, so that voltage and current (d.c. or a.c.) can be measured simultaneously. The same firm also showed single meters with very clear-reading 270° scales. The sensitivity of the Pye "Scalamp" galvanometers has now been doubled, as a result of suspension improvements. Another well-known range of instruments, the Evershed "Megger," has been extended by a mains-driven model with a test voltage of 10 kV. It has two scales: 0-1,000 MΩ and 60-200,000 MΩ.

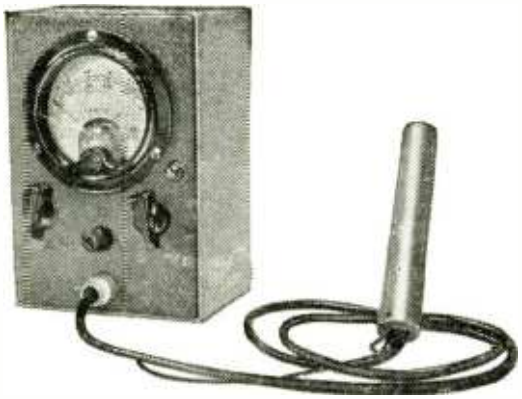
New valve voltmeters continue to be produced. The Solartron 20 c/s-20 kc/s phase-sensitive voltmeter brought out last year has been supplemented by a model for 0.5 c/s-1 kc/s, which is easier to use, because the four-phase output from the OS103 oscillator obviates the necessity for frequency-sensitive phasing adjustments on the voltmeter. Elaborate use of negative feedback in the Solartron VF252 voltmeter enables +1% accuracy to be claimed over a range of 10 c/s to 100 kc/s, while exceptional sensitivity readings can be made down to 20 μV. Instruments in this class are necessarily large and mains-driven; in complete contrast is the Furzehill V210 crystal diode valve voltmeter, which, although provided with six d.c. ranges (1-300 full-scale) and all these except the 300-V range for a.c., are completely self-contained, including batteries, in the very small case shown here. A flashing neon tube indicates when the unit is on, and also by its frequency gives a guide to the condition of the batteries. The Cintel signal-level meter comprises an amplifier, meter, and calibrated attenuator; its frequency range is 20 c/s-100 kc/s, and lowest range 0-1 mV. An instrument shown by Joyce, Loebl comprises a sub-standard a.c. voltmeter preceded by a highly-stabilized amplifier, enabling nearly the full accuracy of the meter to be retained, with the addition of very high input impedance. Although not a precision instrument, the Langham Thompson cathode-follower unit also operates as a high-to-low impedance matcher, and is notable for its extremely small size, in spite of containing its own battery power.

The principle of the well-known heterodyne type of wave analyser for a.f. has been adopted by Airmec in an instrument covering the wide r.f. range of 30 kc/s-30 Mc/s. To avoid second-channel difficulties the i.f. is 0 ± 3 kc/s. This instrument, type 853, is suitable for measurements of field-strength, interference, insertion gain and loss, frequency, etc.

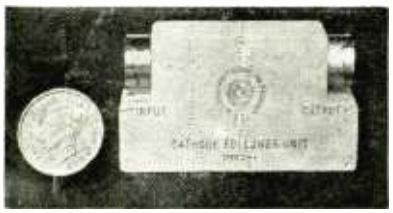
There are few new oscilloscopes, though a number of improved models. Mark II of the Mullard wide-band oscilloscope is an engineered version of the model previously shown, having a flexible and comprehensive triggered time base of constant sweep length, and calibrated delay circuits. It is particularly suitable for the analysis of high-speed complex waveforms. The Furzehill oscilloscopes, notable for some years for their direct-coupled amplifiers, are now obtainable with single-stroke time base, and one of them (type 0.100) has calibrated time and voltage. There is also an entirely new and relatively small general-purpose model (0.120) at a moderate price.

The construction of decade resistance boxes has changed little for a good many years, but now a notable departure by Tinsley is the substitution of printed units in place of the groups of conventional wire-wound resistors. Compactness, stability and low reactance are combined with higher power dissipation. Another new decade resistance technique has been developed by Pye: a box giving very precise and stable small increments of resistance. If steps of 0.0001Ω were provided in the conventional manner they would be subject to large uncertainty owing to switch contacts. In the Pye box low-resistance steps are brought in by shunting a fixed resistance with relatively large values of resistance, sufficient to swamp the switch resistance very effectively. Total range in the specimen shown is 50-61.111Ω; the 50Ω residual resistance can be tolerated in bridge and other measurements for accurate low resistance, because they would in any case be made on a difference basis. To avoid risk to more precise standards through overloading, Furzehill have introduced a workmanlike high-dissipation five-decade ±1-% resistance box (R600) totalling over 1 MΩ in steps of 10Ω.

A precise decade of capacitance is costly, but where ±1% is good enough the box now produced by Servomex gives 0.001-0.999 μF inexpensively, using three 3-pole wafer switches and groups of capacitors in 1:2:2:5 ratio. The principle of the Sullivan capacitor introduced some years ago, in which the range of a 100-pF variable air capacitor is multiplied tenfold by a decade unit also with air dielectric, has now been extended in a model having the same total capacitance made up of a 10-pF variable (giving more precise readings) and two decade units. This capacitor is incorporated in a new Schering bridge covering 0.1 pF-100 μF with ±0.01% precision. British Physical Laboratories also showed a Schering bridge, using a tuned visual null indicator. The trend towards transformer ratio arms continues. Langham

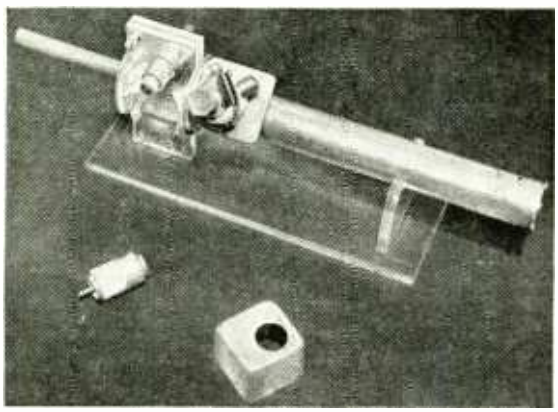


Furzehill V210 portable valve voltmeter.



Miniaturized cathode follower unit made by Langham Thompson.

Standing-wave indicator for 3-cm band made by Elliott.



Piston attenuator made by Advance Components.

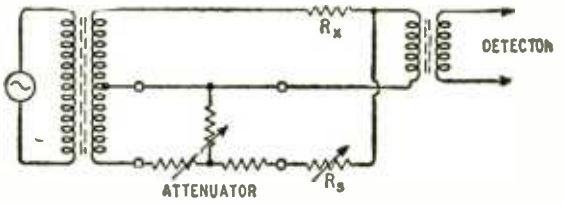


Fig. 1. In transformer-ratio bridges for v.h.f., the range of values of the standard resistance R_s, and of the ratio, is limited. In an exhibit by Wayne-Kerr this limitation was shown to be overcome by an attenuator inserted as shown.

Thompson have a capacitance bridge on this principle, reading up to 250 pF in three ranges; and Wayne-Kerr (who use it exclusively in their bridges) have two new self-contained mains-driven models with "magic-eye" balance indicator; the B321 for inductance and resistance, with a discrimination of 0.00001 μH at 10 kc/s (max. 10 mH), and the B221 for capacitance and conductance, with a discrimination of 0.0001 pF at $10/2\pi$ k/cs (max. 100 μF). An interesting feature of both these bridges is that the readings come up in figures at a window, as in a cyclometer, and the unit symbol and the position of the decimal point is controlled by the range switch! Errors in reading are thereby excluded. An experimental v.h.f. bridge technique demonstrated by Wayne-Kerr is shown schematically in Fig. 1. Where values of standard resistance or transformer ratio would in the ordinary way be impractically high, an attenuator is used instead. A modification of the Marconi Instruments universal bridge is now available under the type number TF868/1, having the alternative frequency of 10 kc/s to give greater discrimination when measuring low values of reactance. Finally in this section, two Hay bridges for measuring incremental inductance of iron-cored components: the Furzehill B800 covering 50 mH-500 H in four ranges at frequencies of 25-2,000 c/s; the other by Cintel, 10 mH-1,000 H in seven ranges, at 50 c/s. Both provide for Q measurement from 3 upwards, and convenient application of desired amounts of a.c. and d.c.

Adjustable stabilized power supplies are indispensable laboratory equipment, and there is now a much wider choice of units, especially for a.c. and for relatively heavy currents. The Solartron range of valve-stabilized d.c. power units has been extended by compact and inexpensive chassis models for incorporating in experimental equipment; they also provide unstabilized l.t. a.c. Although h.t. accumulators have been virtually banished, it has been difficult to find a substitute for the large l.t. accumulators, but a unit is now offered by Servomex providing up to 7 A at 1-30 V, stabilized within 25 mV. It is a servo-controlled motor-regulated equipment. Two l.t. power outputs, each up to 20 A 14 V, a.c. or d.c. or both, but unstabilized, are provided from a Joyce, Loebl unit. Of the new a.c. mains stabilizers, the Cintel employs a motor-operated Variac, and full load at 230 V is 15 A. The Sorensen type of stabilizer is supplied by Langham Thompson with maximum outputs from 0.25-15 kVA, and uses the saturable-reactor principle. The difficulty of making saturated transformer regulation satisfactory against variations in frequency and load power factor without reducing the high-speed correction of voltage variations is solved in a novel manner by Philips: the quick-acting transformer is used straightforwardly for voltage stabilization, and is compensated for frequency and power-factor variations by a separate electronic chain which (since these variations are much slower) is not restricted in design by the need for fast response.

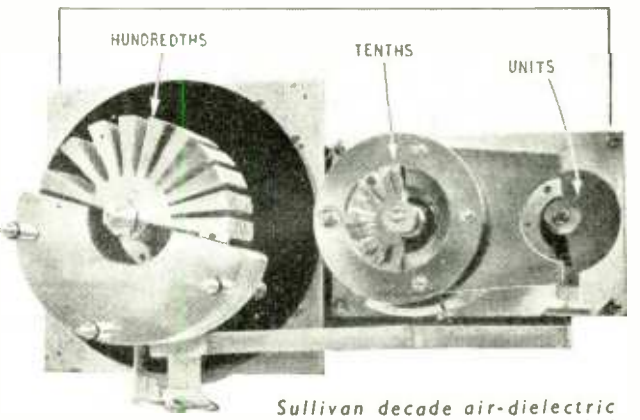
The Elliott power frequency generator, a production form of a prototype shown a year or two ago, is a link between stabilized a.c. power units and signal generators.

(*Continued on page* 301)

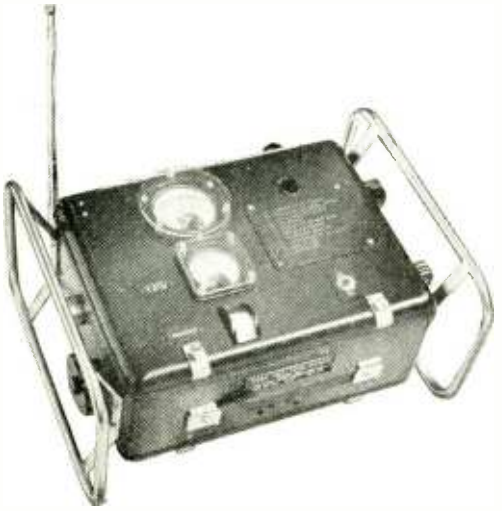
It provides two outputs of 70 VA at 0-750 V, 0-5 A, and 40-2,500 c/s. Output stability is better than ±0.02%, and frequency better than ±0.005%; and the relative phase can be adjusted from 0° to 360°. The basis is an RC oscillator, amplified, and stabilized by negative feedback.

Arranged in ascending order of frequency, new signal sources begin with the Solartron OS103 decade oscillator, at 0.1 c/s, or even (to order) 0.01 c/s. The top frequency in both models is 11.1 kc/s. A special feature is the four-phase output, intended primarily for use with the phase-discriminating voltmeter already mentioned. Associated Electronic Engineers have two RC a.f. oscillators: one to provide 4 watts output over the usual 20 c/s-20 kc/s in three ranges; and the other with slightly less output but exceptionally pure waveform—a total harmonic content of 0.06% is claimed. Airmec showed two r.f. signal generators to Government specification for use under arduous field conditions in any climate, and provided with both a.m. and f.m.: type 871 covering 85 kc/s-32 Mc/s and type 872 20-80 Mc/s. Also, mainly for use with a r.f. wave analyser to be mentioned later, a calibrating oscillator, type 858, 30 kc/s-30 Mc/s, for providing accurately known fixed outputs at 10 mV, 100 mV and 500 mV, with less precise interpolation. The Wayne-Kerr v.f. oscillator, 10 kc/s-10 Mc/s, is now provided (as type S341) with a 50-c/s square-wave output. Increasing interest in the v.h.f. and u.h.f. bands has brought forth a number of new oscillators. Particularly suitable for television servicing in bands I and III is the Advance Q1, covering 7.5-250 Mc/s, with such facilities as sine and square-wave modulation, and output variable 1 mV-100 mV, at a very reasonable price. The well-known D1 10-300 Mc/s signal generator is now modified as D1/D with direct-reading voltage and frequency scales. Its inductive continuously variable 20-db attenuator, as well as the familiar resistive step attenuator, is now separately available. The 300-1,000 Mc/s L1 signal generator shown last year is now in production, and its piston attenuator is separately available. It works in the H_{11} mode, is provided with a screen to exclude E modes, and a crystal diode for monitoring the output, and its attenuation range is 126 db. The Standard Telephones QD2, a high-performance signal generator covering the range 96-160 Mc/s, also employs a piston attenuator, calibrated in decibels and millivolts or microvolts from 0.5 V-100 mV to an accuracy of ±1 db. Particular attention has been paid to linear modulation up to 90 per cent depth at frequencies 30 c/s-10 kc/s. The extensive "Windsor" range of Taylor testgear will shortly include a synchronized TV pattern generator having a carrier range of 40-240 Mc/s and output approximately 50 μV-10 mV, available for either 405-line or 525-line standards.

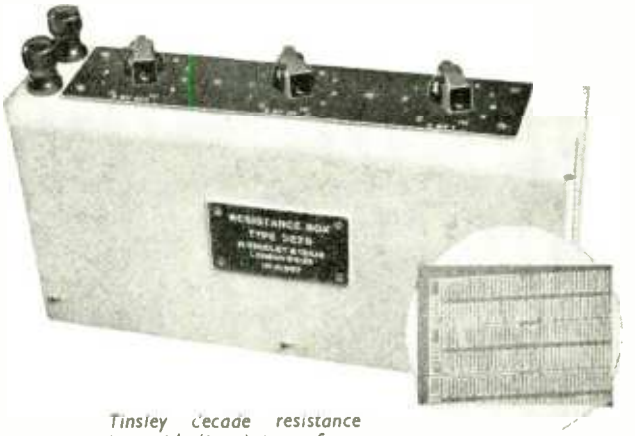
A considerable amount of new microwave apparatus was shown this year, including X-band (3 cm) waveguide test benches by Decca, Elliott, Ferranti, Marconi Instruments, and Metrovick. The Ferranti outfit is a break-away from the usual assembly of pipes, the guides being milled out of the two halves of a light-alloy block. Another of its notable features is a three-klystron input, to facilitate measurements at several spot frequencies without re-adjustment. The attenuator elements in most microwave equipment are thin nichrome films deposited on rhomboidal glass slips, giving a wide frequency range and little reflection. For use with the Elliott X-band torque-vane wattmeter shown last year there is now an artificial load with ceramic element and a quarter-wavelength slider for the elimination of standing-wave errors. A different approach to the standing-wave problem is shown in the Wayne-Kerr instrument, which contains two vanes on the same suspension, separated by quarter of a wavelength, as shown in Fig. 2. The same firm also demonstrated an X and S band Q meter, incorporating a new klystron oscillator unit obtainable separately. The Q meter oscilloscopically compares the decay of oscillations in a resonant cavity with the known rate of a capacitor discharge, and an accuracy better than ±1% is claimed.



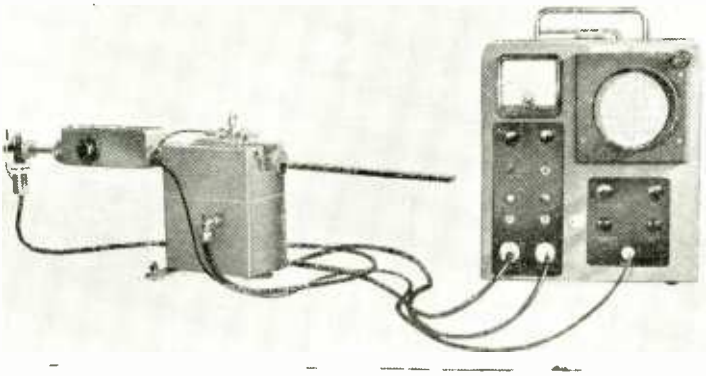
Sullivan decade air-dielectric capacitor; the capacitor marked "units" is 10 pF and continuously variable.



Transmitter and receiver performance tester made by Wayne-Kerr.

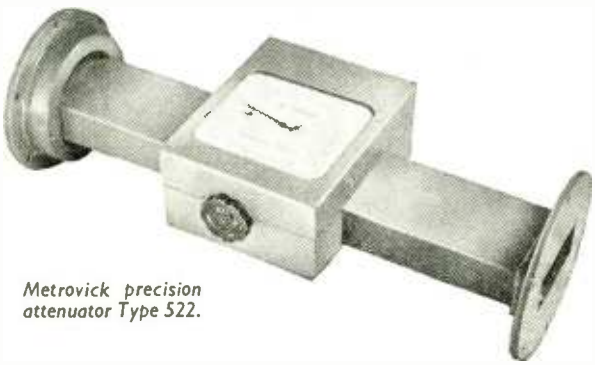


Tinsley decade resistance box with (inset) part of one of the printed circuit units.



Marconi Instruments automatic standing-wave indicator.

Reverting to Elliott X-band equipment, other well-engineered items are a precision wavemeter of the piston type with a resetting accuracy of 0.0003 in, with clock-gauge method of position indication within 0.01 mm. Equipment for the 0.9 cm band was also shown. The trend towards cleaner exteriors and the use of clock gauges for position indication was also exemplified on the Metrovick stand. Standing-wave-ratio measuring gear by Marconi Instruments incorporated a mechanically reciprocated receiver probe and a c.r. display. Barr & Stroud, besides a nichrome/glass attenuator, showed an automatic X-band aerial diagram plotter, recording in cartesion form on Teledeltos paper. The previously shown Ekco plotter is now "tidied up," and an interesting feature of the demonstration was the "free-space" cabinet for the aerial, lined with aquadag-coated slats—analogous to the acoustic rooms used for testing loudspeakers.



Metrovick precision attenuator Type 522.

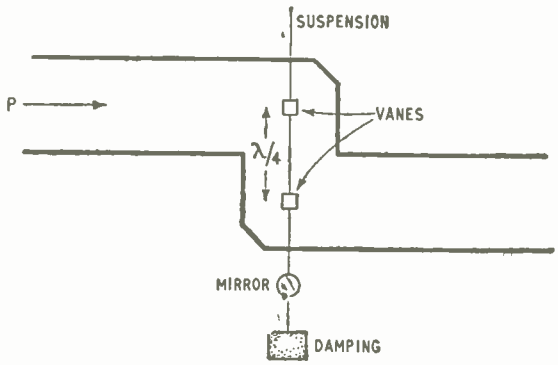


Fig. 2. Suspended-vane Wayne-Kerr waveguide wattmeter; two vanes are used to minimize standing-wave errors.

The remaining instruments fall outside the foregoing categories. The Marconi Instruments TF982 mobile v.h.f. test set, for example, includes almost everything: r.f. oscillator, a.m. modulator, a.f. oscillator, i.f. check with four crystals, r.f. power meter, a.f. power meter, multi-range test set, attenuator and terminating unit. Another new exhibit by the same firm was the TF1054 radio-noise and field-strength measuring equipment for the range 0.15-2.4 Mc/s. The TF1055 is the same except for frequency range 2.4-30 Mc/s. They will be used to test compliance with the new legal requirements for the suppression of interference, and consist of two receivers with loop and rod aerials; gain is standardized by a noise diode. Similar models are being produced to extend the frequency range up to 600 Mc/s. The Wayne-Kerr Test Set X740A is a Service instrument for the comprehensive testing of v.h.f. transmitter-receivers by non-technical personnel. Although weighing only 16 lb, it includes a.f. and r.f. signal generators, v.h.f. wattmeter and a.f. output meter, and the results of measurements are indicated as "Pass" or "Reject." Tests include transmitter power output, noise, and modulation depth, and receiver sensitivity and noise. Development of the accurate Solartron feed-back voltmeter already mentioned necessitated precise calibration, and the instrument for doing this was shown, as model AT203, since it is of general utility for use with amplifiers, valve voltmeters, etc. It takes a 10-V signal at 0-300 kc/s, provides a meter check of correct level, and subdivides it down to 10 μV. A new Cintel frequency monitor has been produced, similar in technique to other models by this firm, but with a frequency range extended to 20 Mc/s. Frequencies over 10 Mc/s are divided by 10 for measurement. The oscilloscopic spectrometer by Salford Instruments contains 38 filters which analyse an incoming signal and present the relative outputs as vertical lines on the c.r.t. screen. The range is 10 c/s-100 kc/s. C.r.t. presentation of families of valve curves has been adapted by Mullard for transistors, and is obviously a great labour saver. A frequency-standardizing equipment by British Physical Laboratories uses the B.B.C. broadcast transmission on 200 kc/s to control a chain of multivibrators and a clock; accuracy about 1 in 10^6. The same firm showed a frequency discriminator for giving direct reading of the difference between two frequencies. A possible application is the reading of weather conditions from radio sondes. Servomex demonstrated a great improvement on the usual rather crude method of testing stickiness of meter movements. The equipment consists in effect of a 3-speed slow time base. An important feature is protection against external surges, etc., that would otherwise cause misleading irregularities in the movement of the pointers.

Interference Suppression

BRIEF reference is made to the work on the design of inexpensive radio-interference suppression chokes with ferromagnetic cores, undertaken by the British Electrical and Allied Industries Research Association during the past year, in the 33rd annual report of the E.R.A. A comprehensive survey, however, of this work has been prepared under the title "The Properties and Design of Iron-Cored Suppression Chokes," by J. Miedzinski, B.Sc., and will eventually be available from the E.R.A., Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Further reports on the properties of the core materials are being prepared.

Reference is also made in the annual report to the work undertaken on the measurement of radio interference from high-voltage transmission lines and a survey covering this investigation is in course of preparation.

Plotting Aircraft Positions

AN aircraft plotting system in which the radio bearings from a number of direction-finding stations are passed automatically to a traffic control centre and there displayed on a map of the service area has been developed by Standard Telephones and Cables. It is intended to operate primarily in conjunction with a network of S.T.C. cathode-ray v.h.f. direction finders Type PV1B, but it is possible to adapt it for use with certain other types of v.h.f. direction-finding equipments. It enables the position of an aircraft to be determined by radio bearings taken on v.h.f. telephone messages and the time taken to fix its position is less than that normally required for the aircraft to establish its identity. The actual position can be passed back on completion of the identifying or other message.

The principal equipment required at the position-finding centre is a display cabinet fitted with a ground-glass screen on which is engraved a map of the service area showing the usual topographical features and any other special data required. The screen can be either 40 in or 60 in square.

Mounted at the back of the cabinet is an assembly of projection cathode-ray tubes, each corresponding as closely as possible to the position of the d.f. stations comprising the network. These projector units are similar to those used in projection television receivers, but have deflector coils designed to give very high angular accuracy. They project a rotatable trace on to the map as shown in the illustration. The point of intersection of three such traces, as in normal radio d.f. practice, gives the position of the aircraft.

Signals for operating the display are sent automatically by the d.f. stations as soon as a bearing is determined, and there is no delay beyond that needed for the bearing and with the PV1B equipment it is almost instantaneous. The signals can be sent over any ordinary communication channel, line or radio, so that the position-finding centre can be located at any convenient site inside or outside the service area of any of the d.f. stations.

The d.f. stations need not necessarily be devoted exclusively to this aircraft position-finding system and in the case of the PV1B equipment the addition of a telemeter sending attachment enables it simultaneously to perform local services at aerodromes.

Display screen of the S.T.C. aircraft position-finding system showing bearings automatically relayed from three d.f. stations.

RANDOM RADIATIONS

By "DIALLIST"

Any Old Tubes?

SOME TIME AGO a wireless dealer told me of an episode which had been puzzling him quite a bit. A small van arrived at his shop one day. From it descended a couple of "spiv" types, who asked if he'd any discarded television c.r. tubes, offering to pay good money for any that passed a "little test." Not liking the look of the men and realizing that they were up to no good, he chased them out. But what could their particular ramp be? What on earth could they do with cast-off c.r. tubes? The answer, as he had just discovered when I saw him a day or two before writing this, was tied up with the fact that none that he might have offered would have passed that "little test." He is a skilled man, who looks after his customers well, reactivating (where possible) tubes whose emission is down and giving a new lease of life to any suffering from cathode-to-heater short-circuit by fitting an isolating transformer. Any tube that he discards is a genuine dud. The aforesaid test would have led to the purchase of any tube if it suffered from nothing beyond the defects mentioned. Not all dealers are as scrupulous or as skilled as he is and anyway the isolating transformer can't be used where the mains supply is d.c. These things had made it well worth the while of his unsavoury visitors to equip themselves with a small motor van and to make dealing in discarded cathode-ray tubes a whole-time job.

Service!

How do they make their profit? My dealer had found the answer to that question when spending the Easter holiday with an entirely non-technical relative of his in another town. The relative, who owns a 15-inch television receiver, had been roped in to subscribe to a ridiculously low-priced all-in maintenance scheme operated by newcomers to the neighbourhood. He was delighted with it: "Other firms wouldn't insure my set because it is nearly two years old. But *they* did; and when the tube passed out last week they fitted a new one without a murmur." My dealer asked whether the present tube carried a guarantee: "They say that they keep that, as they're maintaining the set." He asked whether the dark patch in the middle of the screen was there when the set was returned with its replacement tube: "Oh, yes; they tell me that these tubes always have it when new, but that it soon wears off." Whipping off the back of the set the dealer found, as he'd come by now to expect, that the "new" c.r. tube had been provided with an isolating transformer for its heater. I'm not saying that this is what is done with all the c.r.t. throw-outs that are bought; there may be perfectly legitimate uses that I am not aware of for some of them. But this incident certainly provides food for thought.

Those D—d Dots

FOR SOME TIME now I've been suffering from an annoying form of television interference: innumerable white dots peppered in random fashion all over the screen. At first sight one might think that an unsuppressed motor-car engine had been left running rather fast some little way from the house. But that isn't the answer, for it's always there: Saturdays, Sundays, every day; and at all hours, even the small ones. Having found that all my neighbours were experiencing the same thing, I made a report to the Post Office and two of their engineers arrived to investigate. Well, I hardly need say that the interference was *far* less intense than I'd ever known it in many weeks, and as we watched the screen it became feebler and feebler. When they made a tour round the neighbourhood they couldn't get so much as a smell of it, even with their most sensitive apparatus. Shortly after they'd gone it was back again as bad as ever. One can't help wondering whether the person responsible for the interference spotted the Post Office van and took action accordingly.

A Grim Business

RECEIVING a present from a friend on the Continent can be no light matter in the queer times in which we live. Early in April I heard that a pair of valves of a new type were on their way to me. Time passed. Then came a letter from the Customs folk, asking me to complete section so-and-so of the enclosed form. This was almost as big as one's daily newspaper, but my

section consisted of only about half a dozen questions. There was a footnote to the effect that the questionee should reply "Not Known" to any to which he didn't know the answers. As I did not know the weight, the value and so on, this didn't take long. Having signed and dated the document, I returned it with a letter assuring Her Majesty's Officers that I had no intention of selling these articles and that they were purely for my own use for experimental purposes. When the package eventually turned up I found that it bore a label, attached by the sender, on which were the answers to all the questions to which I'd had to reply "Not Known!"

Here's Hoping

BY THE TIME that you read this the international exchange of television programmes will probably have had some trial runs. I hope sincerely that the whole thing will be a real success for it's an excellent idea. I trust that the fears expressed to me when the whole thing was very much in the embryo stage by one of those concerned in trying to organize it will prove completely baseless. "How's the eight-nation hook-up coming along?" I asked. "The gods send it isn't an eight-nation muck-up," was his gloomy reply!

Try It : It Works!

ISN'T IT about time that the powers that be stopped kidding themselves (and trying to kid others) that the policy of persuading people to fit suppressors to motor vehicles is ever going to be successful? From checks that I've made on vehicles passing my own house I'd say that somewhere about 80 per cent of the cars, vans and lorries over a year old continue to radiate interference as freely as ever. If the authorities won't bring pressure to bear, there's one way in which owners of television receivers can. Comparatively few tradesmen seem to have "suppressed" their lorries and delivery vans. When the arrival of your groceries, fish or coal results in a snowstorm on the television screen, or in unpleasant noises from the loudspeaker of the short-wave receiver, a 'phone call to the owner of the offending vehicle to the effect that, if he doesn't mend his ways and spend the necessary couple of shillings on having a suppressor fitted, you'll find another supplier, usually produces rapid and satisfactory results.

UNBIASED

By FREE GRID

$R=V^2+3W$

THE cryptic title to this item, "lifted" direct from the pages of *Amateur Photographer*, lends support to the doubts I cast last month on the somewhat dogmatic statement of an A.M.I.E.E. that repeatedly switching on and off an electric lamp —and by legitimate inference a thermionic valve—does nothing to shorten the life of the filament.

Forcibly impressed

If the writer in *A.P.* and the official publication of a well-known lamp and valve manufacturer, which he quotes, be correct (and who should know better than a manufacturer of these devices?) the switching process *does* shorten filament life owing to the heavy initial surge of current through the cold filament. The writer does not say *why* this heavy initial surge of current shortens its life but surely it can be for no other reason than that it causes a very large and sudden expansion of this delicate thread of wire.

The lamp and valve manufacturer's publication suggests the use of a series resistor—which can be shorted out after a few seconds—to combat this. It also gives the formula at the head of this note for calculating the value of the resistor; R being the required resistance in ohms, V the voltage applied to the lamp and W the lamp wattage. It is useless for those opposed to my views to say that this initial surge is serious only in the case of over-run photographic floodlights, for projector lamps are also mentioned and these are *not* over-run devices. The *A.P.* expert further states that the argument applies to "all filament lamps."

I admit, however, that it does apply in lesser degree to ordinary domestic lamps owing to their lower running temperature and in even less degree to valves with their comparatively low-temperature dull-emitter filaments, but it does apply *a bit*. Could anything meet the case more aptly than the schoolboy's translation of the well-known Latin tag "*Magna est veritas et prevalebit*," namely, "Great is truth and it shall prevail a bit?" I myself recollect so translating this tag in my youth and the enormity of my error was so forcibly impressed on me that its recollection still prevails more than a bit. In this case the truth I spoke about filament life prevailed—at any rate a little bit.

Clinical Radiometry

IT IS astonishing what little use we make of the vast resources of electronics to lessen the labour of man by relieving him of irksome repetitive tasks that could be better done by a machine.

A glaring instance of this came to my notice recently when I happened to be in a hospital ward where several patients were recovering from the immediate effects of an operation which, as after all operations, meant that a nurse was kept trotting round every half-hour to take each patient's pulse and recording it on a chart.

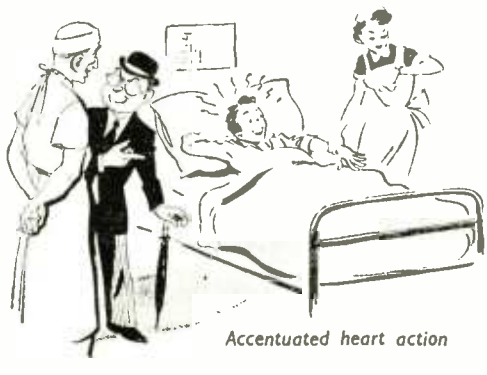
Apart from the fact that it disturbed the patient to be seized by the wrist and manhandled—or should it be womanhandled?—just when he had fallen into a doze it was obvious that, in this particular men's ward at any rate, entirely false readings were being obtained. As the nurse was an exceptionally attractive-looking girl her approach every half-hour accentuated the patient's heart action and in some cases caused it to miss a beat.

This sort of thing causes cardiac strain at a time when it can least be tolerated and the pulse readings are not, of course, a true reflection of the patient's post-operative condition. I pointed this out to the house physician, who at once grasped my point, and the pretty nurse, and replaced her by a more homely looking specimen of her profession with medically satisfactory results.

All these undesirable effects could be avoided and the nurse released for other duties if use were made of the radio-sonde principle whereby changes in the many meteorological "variables" are continually transmitted.

In these days of miniaturization it should not be difficult to construct a micro-wave transmitter not much bigger than a wrist watch. Each transmitter in a ward would work on a slightly different frequency and would radiate a few yards to the ward-sister's office where heartbeats could be read at once and at any or every moment from a battery of small c.r. tubes, one for each patient; any glaring irregularities could be made to cause a red light to flash in order to attract attention. If necessary, film recordings could be made.

By various modifications temperatures and other variables could be similarly transmitted. Maybe the sub-miniature wrist transmitters could be made simpler if they merely had to feed induction signals to a copper band around the ward; a technique about which I wrote last month.



Accentuated heart action

Does It Matter?

HALF-TRUTHS are notoriously dangerous, far more so, in fact, than honest straightforward lies and it is for this reason that I am sorry to see the radio correspondents of certain newspapers telling their readers that television stations have not the coverage of ordinary sound broadcasting stations because TV waves, unlike ordinary radio waves, can only travel in straight lines.

This is such a glib and simple explanation that it is swallowed without question by the lay mind and if you try to challenge it the layman who has accepted it is apt to be rather resentful at any attempt to rob him of it; he usually asks somewhat truculently what is your explanation of the undeniable facts of the case that the reliable range of TV stations is not much more than an optical one. You usually find yourself launched on a full-scale lecture on wave propagation which is far beyond your hearer's understanding and so he soon loses patience and dismisses you as a charlatan.

Perhaps after all it is better to let the public stew in the technical heresies which it loves. Does it matter, for instance, that most people believe that George Stephenson invented the steam locomotive or that Watt invented electric lamps and fires?

The PERFECT TEST TEAM

The illustration depicts a set of modern " AVO " testgear being used to measure the " Q " of the secondary winding of the second I.F. transformer on a chassis of unknown characteristics—just one of many tests which can be performed by this combination of instruments.

A signal of predetermined frequency from the " AVO " Wide Range Signal Generator is being fed into the Electronic Test Unit, where it is amplified and fed to the secondary winding of the transformer. The Electronic Testmeter is connected across the tuned circuit under test and from the readings obtained and the controls of the Electronic Test Unit, the " Q " of the circuit can be determined.

The three instruments, shown as a team, cover a very wide field in measurement and form between them a complete set of laboratory testgear, ruggedly constructed to withstand hard usage.

ELECTRONIC TESTMETER

A 56-range instrument combining the sensitivity of a delicate galvanometer with the robustness and ease of handling of an ordinary multi-range meter. Consists basically of a highly stable D.C. Valve Millivoltmeter, free from mains variations and presenting negligible load on circuit under test. Switched to measure :—

D.C. Volts : 5 mV to 10,000V.
D.C. Current : 0.5μA to 1 Amp.
A.C. Volts : .1V to 2,500V. R.M.S. up to 2 Mc/s. .1V to 250V. R.M.S. up to 200 Mc/s.
A.C. Power Output : 5mW to 5 Watts.
Decibels :—10db to + 20db. Zero level 50 mW.
Capacitance : .0001μF to 50μF.
Resistance: .2 ohm to 10 Megohms.

Operates on 100-130v. and 200-260v. 50-60 c/s. A.C. mains

£40

ELECTRONIC TEST UNIT

For measuring small values of A.C. voltage, inductance, capacity, and "Q" at radio frequencies. Although designed primarily for use with "AVO" instruments, it can be used with any suitable Signal Generator/ Valve Voltmeter combination.

As a Wide Range Amplifier, it is capable of an amplification factor of 40±2—3db between 30c/s and 20Mc/s

As a Capacity Meter, it covers measurements at radio frequency from .5pF to 900pF in two distinctly calibrated ranges.

As an Inductance Meter, it gives direct measurements from .5μH. to 50mH. in six ranges.

As a "Q" Meter, it indicates R.F. coil and condenser losses at frequencies up to 20 Mc/s

Operates on 100-130v. and 200-260v. 50-60 c/s. A.C. mains.

£27

WIDE RANGE SIGNAL GENERATOR

An instrument of wide range and accuracy for use with modern radio and television circuits.

Turret coil switching provides six frequency ranges covering 50 Kc/s. to 80 Mc/s.

Range 1.	50 Kc/s.—150 Kc/s.
" 2.	150 Kc/s.—500 Kc/s.
" 3.	500 Kc/s.—1.5 Mc/s.
" 4.	1.5 Mc/s.—5.5 Mc/s.
" 5.	5.5 Mc/s.—20 Mc/s.
" 6.	20 Mc/s.—80 Mc/s.

Accuracy to within 1% of scale marking. Gives sensibly constant signal of good wave-form, modulated or unmodulated, over entire range. Minimum signal less than 1μV at 20 Mc/s. and less than 3μV between 20 and 80 Mc/s. Gives calibrated output from 1μV to 50mV.

Operates on 100-130v. and 200-260v. 50-60 c/s. A.C. mains.

Battery-operated model also available.

£30

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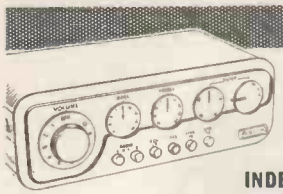
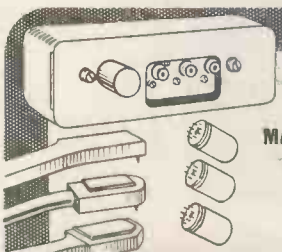
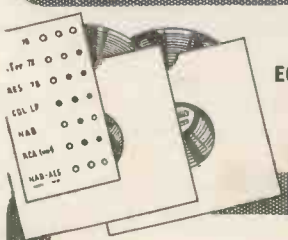
The best which present techniques can devise . . .



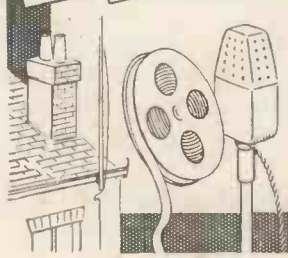
UNIQUE FILTERING SYSTEM INDEPENDENT OF MUSICAL BALANCE



CORRECT MATCHING FOR ANY PICK-UP BY PLUG-IN UNITS



CORRECT EQUALISATION FOR EVERY RECORDING



INPUTS FOR RADIOS TAPE MIC. ETC. VIRTUALLY MADE TO MEASURE

A POWER AMPLIFIER WITH PERFORMANCE STABILITY SPECIFICATION TO DELIGHT THE ENGINEER AND MUSICIAN ALIKE

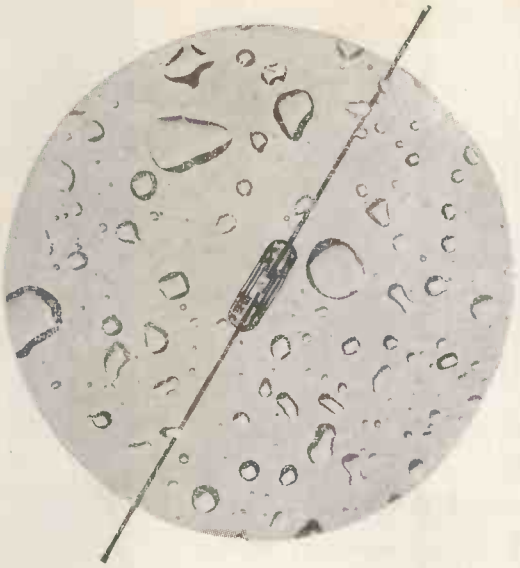
Like its predecessor, the QUAD II embodies outstanding features anticipating trends in both amplifier and associated equipment design. The importance of these features will be apparent to all who have followed the growth of high quality reproduction in recent years.

The criterion, as always, is that the reproduced sound shall be the closest approach to the original—that the enjoyment and appreciation of music may be unimpeded. This is reflected throughout the electrical and mechanical design. It is reflected, too, in the straightforward and logical system of control, achieved without the sacrifice of a single refinement or adjustment capable of contributing to the final objective.

The QUAD II for convenience of installation, is constructed in two units—the main amplifier and the control unit. Each is complementary to the other, offering in complete form the best which present techniques can devise.

ACOUSTICAL MANUFACTURING CO LTD

ACOUSTICAL MANUFACTURING CO. LTD., HUNTINGDON, ENGLAND



OA73

All glass

POINT CONTACT

GERMANIUM DIODE

ABRIDGED DATA

Forward Current:

at +0.25V	....	> 100μA
at +1.0V	....	> 8mA

Reverse Current at 25°C:

at −1.5V	....	< 20μA
at −10V	....	< 200μA
at −20V	....	< 800μA
at −30V	....	< 1.25mA

Operating Ambient Temperature: −50 to +75°C.

R.F. Characteristics: the OA73 is suitable for operation as a wideband R.F. detector.

Fusion sealed

AGAINST MOISTURE

Penetration of water vapour is undoubtedly one of the major factors which affect the stability and reliability of germanium diodes. Partial and complete sealing techniques, while keeping the inside of diodes moisture-free, have in the past often introduced other undesirable fillings.

The Mullard aim has been not only to safeguard diodes from the ill-effects of water vapour, but also to reduce the number of different materials used in construction and so minimise the risk of contamination. The ultimate point in the evolution of this type of construction is marked by the OA73, the first of a Mullard range of *all-glass* diodes.

In this latest form of construction the glass envelope is melted onto the lead-in wires, so forming properly made fusion joints similar to those employed with great success in the many millions of radio valves which are made each year. These joints are entirely sealed and there is no possibility of performance being jeopardised by the entry of moisture or any other substance.

The OA73 has been specially designed for industrial and telecommunications use. It has been tested to the full tropical specifications for the CV442 and is an approved type.

Mullard

MULLARD LIMITED, COMMUNICATIONS & INDUSTRIAL VALVE DEPT.

CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2

MVT157

Hearing is believing . . .

The human ear is capable of hearing approximately one per cent harmonic distortion. Yet even in equipment where this distortion has been reduced to a lower level, the difference between " live " and reproduced sound can still be detected.

The development by Goodmans engineers of the elusive quality of " PRESENCE " is therefore significant for the High Fidelity enthusiast. " PRESENCE " goes beyond the response curve. It implies more than the wide range of response in perfect balance for which Goodmans speakers are noted.

The additional quality of " PRESENCE " offers the nearest possible approach to listening to the actual recording session of the music of your choice.

For the enjoyment of High Fidelity reproduction in its truest form, every link in the chain of reproduction, from pickup to speaker, must be equal to its function. Make an opportunity to listen to a Goodmans speaker. You will find that it is more than equal to its task. For what may be the first time for you, you will hear the music of your choice as it should be played—as it was recorded—with all its depth and richness of feeling.

We will be pleased to supply free dimensioned drawings of specially designed standard or corner reflex cabinets. Numbers of cabinets have been sold reputedly to our design but which do not conform to our specification. Before purchase, it is therefore advisable to check carefully that the specification has in fact been carried out.

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AXIOM 150 MK. II £10 . 5 . 6 *(Tax free)*
AXIOM 102 £9 . 18 . 2 *(Inc. Tax)*
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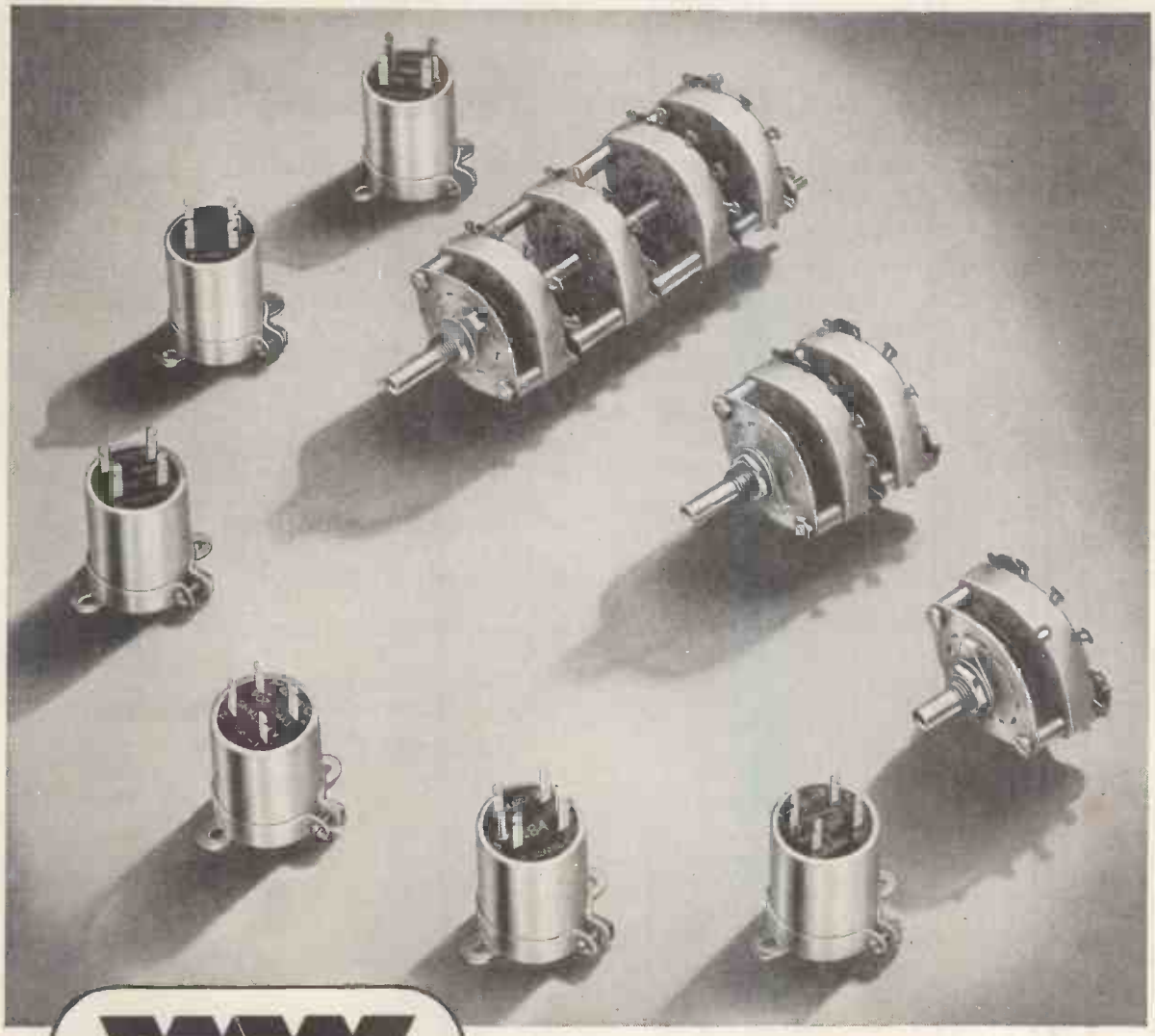
GOODMANS INDUSTRIES LTD.

AXIOM WORKS, WEMBLEY, MIDDX. *'Phone: WEM 1200 Cables: "Goodaxiom" Wembley, England*



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A.F. TRANSFORMERS AND CERAMIC ROTARY SWITCHES

The "Hyperloy" series of A.F. Transformers and Chokes of over a 100 Specifications is now available in hermetically-sealed containers capable of withstanding the most rigorous climatic conditions. Also available in similar gas-tight containers is a range of Bi-limboid transformers having hum-cancelling windings for use in situations demanding the lowest hum-levels without recourse to expensive mumetal screening.

The high-quality ceramic rotary switch is designed for use in low-power transmitters, instruments or for similar circuit selection functions. The insulating material is "Frequentite", and silver-alloy contacts ensure very low contact resistance and trouble-free service over a long life.

A "Wearite" Switch Chest is available for laboratories and research organisations and contains all necessary component parts to permit of the assembly of switches to meet particular requirements.

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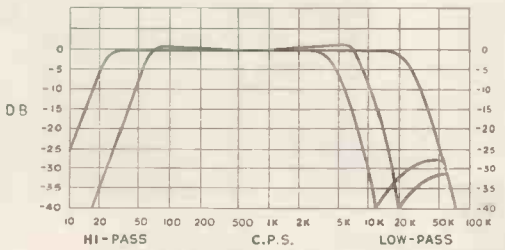
Now... the ultimate in Amplifier Performance

Based on the World-famous Williamson circuit and utilising the latest Partridge ultra-linear C-core output transformer, the RD SENIOR represents the ultimate in modern high fidelity amplifiers. Used in conjunction with a Control Unit embodying every possible refinement, it combines faultless reproduction, flexibility of control and absolute reliability to provide a performance to satisfy the most exacting requirements.

"RD SENIOR"

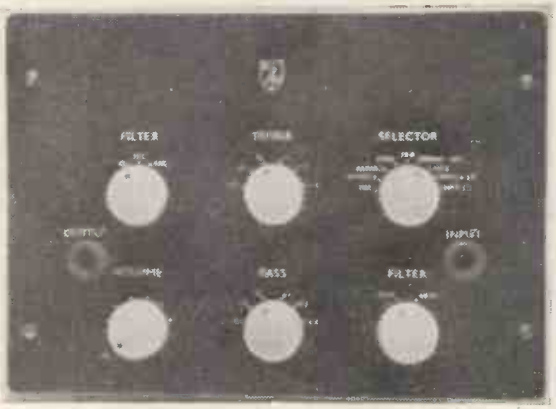
- ★ **Ultra-linear C-core output transformer**
- ★ **Power Output :** 15/20 watts. **Peak:** 25 watts.
- ★ **Frequency Response:** ±.1 DB 20-20,000 cps.
- ★ **Distortion :** .08% for 15 watts. .3% for 20 watts.
- ★ **Intermodulation Distortion :** .35%—15 watts.
- ★ **N.F.B.:** 20 DB (10-50,000 cps.)
- ★ **Partridge Transformers throughout.**

"RD SENIOR" MAIN AMPLIFIER **£28**



FILTER CHARACTERISTICS

- ★ 2-position High Pass Filter.
- ★ 3-position Low Pass Filter.
- ★ 6 Playback characteristics.
- ★ 2 Radio Inputs.
- ★ Microphone Input.
- ★ Very high input sensitivity, average on LP 8 m/V.
- ★ Input and Output Jacks on front panel.
- ★ Illuminated translucent control panel.
- ★ Negligible hum and noise.
- ★ Close tolerance high stability components throughout.
- ★ Wide range switched Bass and Treble controls.
- ★ All Filter and Tone controls operate on all inputs and are all completely independent of one another.



"RD SENIOR" CONTROL UNIT **£15**

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Phenomenal success of new line

NEVER before, in all our 28 years' experience of speaker production, have we created a world-wide demand in a matter of months. It sounds incredible, but that is just what has happened with our High Fidelity range. Since they were first introduced last Autumn, we have received orders for these units from

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In this country, their success has been phenomenal: more than 1,400 users have taken the trouble to write us — a most impressive tribute. The amazing quality of reproduction at remarkably low cost is made possible only by the Whiteley patented Cambric Cone, and by our specialisation and complete control of manufacture from raw material to finished product.

Write for dimensional drawings of suitable cabinets and leaflet giving full technical details, or ask your dealer to demonstrate. Alternatively, these speakers may be heard at our London Office, 109 Kingsway, W.C.2, any Saturday between 9 and 12 noon.

WHITELEY ELECTRICAL RADIO CO. LTD
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Stentorian

HIGH FIDELITY UNITS

WITH THE PATENTED CAMBRIC CONE

MODEL H.F.610. 6" Steel unit, incorporating 10,000 gauss magnet. Handling capacity, 3 watts. Frequency response, 60 c.p.s.-12,000 c.p.s. Bass resonance, 70 c.p.s. Price **£2.10.6** (Tax Paid)

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MODEL H.F.912. 9" Die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 7 watts. Frequency response, 40 c.p.s.-13,000 c.p.s. Bass resonance, 45 c.p.s. Price **£3.7.0** (Tax Paid)

MODEL H.F.1012. 10" Die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 10 watts. Frequency response, 30 c.p.s.-14,000 c.p.s. Bass resonance, 35 c.p.s. Price **£3.13.6** (Tax Paid)

Transformer available if required
All models available either 3 or 15 ohms.

W B

Approved to ENTIRELY NEW Inter-Service Standards

A miniature range of Hunts Electrolytics approved to Inter-Service standards RCS 134 Issue 3 and RCL 134 Addendum Issue 2. Temperature range: —30° C to +70° C max. Please write for leaflet giving details of complete range.

Cap µF	Peak Working Volts at 70°C.	Max. R.M.S. Current at 50/c/s (mA)	Dimensions (inches) L.	D.	List Number	Inter-Service Cat. Number
TYPE L31/1. PATTERN CE4. CLASS HI						
50	25	70	1 1/4	5/8	JB 53AKZ	Z145512
100	25	100	1 3/4	5/8	JB 54KZ	Z145514
1000	25	600	3	1	JB 57KZ	Z145520
25	50	60	1 1/4	5/8	JB102BKZ	Z145508
50	50	100	1 3/4	5/8	JB103KZ	Z145513
500	50	450	3	1	JB106AKZ	Z145519
8	150	60	1 1/4	5/8	JB153BKZ	Z145502
16	150	90	1 3/4	5/8	JB154KZ	Z145505
32	150	160	1 3/4	3/4	JB181KZ	Z145509
8	350	75	1 3/4	5/8	JB403KZ	Z145503
16	350	120	1 3/4	3/4	JB405KZ	Z145506
32	350	225	2	1	JB407AKZ	Z145510
4	450	50	1 3/4	5/8	JB552KZ	Z145501
8	450	100	1 3/4	3/4	JB553BKZ	Z145504
16	450	175	2	1	JB554AKZ	Z145507
32	450	275	3	1	JB555AKZ	Z145511
TYPE L32/1. PATTERN CE5 CLASS HI						
3000	25	1100	4 1/2	1 3/8	KB 62KZ	Z145557
1500	50	1000	4 1/2	1 3/8	KB111KZ	Z145555
60	350	350	2	1 3/8	KB430KZ	Z145552
100	350	450	3	1 3/8	KB411KZ	Z145554
32	450	275	3	1	KB555BKZ	Z145551
60	450	450	3	1 3/8	KB581KZ	Z145553
TYPE L32/3. PATTERN CE6. CLASS HI						
32+32	350	200	2	1 3/8	KB417KZ	Z145601
60+100	350	400	4 1/2	1 3/8	KB420KZ	Z145603
60+250	350	400	4 1/2	1 3/4	KB422KZ	Z145605
100+200	350	550	4 1/2	1 3/4	KB423KZ	Z145606
32+32	450	300	3	1 3/8	KB564AKZ	Z145602
60+100	450	550	4 1/2	1 3/4	KB565KZ	Z145604

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HUNTS CAPACITORS

THE TRADE MARK OF RELIABILITY

All units are insulated by a Suflex sleeve and dimensions must be increased by 1/8" on the length and 1/16" on the diameter to allow for this sleeve.

A. H. HUNT (Capacitors) LIMITED
WANDSWORTH · LONDON · S.W.18
Tel: BATtersea 1083-7 **Est. 1901**
And in Canada • HUNT CAPACITORS (Canada) Ltd., AJAX, ONTARIO

Q. What is a DIFFERENCE DIODE

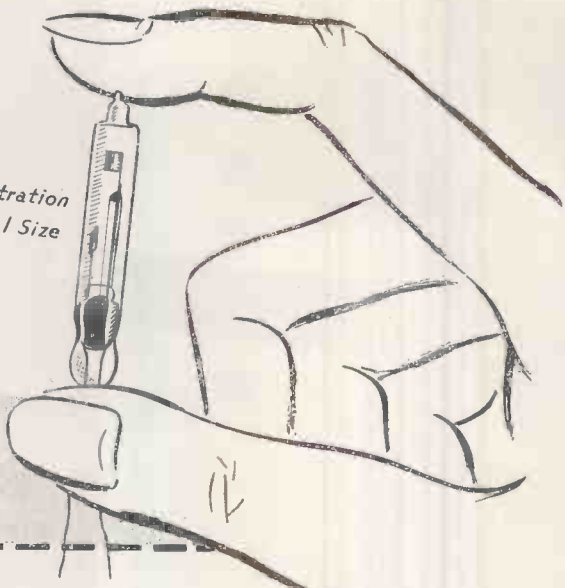


Illustration Actual Size

A. **A *DIFFERENCE DIODE* IS A COLD CATHODE DIODE CHARACTERISED BY A LARGE DIFFERENCE BETWEEN THE STRIKING AND MAINTAINING VOLTAGES.**

The XC14 *Difference Diode* is the latest sub-miniature cold cathode diode developed by Hivac especially for use in the telecommunications and computer fields. The striking and maintaining voltages are controlled between limits giving a minimum difference of 70V, which makes the XC14 ideal for storing, counting, gating and similar functions in electronic circuits.

HIVAC
THE SCIENTIFIC VALVE
BRITISH MADE

Characteristics of the XC14 *DIFFERENCE DIODE*

Strike Voltage.....145-170V.
Maintaining Voltage at 0.5mA.....75V maximum.
Maximum continuous current rating.....0.75mA.

Hivac Limited
GREENHILL CRESCENT, HARROW-ON-THE-HILL.
MIDDLESEX, ENGLAND.
Phone : HARrow 2655 *Cables : Hivac, Harrow.*

A NEW-PRINCIPLE A-C AUTOMATIC VOLTAGE STABILISER

We have now had released to us by a Government Department the design of our "A.C. Mains Regulator, Automatic, Step, Mark II", and are therefore manufacturing this unit for general sale. It ideally fills the need for a cheap, small and light Stabiliser. Although it measures only 8½in. x 4½in. x 5in., weighs as little as 11 lbs., and costs only £24 net, it has a performance fully equal to any similarly rated Automatic Stabiliser of the resonated, saturated core type, without any of the disadvantages.

ASR-1150 has a pure output waveform, is unaffected by changes in mains frequency, and works equally well from no-load to full load, which is 1150 VA. It has a stabilised output at 230V unless otherwise ordered.

Many other Automatic Voltage Stabilisers are now manufactured by us, and all are available for immediate delivery. In some cases the constancy of output is as high as 0.15%. Models are available from 200 VA to 30 kVA, single phase. 3-Phase Stabilisers are also available. Prices are *extremely* competitive.

We can supply from stock all types of American tubes, condensers, valves, potentiometers, etc.

The *NEW "ASR-1150"* costs only *£24* net

Complete information is obtainable from:

CLAUDE LYONS LTD., *STABILISER DIVISION,*
QUEEN'S HOUSE, 180-182 TOTTENHAM COURT ROAD, LONDON, W.1
(Telephone MUSeum 3025-6 Ext. 13)

MEMO: If you are interested in infinitely-variable Transformers, do not forget the almost indispensable "VARIAC" (Reg'd. Trademark). Models are available from 170VA to 21kVA. Our Catalogue V-549 (3rd Edition) tells the whole story, and will gladly be mailed free and post free, on request.

RCA is first choice for television equipments

RCA TELEVISION in the Philippines and Thailand has quickly followed the first TV installation in Asia in 1953. The first transmitter in Japan has now expanded to three . . . all completely RCA-equipped.

So the tremendous educational and cultural capacities of television are being introduced 'round the world . . . the most powerful means ever conceived for public enlightenment and international understanding.

Abroad, as in the U.S.A., RCA provides everything for television . . . from camera to antenna, from mobile remote units such as pictured here to complete studio and transmitter equipments. RCA also makes available the services of distributors and companies long versed in the electronic needs of their countries.

You can look with confidence to RCA for this complete co-ordinated service . . . manufacturing, installation facilities, instruction, servicing . . . *everything* that goes to make RCA TV such a dependable instrument of education and enjoyment throughout the world.

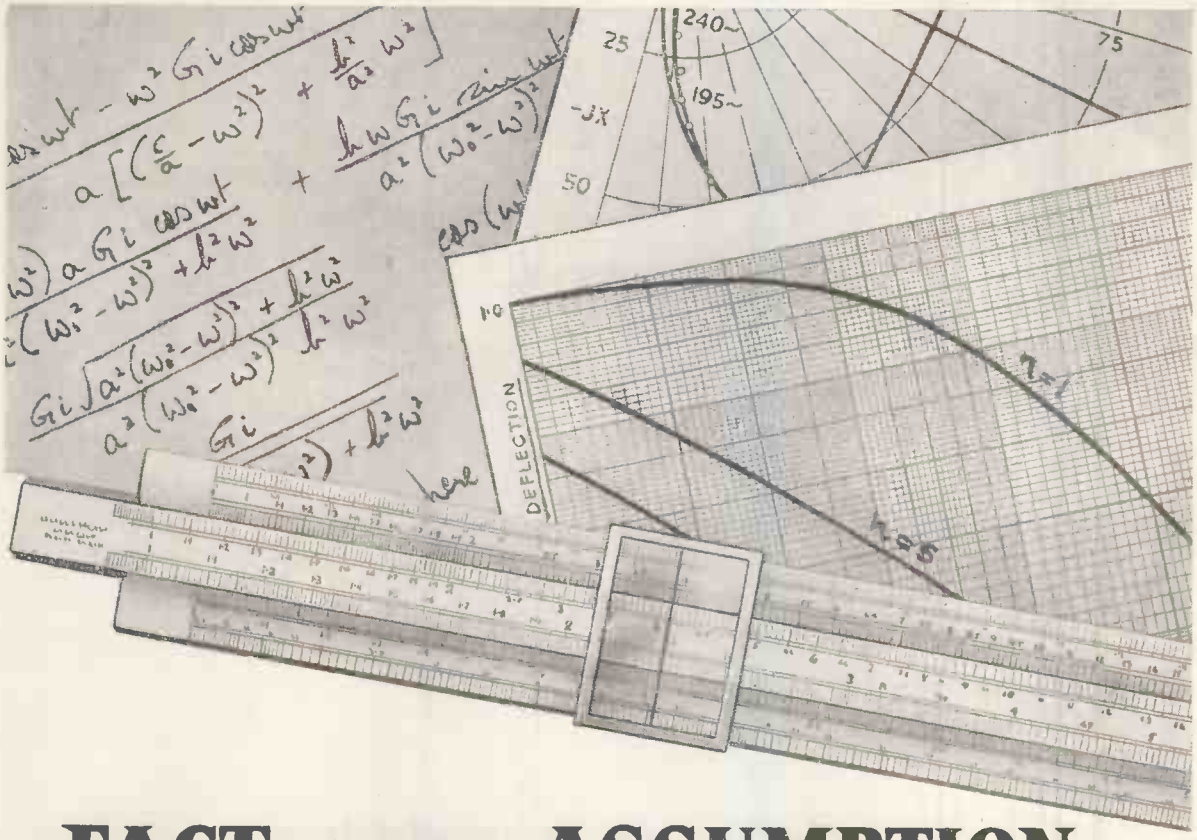
Your RCA distributor or company will gladly tell you about RCA TV; or write to RCA International Division.

RCA produces complete TV studio equipments, from microphones to monitoring consoles. This scene shows a broadcast from the RCA-equipped station DZAQ-TV, Manila.

World Leader in Radio
First in Recorded Music
First in Television

"Marca Registrada"

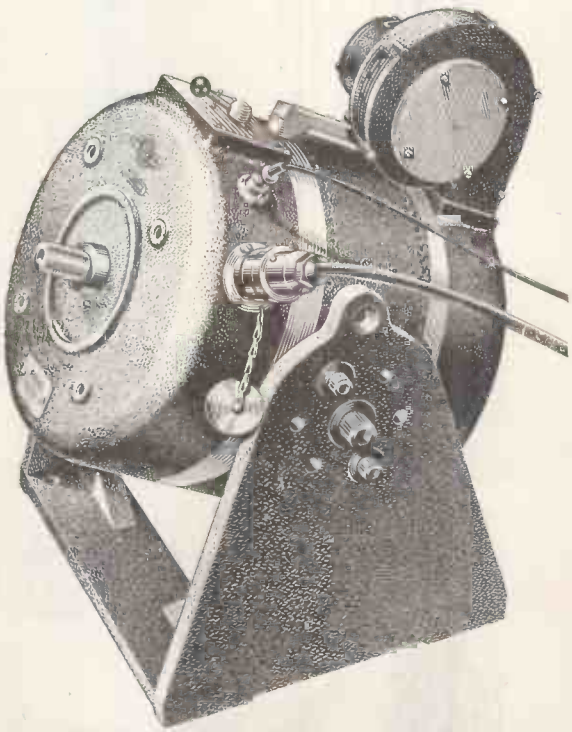
RCA INTERNATIONAL DIVISION
RADIO CORPORATION of AMERICA
RCA BUILDING
30 ROCKEFELLER PLAZA, NEW YORK, N.Y., U.S.A.



FACT *versus* ASSUMPTION

Vibration effects can be assessed by assumption, estimation and long calculation. Prototypes can be built on those assumptions, but with many anxious moments awaiting operational test results—results which may nullify months of patient effort. It is much simpler, and certainly more economical, to conduct preliminary tests in the laboratory by creating vibrations under controlled conditions—and so obtain the facts. That is the precise function of Goodmans Vibration Generators. They provide vibratory sinusoidal forces at controlled frequency and amplitude, by which specific vibratory conditions over a wide frequency range can be accurately simulated to assess their effects on materials, structures and components.

Applications include FATIGUE TESTING, ELECTRICAL COMPONENT TESTING, VALVE MICROPHONY TESTING, TORSIONAL VIBRATION TESTING, FLEXURE TESTING OF METALS AND PLASTICS, ETC., AND MECHANICAL STRUCTURE TESTING.

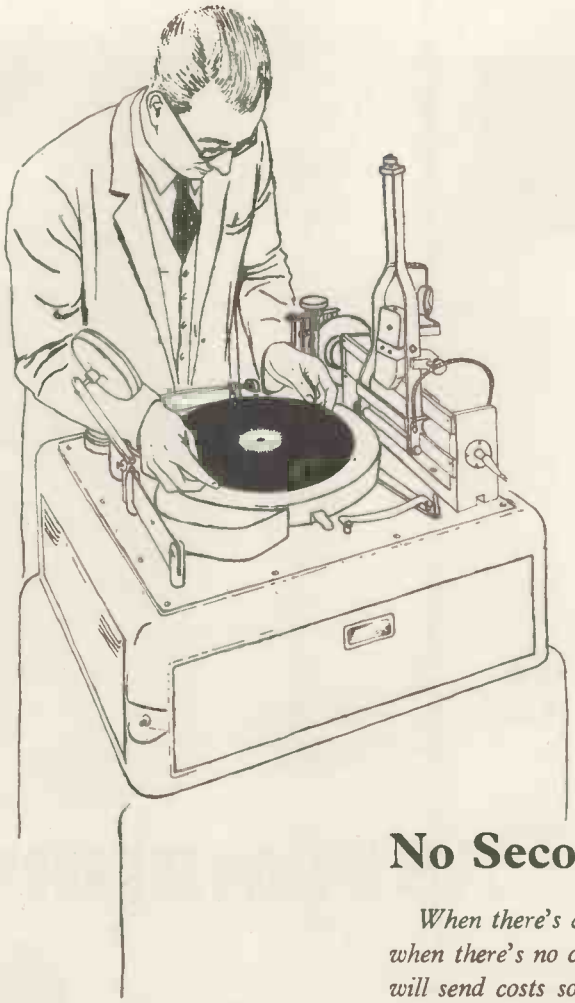


The range includes models from the 8/600 illustrated, developing a force of ± 300lb. to the midget model with a force of ± 2lb.

GOODMANS

VIBRATION GENERATORS

GOODMANS INDUSTRIES LIMITED,
Axiom Works, Wembley, Middx. Tel: WEMbley 1200 (8 lines)



No Second Chance . . . ?

When there's a special recording to be done . . . when there's no chance of a second take, or repeats will send costs soaring — that's when you need the M.S.S. White Label Master Disk.

Out of every hundred recording disks made at M.S.S. most are graded as excellent for direct play-back, but only about *three* meet our stringent demands for master recordings. That will give you an idea what *we* mean by perfection! And that is why so many of the World's recording and broadcasting companies rely upon M.S.S. Disks. There is a range of M.S.S. Disks to suit all types of recording work. May we send you further information?

MSS DIRECT RECORDING DISKS

THE MASTER SOUND SYSTEM

M.S.S. RECORDING COMPANY LTD, POYLE CLOSE, COLNBROOK, BUCKS, ENGLAND. COLNBROOK 284.

MANUFACTURERS OF SOUND RECORDING EQUIPMENT

Potted *with 'Araldite'*

For potting and sealing electrical components, 'Araldite' is without equal. In addition to its remarkable electrical and mechanical qualities, 'Araldite' offers outstanding adhesion to metals, whilst shrinkage on setting is exceptionally low. 'Araldite' is resistant to high temperatures, humidity and corrosive agents and satisfies the Services specification for the sealing and potting of electrical equipment. This new epoxy resin is being extensively used for potting and sealing components for radio, electronics and electrical engineering. Our illustration shows an inductance and mica dielectric capacitor network for shaping a transmitted radar pulse. Potting in 'Araldite' ensures hermetic sealing and permits a reduction in size and weight.

Photo by courtesy of Telegraph Condenser Company Ltd.

These are the new Epoxies!

'Araldite' (regd.) epoxy resins are obtainable in the following forms:—

- *Hot and cold setting adhesives for metals and most other materials in common use.*
- *Casting Resins for the electrical, mechanical and chemical engineering industries.*
- *Surface Coating Resins for the paint industry and for the protection of metal surfaces.*

Full details will be sent gladly on request.

Aero Research Limited

A Ciba Company, DUXFORD, CAMBRIDGE. Telephone: Sawston 187

'Araldite'

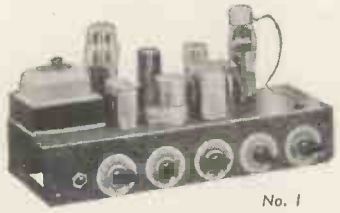
epoxy casting resins

264-65

REAL HIGH FIDELITY *at modest cost . . .*

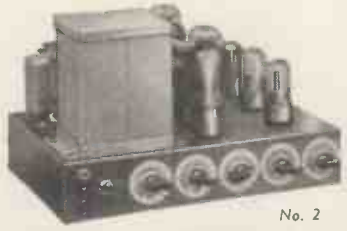
• *Manufacturer-to-Consumer policy saves you one-third cost ! !*

We are now specialising in the supply of units for making up high-fidelity Radio and Record-reproducing Equipments for use in the Home, small Halls, Schools and Gramophone Societies and single items for replacing in existing equipments and radiograms.
Our Chief Engineer, who is operating a Technical Guidance Service, is available daily, including Saturdays, from 10 a.m. to 6 p.m., or will deal with enquiries by return of post. Our new illustrated Catalogue and Supplement will be a great boon to those desiring high quality equipment for modest expenditure. Send two 2½d. stamps for your copy now. It may well save you pounds.



No. 1

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is far more important than mere nominal linear response of the amplifier, as the pick-up, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78's to new L.P.'s. Input is for all types of pick-up of 0.2v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price: 10 gns. (carriage 5/-). Fitted in Portable Steel Cabinet, 35/- extra.



No. 2

No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with 10-watt Push-Pull triode output and triodes throughout. Woden mains and output transformers and choke. Full provision and power for Tuner. Output tapped 3, 7.5 and 15 ohms. Competes with the most expensive amplifiers on the market yet costs only 15 gns. (carriage 5/-). Fitted in portable Steel Cabinet 2 gns. extra.

"SYMPHONY" AMPLIFIERS with REMOTE CONTROL. Both the above model Amplifiers are available with all controls on a separate Control Panel with up to 4 feet flexible cable which simply plugs into the amplifier. Enables the Amplifier proper to be sat in the bottom of a cabinet whilst the controls are mounted conveniently higher up. Extra cost 2 gns.

"STUDIO SYMPHONY" AMPLIFIERS, Models 1 and 2, new models specially designed to get the maximum out of the revolutionary new Collaro Studio pick-ups and heads type "P." Specification as per our Standard Symphony models but with high-gain, low-noise, built-in Pre-amplifier stage with separate switched correctors for Std. and L.P. Third position on switch provides input matching for Acos and similar output pick-ups. These remarkable new models thus provide all the facilities and matching of our Standard Symphony Amplifiers PLUS the specialised Collaro matchings. See March issue of "The Gramophone" for review of these instruments. Price: No. 1, £12/7/6; No. 2, 17 gns. Carriage 5/-.

GARRARD 3-SPEED GRAM UNIT MODEL "TA," fitted with the latest High-Fidelity Acos HGP35 Pick-up Heads (one for Std. and one for L.P.). Price £12/15/-, post and pack. 2/6. Heads only, 43/- each, post 1/-.

MODEL "TB," as above, but with two separate Decca XMS Heads, £13/17/6, post and pack. 2/6. Or with two separate Decca Crystal Heads £12/5/-. Or with Garrard Head for fibres (78) and Decca Crystal for L.P., £12/5/-.

COLLARO latest model A.C.3/544 3-SPEED GRAM UNIT, with new "STUDIO" Pick-up type "O" or "P," £10/6/1, post 2/6.

COLLARO latest model 3RC531 AUTOCHANGER We are pleased to say that after most careful and rigorous, trial, we can highly recommend these latest improved Auto-Changers by Collaro. The standard of engineering is of the highest and in addition to being very easy and quick and fool-proof in operation, they are fitted with the revolutionary high-fidelity plug-in **"STUDIO"** Pick-up heads of which the Type "O" is matched to radio sets and medium-gain amplifiers and the Type "P" is designed for high-gain amplifiers. The Type "P" is exactly matched to our new model Studio Symphony Amplifiers. The price complete with either type pick-up head is £15/3/-. The **3RC532** as above, but mixes 10-inch and 12-inch records, costs £17/10/-. Carriage 5/-. Delivery from stock. Illustrated Leaflet 2½d.

COLLARO "STUDIO" PICK-UP (Arm and Head) type "O" or "P," 74/8, post 2/-.

NEW TYPE ACOS PICK-UPS. Arm with one HGP39 head (Standard or L.P.), £3/8/9, or with both heads, £5/11/-. Post 1/6. Heads separately, 42/3d. each. Immediate delivery.

TAPE RECORDING EQUIPMENT. We recommend and have in stock for immediate delivery the latest TRU-VOX TAPE DECK at 22 gns., a suitable high-fidelity Tape/Gramophone/Microphone/Radio Amplifier to match at 16 gns., and a Portable Cabinet to house these and speaker at 95/-. Also a new Complete Recorder incorporating above Deck and Amplifier with actual space for fitting Radio Tuner. Price 49½ gns. Leaflets 7½d.

WE OLD CODGERS have fallen in love at last—with a wizard Tape Recorder and 'struth it is the new **GRUNDIG 700L.** There is no doubt in our mind that this is the finest Tape Recorder under £100 on the market today, and we recommend it to all those desiring to acquire a real high-fidelity Recorder for both speech and music. Price 80 gns., complete, or £28 down and 5 gns. per month for 12 months. Call for a Demonstration or send 2½d. for Leaflet.

GOODMANS CORNER CABINETS (left) for the AXIOM 150 Mark 2 manufactured by us to Messrs. Goodmans' measurements. Height, 46in. Price: complete kit in plain board with felt, 8 gns. Price ready built, 10 gns. Finished in figured walnut, 16 gns. Other veneers to order. Carriage extra according to area.

"SYMPHONY" BASS REFLEX CABINET KITS. 30in. high, consist of fully-cut ¾in. thick, heavy, inert, non-resonant patent acoustic board, deflector plate, felt, all screws, etc., and full instructions. 8in. speaker model, 85/-; 10in. speaker model, 97/6; 12in. speaker model, £5/7/6. The design is the final result of extensive research in our own laboratory and is your safeguard of optimum acoustic results. Carriage 7/6. Ready built, 10/6 extra.

HIRE PURCHASE FACILITIES
NOW AVAILABLE on orders of £15 or over.
Send one-third deposit with order, balance over 6 or 12 monthly instalments. *State which required.*

NORTHERN RADIO SERVICES

11 & 16 KINGS COLLEGE RD., ADELAIDE RD., LONDON, N.W.3. *Phone: PRImrose 8314*

Tubes: Swiss Cottage and Chalk Farm.
Buses: 2, 13, 31, 113, 187.

REGD. DESIGN

"SYMPHONY" BASS REFLEX CABINETS, fully finished in figured walnut, oak or mahogany to above Registered Design and to match our Console Amplifier Cabinet, enabling the housing of a whole equipment in a two-piece suite, cost: 12in. speaker model, £11/10/-; 10in., £11; 8in., £10/10/-. Carriage according to area. The 10in. model is ideal for the WB HF 1012 (see "The Gramophone" review March).

CONSOLE AMPLIFIER CABINETS (above), 33in. high, lift-up lid with piano hinge, take Gram Unit or Auto-changer, Amplifier, Pre-amplifier, and Radio Feeder Unit, finished medium walnut veneer. De Luxe version, 10 gns., carriage according to area. Bass Reflex Cabinets to match available as above.

DATA for the Designers File

If your field of design covers R.F. Heating it is highly probable that there is a place in your specification for the Ediswan E.S. 833.

The ES.833 is a high mu triode particularly suitable for use as an R.F. Power Amplifier, Oscillator or Class B modulator.

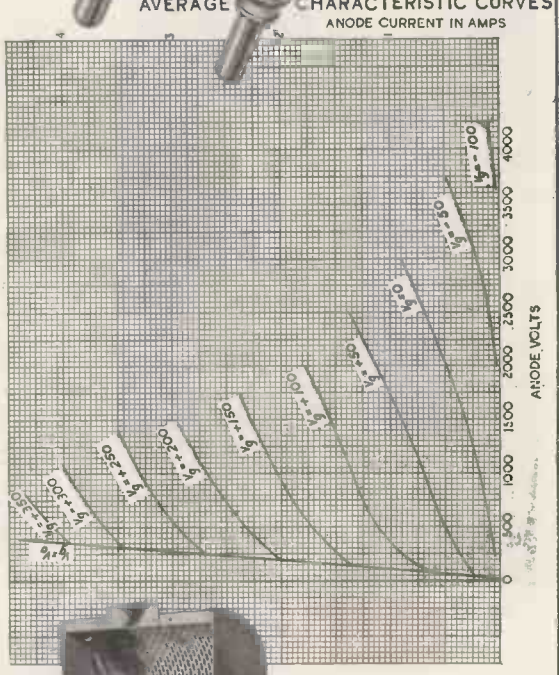
The anode and grid connections are brought out at the top and are taken through metal to glass seals to heavy current terminals. As a result of this construction the valve is exceptionally efficient at higher radio frequencies and may be operated under class 'C' CW conditions at a maximum input of 2kW at frequencies up to 30Mcs. At reduced input rating it is possible to operate the valve as high as 75Mcs.

RATING

Filament Voltage (volts)	V_f	10.0
Filament Current (amps)	I_f	10.0
Maximum Anode Voltage (volts)	$V_{a\ (max)}$	3,000
Maximum Anode Dissipation (watts)	$W_{a\ (max)}$	300
Amplification Factor	μ	35
Maximum Operating Frequency at full rating		*30 Mc/s

* *At higher frequencies the maximum permissible anode voltages and inputs must be reduced.*

AVERAGE CHARACTERISTIC CURVES



'Radyne' Pre-Heating Equipment incorporates the E.S. 833

This small dielectric oven will fully plasticise 6 ozs. of plastic material in one minute. The output of the equipment is approximately 600W. at a frequency of approximately 37 m/cs.

EDISWAN

INDUSTRIAL AND TRANSMITTING VALVES

THE EDISON SWAN ELECTRIC CO. LTD.
155 CHARING CROSS ROAD, LONDON, W.C.2

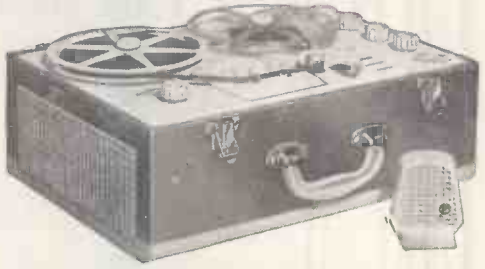
Member of the A.E.I. Group of Companies

EV126

THE ALL NEW Tape Recorder with the

ALL-ROUND SUPERIORITY

THE **Editor**
SUITCASE TAPE RECORDER



Because . . .

its unique lightweight custom-built chassis embraces the latest techniques of recorder construction.

its compact lightweight design features a detachable lid, giving complete access to the controls.

it is the smallest lightweight portable fully automatic tape recorder using 7in. Spools.

. . . *and it costs only* 45 GNS.

COMPLETE WITH MICROPHONE AND TAPE

SPECIFICATION ★ Tape speed 7½in. per second. ★ Miniature Mullard valves. ★ Twin track heads. ★ Three specially designed recording motors provide fast forward run and 50 sec. rewind without unlacing tape. ★ INDEPENDENT BASS AND TREBLE CONTROLS for recording and playback. ★ Negligible wow and flutter. ★ Overall negative feedback. ★ 1,200ft. tape will provide ONE hour playing time. ★ Amplifier may be used independently for high quality record reproduction. ★ High fidelity Recording head. ★ Special high flux speaker. ★ Provision for external speaker. ★ Speaker muting switch. ★ 4 watts output. ★ Positive servo braking on all functions. ★ Compact size for ease of handling, only 16¾in. × 12in. × 5in. (7in. with lid). ★ Magic eye recording indicator. ★ Ronette Desk Microphone.

HIRE PURCHASE £15/15/- deposit. 12 monthly instalments of 60/-, or 18 monthly instalments of 42/-.

CREDIT TERMS. Send only £6 to secure with 8 further monthly payments of £6. Carr. and pkg. 15/-.

Designed and manufactured by Tape Recorders (Electronics) Ltd.

We stock and recommend these HIGH GRADE LOUDSPEAKERS.
They are available under our PERSONAL CREDIT scheme as shown :—

	CASH PRICE	CREDIT SALE 9 payments Send first payment with order	H.P. TERMS Deposit	H.P. TERMS 12 monthly payments
WHARFEDALE				
W15CS	£17 10 0	42/10	£5 16 8	22/–
W15	£15 10 0	39/4	£5 3 4	20/7
Super 12CSAL	£17 10 0	42/10	£5 16 8	22/–
W12CS	£9 15 0	26/2	£3 5 0	14/2
W12	£9 5 0	24/8	£3 5 0	13/4
W10CS (B)	£12 6 6	31/10	£4 2 6	16/11
Golden 10	£7 13 3	21/8	£2 11 0	11/10
Bronze 10	£4 12 8	14/6	£1 10 11	8/2
Super 8CSAL	£6 13 3	19/5	£2 4 5	10/9
Super 8CS	£6 6 7	18/9	£2 2 2	10/1
Bronze 8	£3 3 11	11/5	£1 1 4	6/6
Super 5	£6 13 3	19/5	£2 4 5	10/9
W5	£2 0 0	8/6	16 8	5/–
W.B.				
12in. Concentric Duplex (less transformer)	£22 11 0	57/11	£7 10 4	29/6
Do., (with transformer)	£23 16 0	60/–	£7 19 0	30/9
10in. Concentric Duplex (less transformer)	£9 7 6	24/11	£3 2 6	13/9
Do., (with transformer)	£10 15 6	28/–	£3 12 0	15/4
Tweeter Unit	£3 15 6	12/–	£1 5 0	7/6
HF610 High Fidelity	£2 10 6	9/–	16 10	6/–
HF810 High Fidelity	£3 0 6	10/–	£1 0 2	6/6
HF912 High Fidelity	£3 7 0	11/–	£1 2 4	6/11
HF1012 High Fidelity	£3 13 6	12/–	£1 4 6	7/3
GOODMANS				
Axiom 22	£14 14 0	37/6	£5 4 0	19/2
Axiom 101	£6 12 1	19/2	£2 4 0	10/7
Axiom 102	£9 18 0	26/5	£3 6 0	14/4
Axiom 150	£10 5 6	27/–	£3 8 6	14/9

THE **BURGOYNE** *CUSTOM BUILT*
8 VALVE *Superhet* **Radiogram Chassis**

SPECIFICATION ★ Extra large fully illuminated coloured tuning scale 11½in. × 6½in. ★ Wavebands 16-50; 190-550; 1,000-2,000 metres. ★ Bass and treble controls for cut and lift. ★ Magic eye tuning indicator. ★ Precision flywheel tuning. ★ Chassis size 12in. × 7½in. ★ Overall height 9½in. Chassis height 2½in. ★ 8 Mazda valves 6C9, 6F15, 6L1, 6LD20. UU7, 6MI and (2)6P25. ★ Speech coil impedance 3 or 15 ohms. ★ Extension speaker sockets. ★ Specifically designed for perfect reproduction of the LONG PLAYING record. ★ Brilliant reproduction on radio. ★ TWO YEARS' GUARANTEE.

22 GNS 200-250v. A.C. 50 c/s ONLY

HIRE PURCHASE
Deposit 15/- with 12 monthly payments of 29/-.
CREDIT SALE TERMS
No Deposit, 9 monthly payments of 59/-. the first payment being sent with your order. Carr. and Packing 7/6 extra

M·O·S *See them at the Radio Centre*

E. & G. MAIL ORDER SUPPLY COMPANY

33 Tottenham Court Road, London, W.1 *Telephone : MUSeum 6667*

Hi Fi
High Fidelity
AMPLIFIER

THE PF91 amplifier, with its PF91A remote control unit, is the culmination of many years of research into the problem of Hi Fi reproduction. Its performance will astound the ordinary listener and critical engineer alike. Record players, tape recorders, microphones or radio tuners can be used with the PF91—a versatile and practical unit for those who demand perfect sound reproduction in the home, the school, the broadcasting studio or the social club.

POWER AMPLIFIER PF91.

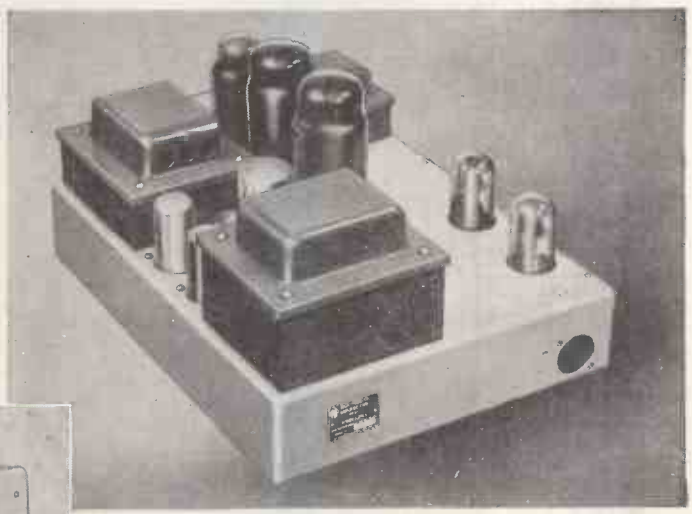
26 db negative feedback and an output from 2 c.p.s. to 160,000 c.p.s. (over 16 octaves).

A combination of negative and positive feedback raises the damping factor of the amplifier to infinity thereby ensuring full control of loudspeaker speech coil movement.

The accurate reproduction of sounds rich in harmonics sets a new standard in the enjoyment of modern recordings.

The output transformer is a specially designed component to meet the exacting specification of the amplifier.

The Power Amplifier is capable of handling peak power pulses in excess of the maximum rating without noticeable distortion.



REMOTE CONTROL UNIT PF91A.

This unit enables remote control of the amplifier up to a distance of 20 ft. (6m).

Cathode follower output from the Remote Control unit reduces cable losses when the Power Amplifier is remotely controlled.

Four switched inputs and the choice of three equalisation networks for L.P., N.A.B. and 78 recording characteristics.

Continuously variable lift and cut controls for bass and treble with clearly marked level positions.

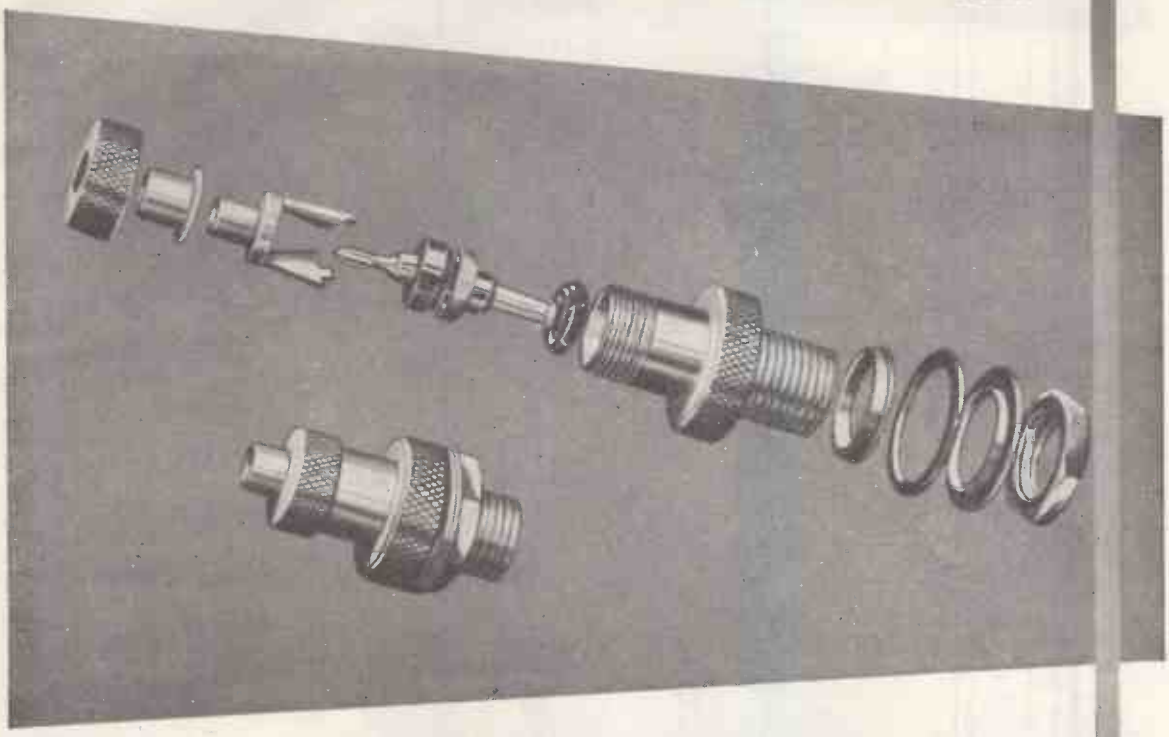
Incorporates a treble filter control, giving three sharp cut-off frequencies and an unrestricted response position.

The Pre-Amplifier incorporated ensures sufficient gain on all inputs for the full loading of the Power Amplifier.

P Y E L I M I T E D · C A M B R I D G E

B

any equipment is its terminals



These versatile Miniature connectors provide perfect coupling between co-axial cables and instruments, and are extensively used in Television, Radar, and Communications equipment. They are 100% pressure and flash tested before despatch. The full range consists of a variety of Cable and Panel Mounting units of either plug or socket type, and a recent addition is an elbow connector for applications where it is desired to keep the face of the panel clear. Suitable for use with co-axial cable Uniradio 32 and 43.

Miniature hermetically sealed Co-axial Plugs and Sockets to RCS.322

A.I.D & A.R.B — APPROVED

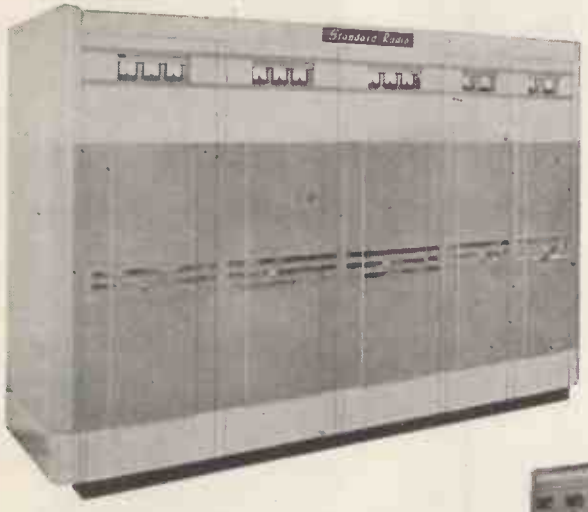
POWER CONTROLS

LIMITED

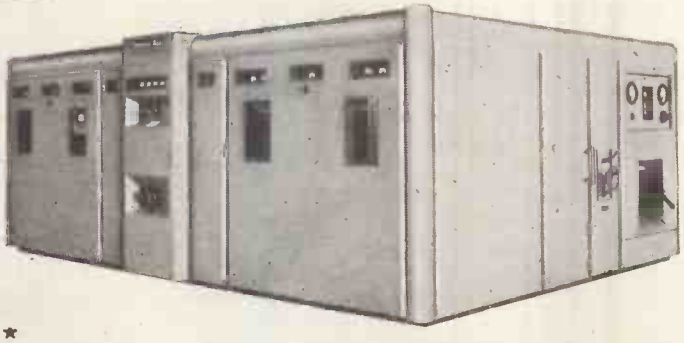
EXNING ROAD, NEWMARKET. TELEPHONE NEWMARKET 3181

Standard in 6 Continents

The D.S. RADIO POINT-TO-POINT TRANSMITTER



Powerful 40 kilowatt D.S.13's were used to transmit Her Majesty the Queen's Speech direct from Auckland, New Zealand, to the United Kingdom on Christmas Day, 1953.



More than 180 of these transmitters are in use throughout the World

✻ **Available for early delivery**

D.S. series of transmitters

D.S.10	**3/5 kW**	*Double Sideband*
D.S.12	**4 kW**	*Independent or Single Sideband*
D.S.13	**40 kW**	*Independent or Single Sideband*

Write for Radio leaflets :

Type **D.S.10** No. 179/14
Type **D.S.12** No. 129/14
Type **D.S.13** No. 130/14

Standard Radio

Standard Telephones and Cables Limited

Registered Office : Connaught House, 63 Aldwych, London, W.C.2.

RADIO DIVISION · OAKLEIGH ROAD · NEW SOUTHGATE . LONDON. N.11

C

FIRST WITH THE NEW "LEAK"

TL/10 Amplifier & "Point-One" Pre-Amplifier AT

27 gns.

COMPLETE

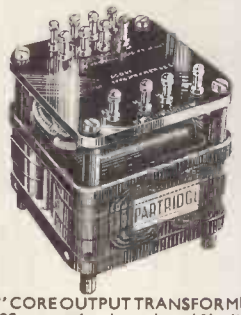
or 9 gns. down and 12 monthly payments of 34/8.

A triple loop feedback circuit based on the famous 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 watt output.
- Feedback magnitude : 26 db. main loop.
- Damping factor : 25.
- Hum :—80 db referred to 10 watts.
- Variable Treble and Bass Tone controls.

The pre-amplifier will operate from any pick-up generally available in the world.

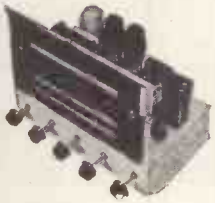
PARTRIDGE P.3064



"C" CORE OUTPUT TRANSFORMER

- 20 watts for less than 1% dist.
- Max. D.C. per half primary 100 mA.
- Anode to Anode load—10,000 ohms.
- Secondary load 0.95 ; 3.8 ; or 15 ohms.
- Freq. response 30-30,000 C/S ± ½db.
- Leakage less than 8 mH.
- Primary shunt induct : 80 H at 5 v. 50 cps.
- Size : 2⅝" x 2⅞" x 3¼". Weight : 2¼ lbs. **PRICE : £4.18.0.**

8-VALVE ARMSTRONG SUPERHET



8 watts push-pull output, Negative feedback, Bass and Treble controls, Short, medium and long wavebands.

£23/13/-.

Or £8 down and 12 monthly payments of 28/9.

Also 10 valve Superhet Chassis (Model RF41)	£31 19 8
EXP. 119 10 v. 6 bandspread, plus M and 2 S	£55 19 4

The latest ACOS Hi-G

Pick-up with interchangeable clip-on heads for either standard or long playing records.

Tracking weight—8 grammes.

Response flat from 40 to 13,000 cps.

GP.20 Hi-G—Arm only	£1 6 5
HGP.39/1.—Std. or LP head	£2 2 3
HGP.35/1.—3 pin plug-in head	£2 2 11

(As above but weight 10 grammes).

THE "WILLIAMSON" AMPLIFIER

This is a world-wide known HIGH QUALITY AMPLIFIER, **BUT** high quality can **ONLY** be obtained if precision quality products as specified by the designer, are used.

WE can supply ALL COMPONENTS, including precision condensers and resistors, potted transformers and chokes, EXACTLY AS SPECIFIED, not substitutes.

GRAMOPHONE UNITS

THE "COLLARO" 3-speed Studio TRANSCRIPTION desk is now available.

- ★ Heavy duty non-ferrous balanced turntable.
- ★ Thrust ball for spindle bearing.
- ★ 100% dynamically balanced rotor assembly.
- ★ Honed stator tunnel giving true electrical balance.
- ★ Off position between each speed change, mechanical and electrical.
- ★ Specially lengthened pick-up arm 16in. long, on banjo unit.
- ★ Rumble, wow and flutter free.

Less Pick-up and arm	£13 9 6
With Studio pick-up	£18 4 9

GARRARD

TA/AC or TB. 3-sp. (less heads)	£7 11 1
Turnover Crystal head (for TA/AC)	£1 19 9
Turnover Magnetic head (for TA/AC)	£2 2 5
HGP 35/1—Std. or LP. (for TA/AC) each	£2 2 11
DECCA XMS—Std. or "H" LP. (for TB.), each	£2 14 8
GARRARD Min. L.I. Std. or L.P., (for TB), each	£1 4 7

COLLARO

3/544 3-sp. with Studio P.U.	£10 6 1
3RC/541. 3-sp. with Studio Auto	£15 3 10
3RC/542. 3-sp. with Studio Auto Mixer	£17 10 0

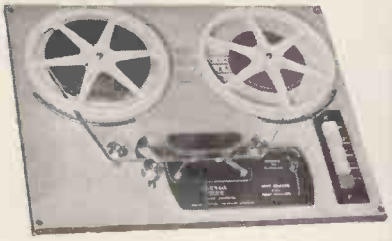
CONNOISSEUR

Transcription Desk 3-speed	£23 8 11
Pick-up with 1 head (25 or 400 ohms)	£5 19 3
Extra heads	£3 6 3
Transformer	15 9

"Q-MAX" MODEL G.D.O.I.A GRID DIP OSCILLATOR

is an ideal instrument for the determination of tuned circuit resonant frequency, tuning transmitters without application of power, for the determination of coil mutual and stray inductances and both fixed and stray capacitances. Covers 1.5 to 300 Mc/s in eight ranges. PRICE : 12 Gns. Complete. Or 4 Gns. Dep. and 12 monthly payments of 15/5.

THE "TRUVOX" TAPE DECK



- 3 shaded pole motors.
- Fast forward and rewind.
- 2 speeds—½ track.
- 50-10,000 c/s at 7½in./sec.
- Overall size : 16½ x 13in.

22 Gns.

or £8 Deposit and 12 monthly payments of 27/9.

"Q-MAX" CHASSIS CUTTERS

STILL the easiest and quickest way of cutting holes in SHEET METAL.

	each
⅜" or ¾"	11/6
⅞"	12/6
1", 1⅛" or 1¼"	14/5
1⅜" or 1½"	16/6
1¾"	18/6
2⅜"	30/-
2½"	35/-
1" square	23/-

Keys, small, 10d. ; medium, 1/3 ; large, 1/9.

Patent No. 619178

SPECIAL PRICE FOR COMPLETE SET, £10.

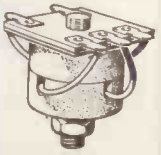
"POLYMAX" UNBREAKABLE INSULATORS

Stand offs : ½", 6d. ; 1", 9d. ; 1½", 1/-.

Beehives, 2/-.

Feed-throughs, 1/3.

THE "LINCOLN" OSCILLATOR COIL



Completely enclosed in "Neosid" former ensuring minimum external field. Unsually good waveform with maximum amplitude at 45 Kc's. Lettered tag panel connections and one-hole fixing.

Overall size, 1½in. x 1½in. x 1in. PRICE 12/6. (Post 6d.)

Complete Oscillator unit with valve, 50/-.

SPEAKERS

Complete range, including Goodmans Axiom 10H, £6/12/1 ; Axiom 102, £9/18/2 ; Axiom 150 Mk. II, £10/5/6 ; Wharfedale Super 5, £6/13/3 ; Super 8 CS/AL, £6/13/3 ; W10CSB, £12/6/6 ; W12CS, £9/15/- ; W15CS, £17/10/-

W.B. STENTORIAN HIGH FIDELITY UNITS

Developed to provide reproduction of high fidelity recordings—speech coil Impedance 3 or 15 ohms.

H.F.1012—10in. die cast unit ; 12,000 gauss magnet ; 10 watts ; 30-14,000 cps., 73/6.

H.F.810—8in. steel unit ; 10,000 gauss ; 5 watts ; 50-12,000 cps., 80/6.

H.F.610—6in. steel unit ; 10,000 gauss ; 3 watts ; 60-12,000 cps., 50/6.

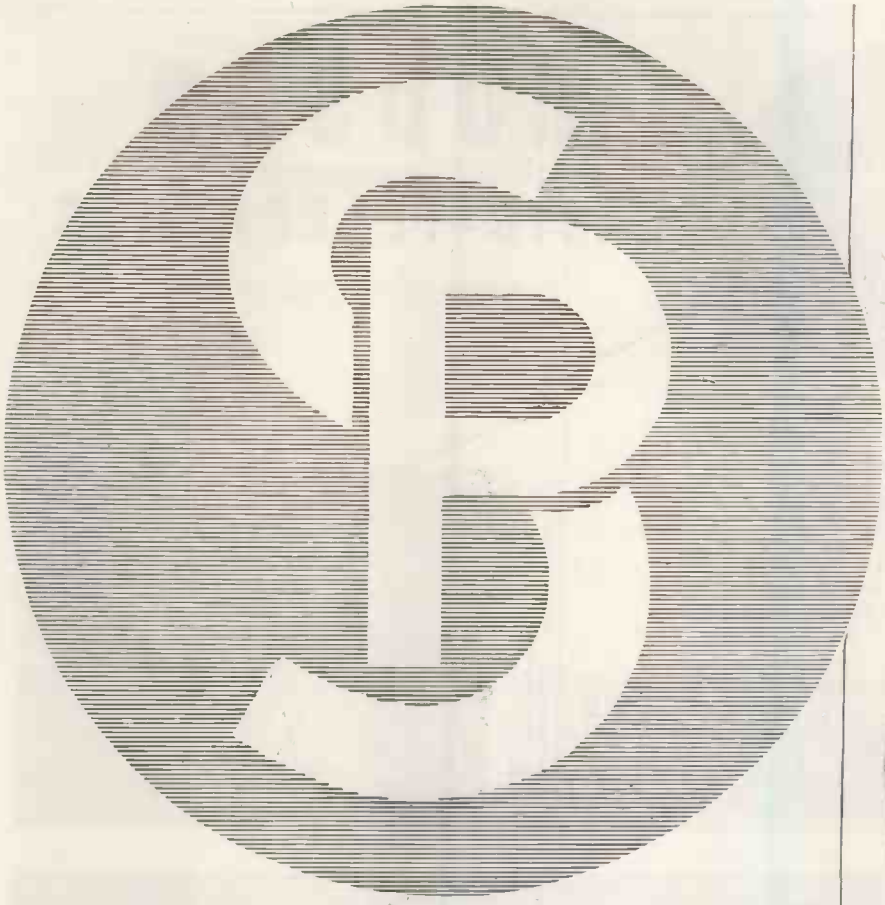
Illustrated Catalogue 6d. post free.

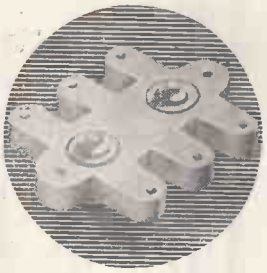
H.P. TERMS AVAILABLE ON PURCHASES OVER £10.

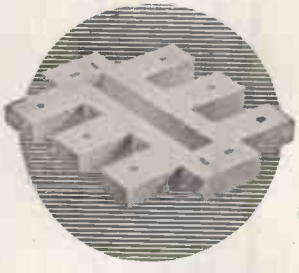
BERRY'S (SHORT WAVE) LTD.

25 HIGH HOLBORN, LONDON, W.C.1

TEL HOLBORN 6231





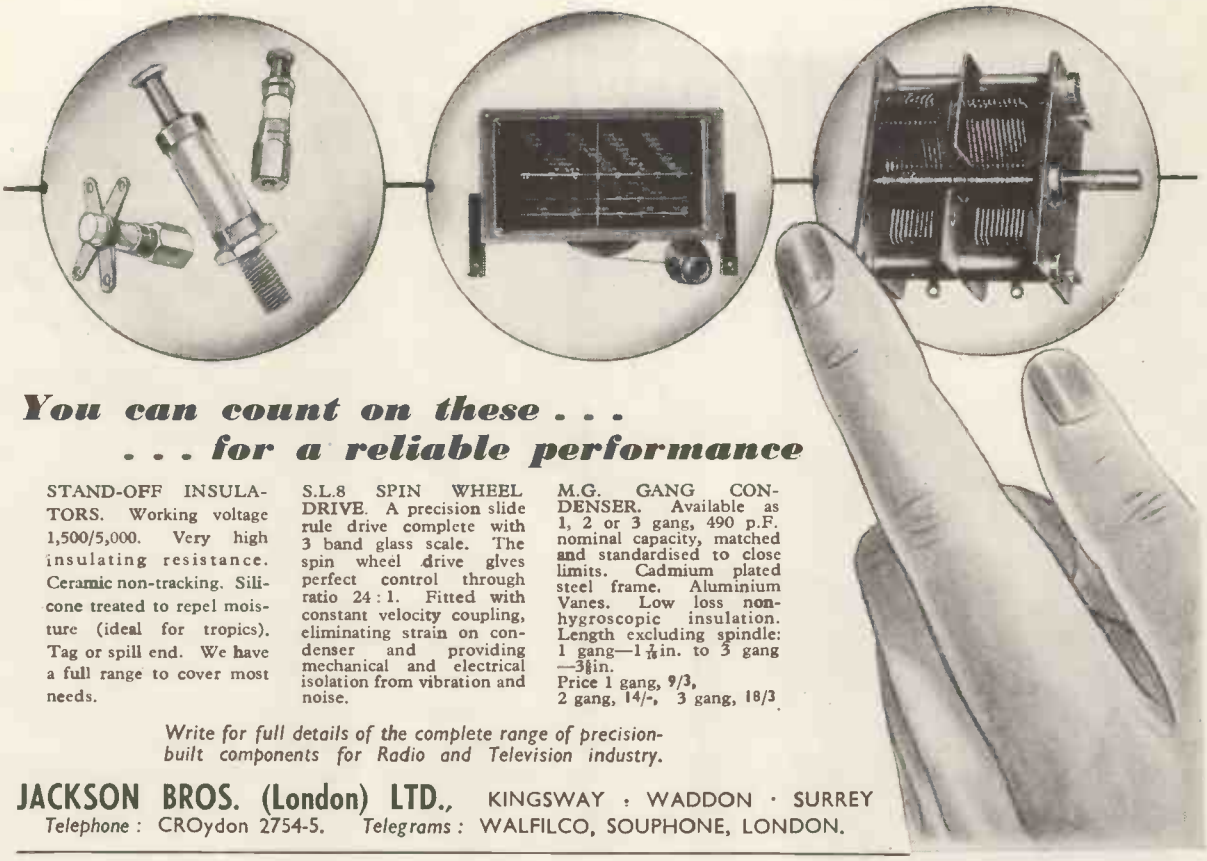


for radio ceramics

STEATITE & PORCELAIN PRODUCTS LTD.

Stourport-on-Severn, Worcestershire. Tel: Stourport 111. Telegrams: Steatain, Stourport

SP87



You can count on these . . .
. . . for a reliable performance

STAND-OFF INSULATORS. Working voltage 1,500/5,000. Very high insulating resistance. Ceramic non-tracking. Silicone treated to repel moisture (ideal for tropics). Tag or spill end. We have a full range to cover most needs.

S.L.8 SPIN WHEEL DRIVE. A precision slide rule drive complete with 3 band glass scale. The spin wheel drive gives perfect control through ratio 24 : 1. Fitted with constant velocity coupling, eliminating strain on condenser and providing mechanical and electrical isolation from vibration and noise.

M.G. GANG CONDENSER. Available as 1, 2 or 3 gang, 490 p.F. nominal capacity, matched and standardised to close limits. Cadmium plated steel frame. Aluminium Vanes. Low loss non-hygroscopic insulation. Length excluding spindle: 1 gang—1 7/16 in. to 3 gang —3⅜in.
Price 1 gang, 9/3,
2 gang, 14/-, 3 gang, 18/3

Write for full details of the complete range of precision-built components for Radio and Television industry.

JACKSON BROS. (London) LTD., KINGSWAY : WADDON · SURREY
Telephone : CROydon 2754-5. *Telegrams :* WALFILCO, SOUPHONE, LONDON.

TWO HOURS RECORDING *on standard 1200 ft. spool*
and TEN WATTS OUTPUT . . .

★ TO THE TRADE: *Ask for details of special Dealer facilities and Information Sheet* T1/6

With standard 1200ft. spools, the SIMON Portable Tape Recorder affords two hours recording and brilliant playback—at 10 watts output if required. Twin tracks, two speeds. Frequency response is wide : 50-12,000 c/s at 7½in./sec. and 50-7,000 c/s at 3¾in./sec. Bass and treble are independently variable.

Designed for the discriminating user, the SIMON Portable opens up new fields of activity in tape recording.

SIZE	*18 in. x 15 in. x 10 in.*
LOUDSPEAKER	*6½ in. built-in monitor*
POWER SUPPLY	*200/250v. 50 Cycles A.C.*
INPUT CHANNELS	*High Impedance for microphone; low or high impedance for radio*
POWER CONSUMPTION	*100 watts approx.*

Simon Portable **TAPE RECORDER**

- ★ *Monomaster "Finger-tip" Control*
- ★ *Separate capstans*
- ★ *Three motor drive*
- ★ *Drop-in loading*
- ★ *Fast rewind and wind-on*
- ★ *Provision for Remote Control and independent use of amplifier for P.A., etc.*

Ask for
"THE GENTLE ART OF TAPESMANSHIP"
and Information Sheet Tl/6

SIMON SOUND SERVICE LTD. (Dept. W)
48-50 GEORGE ST., LONDON, W.1. *Phone: WELbeck 2371 (5 lines)*

SIMON *for Sound Recording at a Sensible Price*

PREMIER RADIO COMPANY

ONLY A FEW LEFT!

THE FAMOUS 'SOBELL' 4-VALVE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS

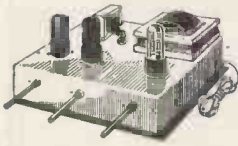
Valve line-up: 12J7, 35L6, 1487, 35Z4.
Entirely transportable and unusually sentive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.
Choice of 2 colours—Brown and Cream.
Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains. **£8.5.0**
Plus 5/- Pkg./carr./Ins.

Fully covered by Manufacturer's Guarantee

1124 RECEIVER UNITS

Range 30 to 40 Mc/s. Contains six new Valves 3-9D2, 1-8D2, 1-15D2 (frequency changer), 1-4D1, 24 ceramic trimmers, 6 ceramic valveholders, 6 valve screening cans, 30 resistors, 1-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and 1 Westector WX4, 5-way 4-bank switch with long spindle I.F. transformers, etc. Slightly soiled. Brand new in transit case 24/- plus 3/6 postage and packing. **17/6**

A 4-watt AMPLIFIER KIT



with everything for

£4-10-0

plus 2/6 Postage & Pack.

Valve line-up 6SL7, 6V6 and 6X5. FOR A.C. MAINS 200/250 VOLTS. The twin triode 6SL7 is used for pre-amplification and also for a comprehensive tone control circuit, which includes two very wide range and continuously variable tone controls for bass and treble. The output Valve is of the beam type and feeds 4 watts into a specially designed output Transformer which is suitable for either 3 ohm or 15 ohm Speakers Negative feed-back is applied from the secondary of the output Transformer over the whole Amplifier to the input stage giving an excellent frequency response. Due to the high gain and wide range tone controls any type of pick-up may be used. Suitable Speakers are listed below. Overall size 9 x 7 x 5in. **Instruction Book with Wiring Diagrams and Priced Stock List 1/- post paid.** Price of Amplifier complete, tested and ready for use £5.5.0. Postage and packing 3/6 extra.

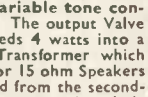
T.V. PRE-AMPLIFIER

Amplifier Unit Type 208A using 2-VR91 valves suitable for operation on London frequency. Brand new. Plus 1/6 pkg. and carr. **19/6**

HIGH QUALITY RADIOGRAM CHASSIS

A limited quantity of these Chassis which were produced by a leading manufacturer of quality Radiograms are available.
The 3 waveband 5 valve Superhet circuit utilises the following Valves: 6K8G—Frequency Changer, 6B8G—IF Amplifier, Detector and AVC, 6SL7G—Pickup Amplifier and AF Amplifier, 6V6G—Beam Power Ouput Tetrode, 5Z4G—full wave Rectifier.
A special Gramophone Pre-amplification circuit is used giving very high gain on any type of Pickup. Also included is a continuously variable Tone Control. The large horizontal tuning scale measures 11in. x 3½in. Chassis measures 14½in. x 9in. x 8in. The Chassis was designed to fit into a Radiogram costing £79.
Our special price is **£13.19.6** plus 5/- packing and carriage.

POWER SUPPLY UNIT



Incorporating output stage Supplies an output of 250 volts at 80 mA. which is suitable for the R1155 with the output stage.
Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. Price £5/5/-, plus 5/- packing and carriage.

CORRECT ASPECT WHITE Rubber Mask—Round or Flat

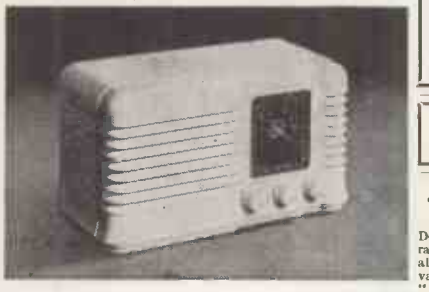
6in.	8/6	9in.	9/6
12in.	16/11	15in.	27/6

METERS

Large stocks available, a few of which are enumerated below:—

Full Scale Deflection	Scale Length in.	External Dimensions in.	Movement	
25 A	1½	2½ round	R.F. Thermo	7/6
3.5 A	1½	2½ x 2½	R.F. Thermo	7/6
4 A	1½	2½ x 2½	R.F. Thermo	7/6
20 A	1½	2½ round	M/C	8/6
40 A	1½	2½ round	M/C	8/6
1.5 mA	1½	2½ round		12/6
5 mA	2	3½ round		7/6
6 mA	2	3½ round		13/9
50 mA	1½	2½ x 2½	M/C	7/6
20 V	2	2½ x 2½	M/C	6/6
40 V	1½	2½ x 2½	M/C	8/6

★ BUILD THE NEW PREMIER TRF RECEIVER for £5.15.0 ...



. . which is less than half to-day's price

The circuit is the latest type TRF using 3 Valves and Metal Rectifiers for operation on 200/250 volt A.C. Mains. Waveband coverage is 180/550 metres on medium wave and 800/2,000 metres on long wave. The Dial is illuminated and the Valve line up is: 6K7—H.F. Pentode, 6J7—Detector and 6V6—Output. The attractive Cabinets to house the Receiver, size 12in. long, 6½in. high, 5½in. deep, can be supplied in either WALNUT or IVORY BAKELITE or WOOD.

below is an example of the excellent value we offer

1 Cabinet and Back (choice of Bakelite in either Ivory or Walnut or Wood)	17/6	1 Drive Drum	1/6
		1 Drive Spring	3d.
		1 Drive Pointer	4d.
2 Chassis TRF	3/9	1 2-band Dial	1/6
1 Chassis Brackets	9d.	1 Front Plate	2/6
1 Drive Spindle (Rear Drive)	1/6	2 Dial Clips L.H.	6d.
		2 Dial Clips R.H.	6d.
		1 Length Drive Cord 15in.	3d.

TOTAL COST £1 10 10
SPECIAL PRICE FOR COMPLETE SECTION £1/5/6
plus packing and postage 2/6.

Send 1/- for Instruction Booklet which includes layout, circuit diagram and point-to-point wiring instructions, also included is a complete stock list of individually priced components.

LOUDSPEAKERS

ELAC—2½in. dia., Moving Coil, 15 ohm imp.	15/-
PLESSEY—3in. dia. Moving Coil, 3 ohms imp.	9/11
ELAC—3½in. dia., Moving Coil, 3 ohms imp.	15/-
GOODMANS—5in. dia., Moving Coil, 3 ohms imp.	15/6
ELAC—8in. dia., Moving Coil, 3 ohms imp.	19/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) with Pentode Transformer	22/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field)	19/6
PLESSEY—10in. dia. Moving Coil, 3 ohms imp.	23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms Plus 5/- packing and carriage.	£8/8
VITAVOX—K12/20 12in. dia., Moving Coil, 15 ohms imp.	£11/11

Plus 5/- packing and carriage.

SPECIAL OFFER

A 12in. TRUVOX P.M. SPEAKER

(2-3 ohm Voice Coil) For only
These are brand new in Maker's Carton: **47/6**
Plus 2/6 Pkg. and Carr.

WHY PAY MORE ?

WILLIAMSON AMPLIFIER KIT 15gns.

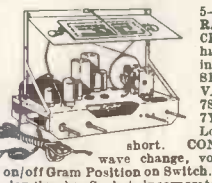
plus 7/6 post, pkg. & ins.
This kit is absolutely complete and all components are guaranteed exactly to author's specification.

WILLIAMSON OUTPUT TRANSFORMER

(author's spec.), 3.6 ohms sec. **£4.4.0**

MAINS TRANSFORMER 8P425A (with additional 6.3 v. 3 a. and capable of supplying an extra 50 mA. for Pre-amp. or Feeder Unit) **£3.7.6**

MANUFACTURER'S SURPLUS STOCK



5-VALVE SUPERHET RADIO RECEIVER CHASSIS, built to high standards ensuring quality reception.
SPECIFICATIONS:—VALVE LINE-UP: 7S7, 7B7, 7C6, 7C5, 7Y4, 3 WAVEBANDS Long, medium and short. CONTROLS: Tuning, wave change, volume tone control on/off Gram Position on Switch. Pick-up and Extension Speaker Sockets incorporated. For use on 200/250 v. A.C. mains. DIMENSIONS: Length 14½in., height 11½in. width 6½in. Distance between controls left to right from edge of chassis: 1in. 3in., 6½in., 3in. Plus 5/- pkg./carr. ins. **£7.19.6**
The above Receiver less Speaker and Output Transformer. A suitable 10in. Moving Coil Speaker and Output Transformer can be supplied at 29/- extra.

AUTO TRANSFORMERS 50 WATTS

Input Output 0-110-210-220-230-240-250 volts. Plus 1/-. P. & P. **7/6**

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" M.O.I.S OUTPUT TRANSFORMER

Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13 : 1 to 80 : 1 all centre tapped and can be used to match any output valves either single- or push-pull Class "A" "AB1" "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price 45/-.

ACCUMULATORS

2 volt 10 amp. (by famous maker) 4/11
2 volt 16 amp. 5/11

MINIATURE TUNING CONDENSERS

2-gang .0005 mfd. with trimmers 6/9

FILAMENT TRANSFORMERS

Input 230 v. A.C. Output 12 v. at 1 amp. Completely shrouded. Price 9/11

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, 3½in. wide, 3½in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain Ex-Govt. components. Plus 2/6 post and pkg. **39/6**

BATTERY CHARGER KITS

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

Cat. No.		
2002	Charges 6 volt accumulator at 1 amp. Resistance, supplied to charge 2 v. accumulator	19/6
2004	Charges 2, 6 and 12 v. accumulators at 1 amp.	22/6

MICROPHONES

LUSTRAPHONE: Moving Coil; High Impedance. Stand Type: £5/15/6—Hand Mike £6/6/-.
RONETTE—Crystal Mike: Incorp. the Filter Cell Insert; High Imped. Ball Type: £3/19/6.
CRYSTAL MICROPHONE—Rothermel 2AD56. Especially recommended. £2/19/6. Table stands for all the above 10/6 and 17/6.
ACOS. High impedance Crystal Microphone, type 35-1, 25/-.
ACOS. High impedance Crystal Microphone, type 33-1, £2/10/-.
ACOS. 'MIC 30 'Impedance Crystal Microphone, £2/10/-. (This Microphone can be used as either Hand or Desk type)

CRYSTAL HAND MICROPHONE

High Impedance. Excellent frequency response, light weight. Gives very high quality results when used with tape recorder, amplified for any type of P.A. equipment. Complete with screen lead and plug plus 1/6 Pkg. & Carr. Price 29/6.

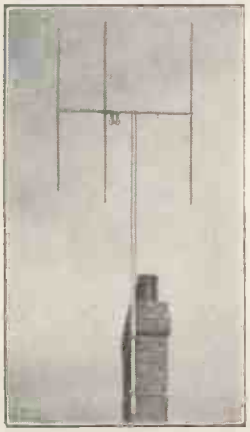
CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance No background noise, really natural tone. The ideal Mike for tape, wire and sound projectors. Price 22/6.

"BELLING-LEE" NOTES

Choice of an Aerial

How often the choice of a television aerial is considered unworthy of much thought. Fifty to a hundred pounds are spent on a receiver, but "any old aerial will do." In a paper by C. B. B. Wood, Research Department, Engineering Division, B.B.C., and published in the Journal of the Television Society for October-December 1953, Mr. Wood says: "It is an unfortunate feature of television in its present state that very few decibels in signal-to-noise ratio separate the very best pictures and those that are unacceptable, and the addition of only three decibels of noise in reproduction can easily turn a moderate original into a very poor repeat programme." Mr. Wood was writing about Telerecording, but a decibel is always a decibel, and when we say that a certain aerial is better by three decibels, that is important. Those who spend their days and evenings endeavouring to receive a good picture in areas of weak signal know all this, or they just would not get a picture, and that is why so many "Belling-Lee" aerials are seen in out-of-the-way places. Only too many viewers receive a picture too easily, they do not realise how much better their picture would be if they fitted an outside aerial by "Belling-Lee." Approximately 50 per cent of all television aerials sold are made by "Belling-Lee."



"Belling-Lee" "Junior Multirod," 3-element array.

We are fully aware that most of the people with "Belling-Lee" aerials on their roofs do not know how lucky they are to be receiving such a good picture. They put their trust in their radio dealer who did not let them down. The radio dealer knows that mechanically as well as electrically "Belling-Lee" aerials are as trouble-free as experience and care can make them.

A Novel Valve Extractor and Pin Straightener

This novel valve extractor is suitable for B7G, B8A and B9A valves and enables their removal from equipment made up of closely packed components. The extractor is moulded in rubber, and the handle incorporates a pin straightener for B7G and B9A types.
This is accurately moulded in a hard phenolic material, and will obviate the damage to valves and/or sockets, caused through trying to force insertion with distorted pins.

Valve extractor and pin straightener.

for

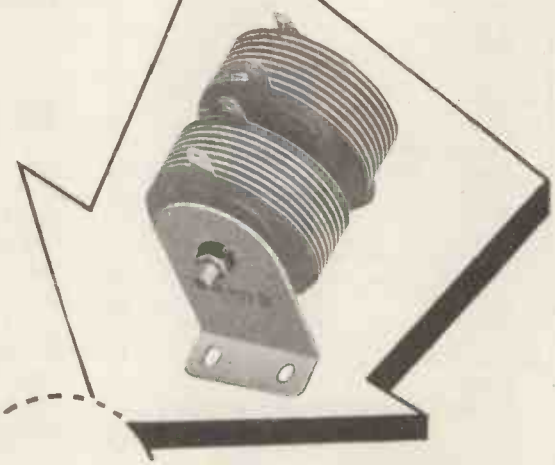
Band III Convertors

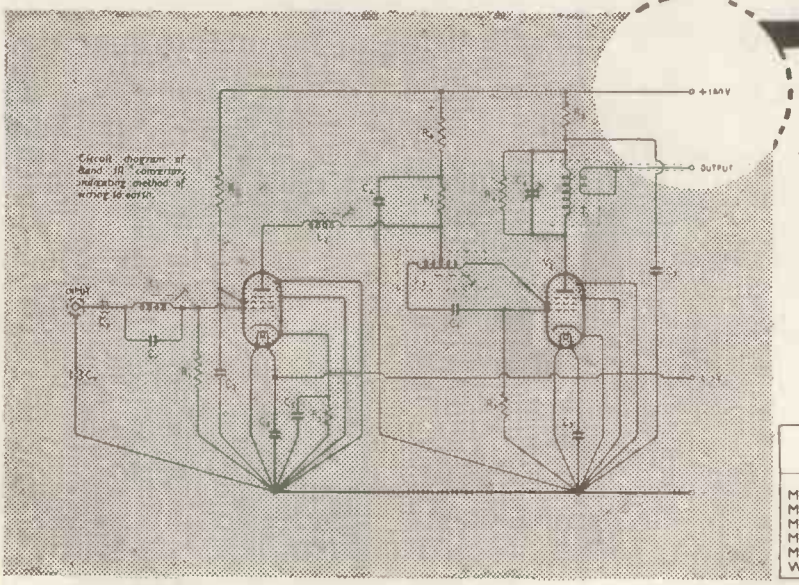
use *SenTerCel* selenium rectifiers

as recommended in the "Wireless World" *(May issue)*

From a range of miniature rectifiers designed for domestic Radio and Television receivers, types RM 0 and RM 1 are recommended for use in T.V. Band III Converters.

It may be covenient to use type DRM1 ; an assembly of two RM1 rectifiers on a spindle and bracket.





Circuit diagram of Band III converter, indicating method of wiring to earth.

Send for Leaflet F/SRL. 9.

TYPE	RM0	RM1
Maximum ambient temperature	35°C 55°C	35°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA
Maximum Input voltage (r.m.s.)	125V	125V
Maximum peak Inverse voltage	350V	350V
Max. instantaneous peak current	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.

SELENIUM *SenTerCel* RECTIFIERS

REGISTERED TRADE MARK

Standard Telephones and Cables Limited

(Registered Office: Connaught House, Aldwych, W.C.2)

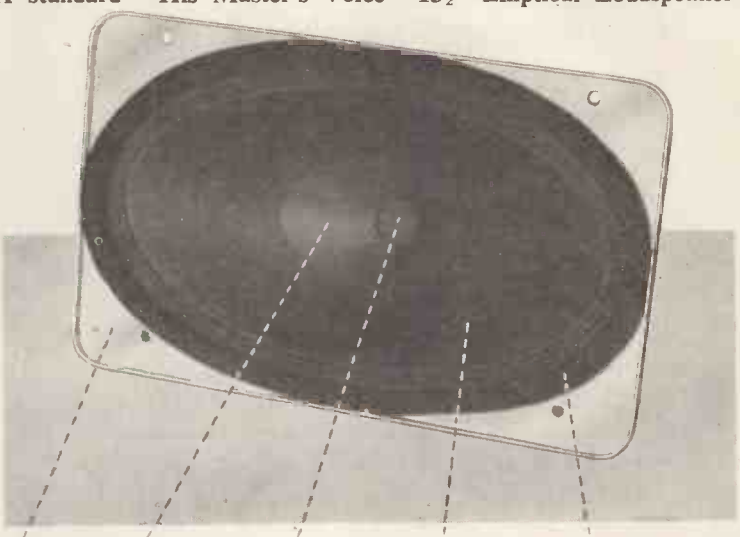
RECTIFIER DIVISION: Warwick Road, Boreham Wood, Hertfordshire.

Telephone: Elstree 2401 Telegrams: Sentercel, Borehamwood

LOUDSPEAKERS—Why an Elliptical Cone?

It is generally agreed that the weakest link in a reproducer chain is the loudspeaker. For example, in the very important matter of frequency response, a response variation of ± 1db over the useful audio frequency range is fairly easily obtained from an amplifier, but the corresponding deviation for the best loudspeakers is of the order of ± 5db. Even these loudspeaker variations are only true on the axis of the loudspeaker and off this axis much wider variations are obtained. This relatively poor performance of loudspeakers as compared with other components does not only apply to frequency response, and a similar comparison exists for transient response, distortion etc. Therefore any approach to high fidelity must be based on a first-class loudspeaker, and without it any improvements which may be obtained from amplifiers will be of little avail.

A standard "His Master's Voice" 13½" Elliptical Loudspeaker



Rigid chassis for stability of speech coil centering. *Aluminium centre cone.* *Speech coil dustproofed.* *Wide angle diffusion of high frequencies due to elliptical cone shape.* *Felt pad ensures efficient sealing to baffle.*

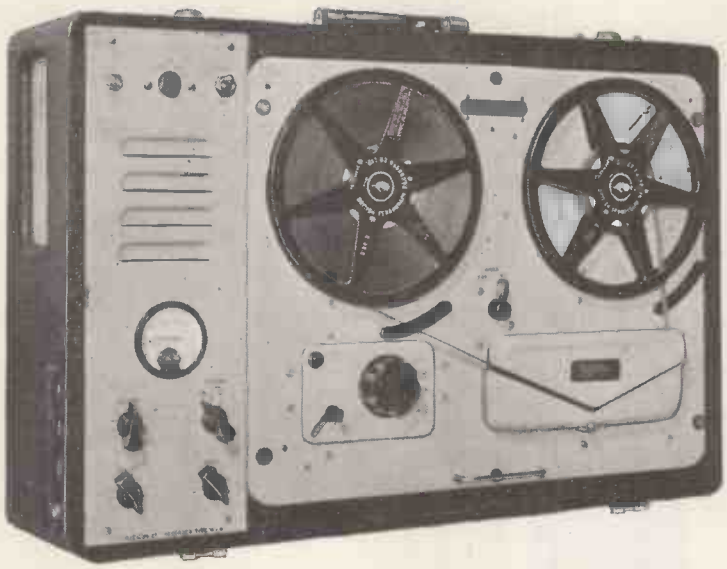
Many of the imperfections of loudspeakers, particularly as regards frequency and transient response, arise from the fact that in the high frequencies the loudspeaker cone does not act as a simple piston but "breaks up" into its own resonances, which give rise to response changes with frequency and "hangover" effects or poor transient response.

These resonances may give either increased or decreased sound output at any particular frequency. An increase in output arises when all the resonating parts of the cone are in phase, that is, they all move forwards and backwards together, and a decrease in output arises when different parts of the cone are vibrating out of phase, that is, when one part of the cone moves forwards while another moves backwards, so that the output from the two parts cancels. These effects can obviously be reduced if the cone is not of a symmetrical conical form, so that although localised break-up cannot be avoided, resonant break-up of the whole cone will not occur, and variations in response and "hangover" effects will be reduced.

The elliptical loudspeaker offers a solution to many of the loudspeaker designer's problems since the lesser degree of symmetry as compared with a circular cone renders the "break up" effects less marked. In addition, for a given frequency response the elliptical cone gives an improved spread of the high frequencies so that the response shows less variation off the loudspeaker axis.

Cone "break up" effects may be further reduced by not making the cone material homogenous throughout, so that the symmetry of the cone is further reduced. This may be done by making the centre of the cone of a material with different elastic properties from the outside, for example the centre of the cone may be made of aluminium and the outside of paper. This arrangement gives a remarkably smooth and wide range response and perhaps gives the best possible reproduction obtainable from cone type loudspeakers. This type of loudspeaker has been embodied in "His Master's Voice" radios and radiogramophones for the past 20 years, and while it is true there has been a trend in the past year or two towards the elliptical loudspeaker technique, the use of the elliptical cone with two different materials for its construction remains an important "His Master's Voice" feature.

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.

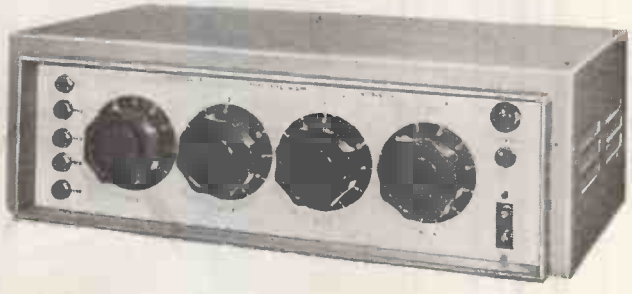
★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ 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.**

FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different Items have to be mixed on one tape recording.
It is recommended by a number of tape recorder manufacturers for this purpose.
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.
The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.
The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.
An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.
Used in many hundreds of large public address installations and recording studios throughout the world.



PRICE £36 15 0.

Manufactured by

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

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

Introducing *to Britain an entirely* **NEW**

AMPLIFIER & PRE-AMPLIFIER

by LEAK

27 GNS. COMPLETE

A price made possible only by world wide sales.

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 loop.

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 any 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 technlques.

★ **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 *Telegrams : Sinusoidal, Ealux, London* *Cables : Sinusoidal, London*

THE "STROLLER"

EXCITING NEW BATTERY PORTABLE WHICH CONVERTS TO A PICNIC RECORD PLAYER

★ **Sensitive 4-valve superhet.**

★ **Attractive 2-tone case and three colour scale.**

★ **7 inch elliptical speaker.**

★ **Full A.V.C. and fixed tone correction.**

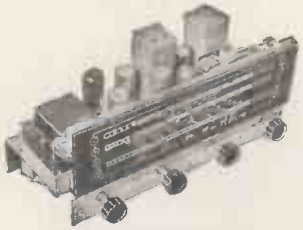
★ **Space for Mains Unit.**

★ **Factory-built look.**

The Elpreq "Stroller" is an all-dry battery operated superhet, using frame aerial and 1.5 volt valves Type 1R5, 1T4, 1S5 and 3S4. It is particularly selective and gives powerful results on long and medium waves. Battery consumption, however, is quite low. The cabinet is ultra-modern and finished crocodile and/or lizard skin in two shades. The control-board is similarly finished, and with the three-coloured dial, gives the whole a factory-built aspect.

Full constructional details of this superhet and of the Picnic Player unit which, by the undoing of four screws, slips into the cabinet in place of the radio, will be found in our booklet "The Stroller," price 2/6 (returnable if parts purchased).

Cost of portable cabinet and all parts for Stroller, including valves, speaker, but not batteries, is £8/17/6 (H.P. deposit £2/19/2), carriage 5/-. Cabinet available separately, price 37/6, plus 3/6 postage.

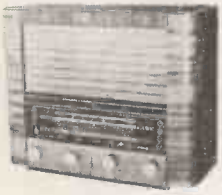


THE "WINDSOR" 5

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 £3/7/- deposit.

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 chassis above with 6½in. speaker.



A FEW REMAIN

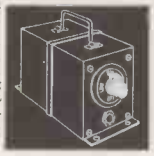
This cabinet is offered below cost. It is suitable for a televisor using tube sizes varying from 12in. to 17in., its overall dimensions being 3ft. 5in. high, 1ft. 4in. deep, 1ft. 10in. wide. It is complete with plywood back and "Bowler Hat." Originally made for a very expensive televisor and really good quality. Unrepeatable. Offered at £7/5/- or £2/8/4 dep., carriage, packing, etc., 12/6. Note: These are cut for 12in. tubes, but the holes for the controls are not drilled.

BEETHOVEN 5-VALVE SUPERHET

Complete with valves and Rola loudspeaker, ready to work off A.C. mains—three waves (L., M. and S.)—large dial, slow motion drive, dust cored coils, etc., £8/17/6, or £3 deposit (balance over 12 months), carr. 7/6.

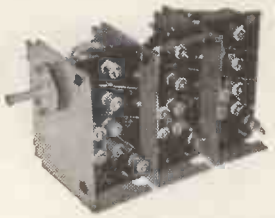
Fine walnut veneered and polished cabinet to take the Beethoven 5-valve Superhet with 6½in. loudspeaker, thus making a really excellent table model—worth £18-£20. Price 49/6, carr. and packing, 5/- extra. If bought with the Beethoven chassis, the hire purchase deposit £3/15/8, carr. 10/-.

WELDING TRANSFORMER



Totally enclosed and fitted High, Low and off Switch. Intermittent output 4 volts 1,000 amp. Ideal all welding or as power unit for spot welder. Price £4/10/-, carriage and packing 7/6.

7-WAVE BAND ASSEMBLY

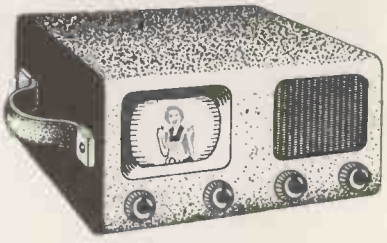


7-wave coil pack for up to 11 mtrs. with R.F. stage, three-gang tuning condenser, slow motion drive, I.F. transformers and numerous other parts, make a really fine receiver. Price £6, plus 10/- post and insurance.
Note: The above are new, but removed from chassis.

EX-GOVT. BATTERY SET ONLY 30/-

Medium waveband battery superhet, made originally for canteens, etc. In cabinet, less valves, soiled needs servicing, few only to clear. Price 30/- each, plus 5/- carriage.

MINIATURE PORTABLE T.V.



You can probably think of many other reasons when you may need a midget televisor, but it will certainly be useful when:—

(a) Someone is ill, or confined to another room.
(b) Your big T.V. fails.
(c) You want to alter or adjust your big T.V.
(d) The commercial programmes start.
(e) Servicing an aerial installation.

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 V.C.R. 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, and very good results have been obtained.

The total cost, if you have to buy every part, would come to £16-£17, but you may have many of the components already in stock as only standard conventional components are used. A carrying case, similar to the artist's illustration above, will be available shortly. Its size will be approximately 9½in. × 8in. × 6in. (internally).

Full construction data, layouts, diagrams templates, etc., running into some 50 sheets, is available, price 5/- post free.

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, limited quantity, so act quickly.

ELECTRONIC PRECISION EQUIPMENT LTD.

DEPT. 2, ELPREQ HOUSE · HIGH STREET · WEALDSTONE · MIDDX

CLEARANCE BARGAINS

4/6 postage 1/6.

4-inch NAVIGATIONAL COMPASS

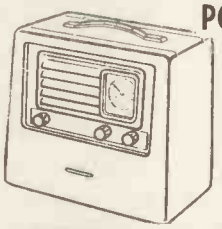
In wooden carrying case, but less fluid. Damaged, but repairable.

7/6 postage 2/-.

ELECTRICAL K.W. METER

By Ferranti. Complete works, less the case. Slightly damaged, but repairable, and contains very useful spares.

12/6 postage 2/6.



PORTABLE CABINET

Rexine covered. Perfect, with back and handle. Ready to take chassis. Room for batteries or power pack. Size 12in. × 10½in. × 7½in.

3/6 postage 6d.

DEAF AID CASE

Polished Bakelite, with pocket clip.

1/6 postage 6d.

BUTTON MICROPHONE

Extremely small, carbon granule type. Quantity price 15/- doz.

29/6 postage 2/6.

NOVELTY RADIO

Complete tunable M/L Radio with room for 3in. speaker in base. Needs only valves, speaker and batteries.

3/6 postage 1/-.

CLOCK CASE

Made from hard wood, veneered and polished. Undrilled so suit any clock or other movement.

2/6 postage 9d.

WIRE JOINTER

In Bakelite case with carbon contacts and trigger action.

6/6 postage 9d.

HAND SPRAY GUN

Suitable all liquids or powder. Ideal for finishing models, etc.

TRULY PORTABLE

Introducing the

CLEVELAND *SPRINGBAT* Record Player

To be truly portable, a record player must be independent of the mains. Owing to the cost and weight of dry batteries, however, it is not advisable to use an electric motor. Fortunately, at the picnic and other functions, when the player is most needed, there are plenty of willing hands to wind. Therefore a spring motor is no objection.

The Cleveland Portable Picnic Player combines the true and full response of electronic recording with the convenience of a modern spring-wound motor. All nicely put together in a handsome carrying case. Price complete ready to work (less batteries) £13/13/-, or £4/11/- deposit, carriage free. Batteries 10/7 the two.

BATTERY AMPLIFIER

We call this the "Ready." It is a 2-valve amplifier and uses a most efficient circuit, ensuring maximum volume and quality for minimum battery consumption. Midget construction throughout. Size approximately 2 × 2½ × 6in. Complete, ready to work with O.P. transformer, but less speaker, price 47/6.

THREE OUTSTANDING BARGAINS

CONSORT CABINET In two-tone, highly polished walnut veneer, with contrasting inlaid bands. Lift-up lid and storage compartments. Uncut motor board. Size 2ft. 6in. wide, 2ft. 5½in. high, 1ft. 2in. deep. Clearance to motor board is 6in. Price £9/18/6 plus 15/- carriage and insurance. Or H.P. £3/6/2 deposit.

ALL-WAVE RADIO CHASSIS 5-valve superhet for A.C. only. Coloured Edge-lit dial, usual refinements, good output on long, medium and short waves, as well as on gram. Price £9/19/6, plus 7/6 carriage and insurance. Or H.P. £3/6/6 deposit.

AUTO CHANGE RECORD PLAYER Three-speed with famous Studio pickup for all records. Price £11/10/- plus 10/- carr. and packing. Or H.P. terms £3/16/8 deposit.

152-153 FLEET STREET, E.C.4.
Phone: CENTRAL 2833.
Half-day Saturday.

42-46 WINDMILL HILL, RUISLIP, MIDDX.
Phone: RUISLIP 5780.
Half-day, Wednesday.

29 STROUD GREEN ROAD, FINSBURY PARK.
Phone: ARCHWAY 1049.
Half-day Thursday.

Personal shoppers to any one of these addresses.

SOUND VALUE in SOUND RECORDING!

the "ELIZABETHAN"

now more compact than ever!

48 GNS

2 speed, twin-track recording. Mixing of 2 inputs. Simple push-button control. Electronic braking. "Magic Eye" plus headphone monitoring. Miniature BVA valves. 3 watts output. Size: 15½in. x 13¼in. x 8½in. Weight: 34 lbs.

the superb

"ARISTOCRAT"

incorporating the famous TRUVOX Mk. III Tape Deck and the EAP 3 Amplifier

54 GNS

Smart, contemporary-styled cabinet. "Magic Eye" monitoring. Completely portable. Amplifier can be used independently for reproduction from gram or radio unit. 7in. x 4in. elliptical speaker. Negative feedback. Miniature BVA valves. Size: 20¾in. x 13¾in. x 9in. Weight: 32 lbs.

Both models supplied complete with the renowned RONETTE FC7 Filter Cell Insert Microphone and 1,200 feet of SCOTCH BOY MC2-III Tape

the exclusive

E A "MINOR"

This specially designed, 2 waveband, crystal feeder unit enables the "Elizabethan" or "Aristocrat" to operate as a full-size radio! Optional extra at £3-15-0 including tax.

the EAP 3 TAPE RECORDER AMPLIFIER

recommended and approved by TRUVOX for their Mk. III Tape Deck

Frequency range: 75 c/s—10 kc/s. 3 watts output on playback. Separate high and low gain inputs with mixer control. "Magic Eye" record level indicator. Variable tone control. Amplifier can be used for high-fidelity reproduction from gram or radio feeder unit. Separate power pack, supplying instantaneous braking voltage. **Price £15** (*carriage extra*).

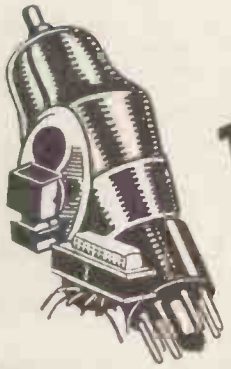
Model EAP2, at the same price, with similar specification, is available for use with the MOTEK and LANE Tape Units.

All E A Products are guaranteed for 12 months

Manufactured by

EAP (Tape Recorders) LTD. 546, KINGSLAND ROAD, LONDON, E.8.

Telephone : CLISSOLD 7586



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Winter Trading Co. Ltd

6, HARROW ROAD, PADDINGTON, W.2

Telephone : PADdington 3646 (6 lines).

SOUTHAMPTON : 20, BEVOIS VALLEY ROAD. *Telephone : 54273.*
CARDIFF : 31, BRIDGE STREET. *Telephone : 21829.*
BIRMINGHAM : 58, PERSHORE STREET. *Telephone : MIDLAND 1920.*

CLASSIC EXAMPLES of HIGH-FIDELITY EQUIPMENT and COMPONENTS

The outright purchase of equipment can be a heavy item, but that is no reason why you should not straight away have the best of gear available by Classic H.P. Here are a few examples showing deposits in relation to the full cash purchase price.

TAPE RECORDERS	Cash Price £ s. d.	Deposit £ s. d.
Ferrograph	79 10 0	27 0 0
Vortexion	84 0 0	28 0 0
Grundig 700L	84 0 0	28 0 0
Grundig Tk.9	68 5 0	22 15 0
M.S.S. PMR.3	99 0 0	33 0 0
C.J.R.	129 10 0	43 10 0
Reflectograph	87 0 0	29 0 0
G.B.	84 0 0	28 0 0
E.M.I.	150 0 0	50 0 0
Soundmaster (Kit)	60 0 0	20 0 0
Lane	47 5 0	16 5 0
Kenton (Truvox Deck)	63 0 0	21 0 0
TAPE DECKS		
Wearite	35 0 0	12 0 0
Bradmatic	41 0 0	14 0 0
Truvox	23 2 0	8 2 0
Reflectograph	39 10 0	13 10 0
Lane	17 10 0	6 0 0
Motek	17 17 0	5 12 4
Soundmaster	22 0 0	7 6 8
AMPLIFIERS AND MISCELLANEOUS		
Kenton (for Truvox)	22 0 0	7 6 8
Kenton (for Truvox)	29 10 0	9 10 0
Lane Kit	13 0 0	5 13 0
E.A. Products for Truvox	15 0 0	5 0 0
Elpico for Truvox	16 16 0	5 16 0
Amp. for Lane Deck	15 0 0	5 0 0
Reslo Ribbon Microphone	9 0 0	3 0 0
Reslo Moving Coil Microphone	6 0 0	—
Acos 22.1 crystal	4 4 0	—
Lustraphone Moving Coil	5 5 0	—
Lustraphone Moving Coil	5 15 6	—
Lustraphone LX.55	2 10 0	—

MOTORS
All types available.

HEADS
Wearite. Bradmatic, etc.

MICROPHONE STANDS
All types available.

TAPES
Scotch Boy, B.A.S.F., Agfa, Gevaert, Emitape, Ferrograph, etc.

SOUNDMASTER PARTS IN KIT FORM
—send for special list.

WEARITE PARTS
Oscillator coils, etc., from stock.

MOTORS AND PICKUPS	Cash Price £ s. d.	Deposit £ s. d.
Thorens 3-speed	32 0 0	10 13 4
Connoisseur 3-speed	23 8 11	7 18 11
Collaro with pickup	18 18 0	6 6 0
Jason Motor, 3-speed	12 12 0	4 4 0
Decca GU.4 3-speed, with 2 Decca pickups (mounted in walnut case)	12 10 0	4 4 0
Collaro 3/534 with pickup	10 6 1	3 12 9
Monarch Autochangers	16 10 0	5 10 0
Garrard R.C.80	19 6 7	6 6 7
Garrard R.C.90 (as available)	22 8 11	7 9 8
Diamond stylus pickups		
Leak 78	17 10 0	5 16 8
33⅓	17 10 0	5 16 8
Lowther 78	21 19 9	7 19 9
33⅓	21 19 9	7 19 9
Diamond stylus pickup heads		
Decca STD	5 19 1	2 19 1
L.P.	6 18 9	2 6 3
"H"	6 18 9	2 6 3
Connoisseur Std. or L.P.	7 9 5	2 9 5
RADIO FEEDER UNITS		
Chapman F/M	15 0 0	5 0 0
Chapman S.5	21 6 6	7 6 6
Chapman S.6 BS	44 0 0	14 13 4
Lowther R.E.S.	23 15 9	8 15 9
Lowther D.T.4	37 17 10	13 17 10
Lowther D.T.5	44 0 0	14 13 8
Lowther F.M.	22 0 0	7 6 8
Leak	34 19 0	11 19 0
Armstrong F.C.38	23 13 0	8 0 0
Armstrong RF.41	31 19 8	11 13 4
AMPLIFIERS—WITH CONTROL UNITS		
Goodsell—Williamson	45 12 0	15 4 0
Leak TL.10	28 17 0	9 9 0
QUAD Mark II	42 0 0	14 0 0
Pye P.F.91/P.F.19A	42 0 0	14 0 0
Rogers Baby de luxe	23 0 0	7 13 4
Rogers Minor	11 10 0	3 16 8
Lowther L.E.S.	23 15 9	8 15 9
Rogers Senior amplifier and control unit	43 0 0	14 6 8
Goodsell CR.500	30 10 0	10 3 4
Armstrong A.10	29 10 0	9 16 8
LOUDSPEAKERS		
Klipschorn-Vitavox	145 0 0	50 0 0
Corner Ribbon-Acoustical	95 0 0	32 10 0
Corner-Lowther	96 0 0	32 10 0
Tannoy 12in. in Cabinet	30 16 0	10 4 0
Wharfedale Super 12CSAL	35 0 0	12 0 0
Voight Corner Horn (S/H.)	42 10 0	14 3 4
LOUDSPEAKER UNITS		
Goodmans Axiom 150	10 5 9	3 15 9
Tannoy 12in. Duo Concentric	27 10 0	9 3 4
Wharfedale U15CS	17 10 0	5 16 8
Wharfedale W12CS	9 15 0	3 5 0
Wharfedale Golden 10CSB	8 6 7	3 0 0
LOUDSPEAKER CABINETS		
For Goodmans 60 or 150—Corner Bass Reflex, Walnut	19 10 0	6 10 0
For Goodmans 150 or 22—Corner Bass Reflex, walnut	25 0 0	8 6 8
For Wharfedale Super. 12CSAL—Corner Bass Reflex, walnut	21 0 0	7 0 0
For Wharfedale Super 12CS/AL—Bass Reflex Cabinet	18 0 0	6 0 0

And our vast and varied range of apparatus and equipment, possibly the largest in the country, is backed by the famous Classic pre-sales test scheme, whereby every piece of apparatus is thoroughly tested before despatch and guaranteed by our own highly skilled technicians, thus enabling us to give a firm guarantee.

CLASSIC ELECTRICAL CO LTD

352-364 LOWER ADDISCOMBE ROAD · CROYDON · SURREY TEL · ADDISCOMBE 6061-2

CITY SALE & EXCHANGE

THE HI-FI SPECIALISTS LIMITED

90-94 Fleet Street, London, E.C.4 **Phone: Central 9391/2**

Offer the following from their extensive stock :—

LEAK
TL/10 amplifier and preamplifier, 27 gns. TL/12 amplifier and Varislope, 39 gns. V.S. tuner for above £35/6/3.

ROGERS R.D. Senior amplifier and control unit, £43. R.D. Baby de Luxe amplifier with Junior preamp., £23. Minor amplifier, £12/17/6.

ACOUSTICAL
QUAD Mark II amplifier with control unit, £42.

RECOMMENDED SPEAKER SYSTEMS

Wharfedale treble assembly—15in., 8in. and 5in. units in sandfilled corner baffle, separate volume controls for two top units, £72.

R.D. Junior corner horn with Axiom 102 unit, £28/15/-.

Salex 8in. reflex cabinet with R.D. 8in. speaker, £12.

Salex sandfilled corner baffle with 12in. Tannoy direct radiator, £20/7/6.

Daily Demonstrations of F.M. transmissions from Wrotham.

Lowther FM/AM tuner at £22—**Chapman** FM tuner, £15.

OUR DEMONSTRATION ROOM is now equipped to let you hear nearly 400 combinations of pick-up/amplifier/speaker/tuner units to give immediate comparison.

EASY PAYMENTS

Terms arranged on all new apparatus over £10—one-third deposit, and the balance over 6, 12 or 18 months. Write for order forms.

Great Britain's Valve Mail-Order House

SALE (2,000 101 TYPES) VALVES FROM (post. 9d.) 2'-

Types and Prices subject to stock. We may send equivalents. When ordering cross (blank) postal order.

RADIO BULLS VALVES 246 HIGH ST. HARLESDEN, NW10

SERVICE SHEETS
The one you require enclosed if available in a dozen assorted of our best choice. **10/6**

TAYLOR METERS ON EASY TERMS

Model	Cash Price	Deposit	10 Monthly p'mnts of	Total H.P. Price
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20B	15 15 0	2 7 3	1 10 2	17 8 11
45B	25 10 0	3 16 6	2 8 9	28 4 0
66A	22 10 0	3 7 6	2 3 0	24 17 6
71A	12 10 0	1 17 6	1 4 0	13 17 6
72A	16 0 0	2 8 0	1 10 8	17 14 8
77A	15 0 0	2 5 0	1 8 8	16 11 8
88A	21 10 0	3 4 6	2 1 2	23 16 2
110C	14 10 0	2 3 6	1 7 9	16 1 0
120A	9 0 0	1 7 0	17 3	9 19 6
130A	15 0 0	2 5 0	1 8 8	16 11 8
170A	24 0 0	3 12 0	2 5 11	26 11 2
190A	22 10 0	3 7 6	2 3 0	24 17 6
240A	14 0 0	2 2 0	1 6 9	15 9 6
260A	36 15 0	5 10 3	3 10 4	40 13 7
520A	10 0 0	1 10 0	19 2	11 1 8
290A	29 10 0	4 8 6	2 16 5	32 12 8

HIVAC MIDGET AND SUB-MINIATURE VALVES

The opposite can be supplied for 2 volts at the same prices, also Type XVS 2.0 v. at 15/6.

MIDGET TYPES				SUB-MINIATURE TYPES			
XSG	15/6	XL	10/6	XWO.75B	17/6	XFY10	17/6
XW	15/6	XLO	10/6	XY1.4B	17/6	XFY111	7/6
XH	10/6	XP	12/6	XY1.4C	17/6	XFY12	17/6
XD	10/6	XY	15/6	XFW10	17/6	XFG1	21/4

ELECTRIC PAINT STRIPPER

37/6 POST 1/-.

It's a unique, foolproof electric tool. Easy and fast. Clean and safe. Paint goes like magic. Cost ½d. per hour. A.C./D.C. Complete. Guaranteed. Outdates blow-lamp.

IR5	16/5	35Z5GT	13 3/-	ECL80	23/4
I85	16/5	50L6GT	16/5	EF9	19/6
IT4	14/6	10	12/-	EF37A	22/1
384	14/6	22	18/3	EF39	16/5
3V4	14/6	80	13/3	EF40	22/1
01A	7/4	81	18/11	EF41	16/5
1A4	13/3	71A	8/10	EF50	22/1
IB4	13/3	112A	12/-	EF80	22/1
IP4	10/2	1A7GT	18/11	EF91	22/1
1E5G	12/-	1C5GT	14/6	EK32	22/8
1F5G	11/4	1H5GT	14/6	EL3(N)	20/2
1J6G	12/-	1N5GT	14/6	EL33	16/5
5Y3GT	13/3	3A4	18/11	EL37	22/1
6A4	15/1	3A5	31/6	EL38	25/2
6AL5	11/4	6X5G	13/3	EL41	16/5
6AQ5	16/5	1561(1W4)	13/3	EM1	16/5
6AT6	15/1	AZ1	13/3	EM4	16/5
6AU6	22/1	AZ31	13/3	EM34	16/5
6BA6	16/5	AZ50		GZ34(G)	18/6
6X4	13/3	(DW4)	13/3	EY51	25/2
6J6	31/6	CBL1	22/1	EZ40	13/3
68A7GT	20/2	CL4	20/2	EZ41	13/3
68K7GT	16/5	CY1	13/3	PY80	15/9
6SQ7GT	15/1	EB41	11/4	PY81	18/11
6V6GT	16/5	EB91		PY82	13/3
7E7	14/6	(6AL5)	11/4	PL81	16/5
12AT7	22/1	EBC33	15/1	PL82	16/5
12AU7	22/1	EBL1	22/1	UBC41	15/1
12AX7	22/1	EBF80	18/11	UBL21	20/2
12SA7GT	20/2	ECC40	22/1	UCH21	20/2
12SK7GT	16/5	ECH3	22/8	UF41	16/5
12SQ7GT	15/1	ECH35	20/2	UL41	16/5
25L6GT	16/5	ECH42	20/2	UY41	13/3

Post 9d. Lower Prices—One-Year Guarantee.

BLACK & DECKER

HANDY-UTILITY ¼in. Portable Electric DRILL.
Deposit £2
CASH PRICE £5/19/6 or 9 easy payments. Monthly **10/6**

Post 9d.			
01A	2/-	954	2/-
1B4	3/-	117Z6	7/-
1H6	3/-	4TSA	6/-
1LN5	7/-	4TSP	5/-
2A6	2/-	138PA	5/-
2A7	3/-	71A	2/-
2B7	2/-	2028TH	8/-
6F7	6/-	215P	2/-
12A	2/-	220PT	4/-
12SF5	6/-	ACHLDDD	6/-
31	2/-	EF6	17/6
34	3/-	P2	3/-
48	4/-	P215	2/-
50Y6	8/-	PM24A	7/6
		PX25	10/-

2/3 "DEMOBBED VALVES MANUAL" 2/3
Giving equivalents of British and American Service and Cross Reference of Commercial Types with an Appendix of B.V.A. Equivalents and Comprehensive Price List. We have still some Valves left at very old Budget Rates (33⅓%).

ROD Antennas, 1ft. sections, interlocking and extending, copper plated steel. BARGAIN 2/6 doz.

TYANA TRIPLE THREE
Small Soldering Iron. Latest development. Complete with detachable bench stand. Post 1/-. **19/6**

BIB The new 3 in one Tool. Strips insulation without "nicking" wire. Cuts wire—no rough edges. Splits flex. **3/6**

Deposit and Monthly **10/-**
AC ELECTRIC PAINT SPRAYER
Just plug in and spray. Easier than a brush and twice as fast. 75/- Post 2/-.

Tax Free

The High Quality Portable "ELIZABETHAN" Tape Recorder 2 SP.
Recording medium standard ¼in. plastic coated tape. Tape speeds, 7½in. and 5in. per second. Running time, 60 or 90 minutes. Rewind, 60 seconds. Frequency range, 40 c.p.s.-10 Kc. at 7½in. per second. Loudspeaker, 6in. Moving Coil. Output, 3 watts. Mains supply, 200-250 A.C., 50 c.p.s. Mains consumption, 50 watts. Dimensions, 16½in. × 13½in. × 8½in. Weight, 35 lb. Supplied with crystal mic. and 1,200ft. of tape. Fully guaranteed.

Twin track recording, doubles playing time per reel. Fast forward and rewind. Separate mic. and gram inputs. Separate amplifier position to enable use as high quality amplifier for disc record players and R.F. units. CUEING STRIP for ease in finding recorded information or music. No unlacing of tape. "MAGIC EYE" recording level indicator. Variable tone control for playback. Provision for Ext. L/S. TERMS : Deposit £16/16/-, balance in 12 monthly instalments of £3/4/5, or 48 gns. Cash.

RECEIVER CHASSIS — *Modernise your old Radiogram* — RECORD PLAYERS

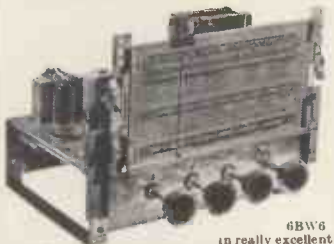
COMPLETE RADIOGRAM EQUIPMENT—QUALITY AT LOW COST

THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3 A 5-valve 3-waveband Receiver.
- Model B.3.P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P./R.F. A 7-valve 3-waveband Receiver incorporating an R.F. stage with PUSH-PULL OUTPUT.

The three Receivers are for operation on A.C. mains 100/110 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram. and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up. 6T E6, 6BA6, 6AT6, 6BW6, 6X4—wave-band coverage short 16-50 medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wavechange and gram.; (4) tone (3-position switch operative on gram. and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 × 7½ × 8¼in. high. Dial size 8½ × 4¼in. Price complete and READY FOR USE, excluding speaker, £12/12/- (carr. and Ins. 7/6 extra).

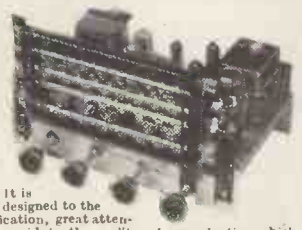


H.P. Terms: £4/4/- deposit, 12 months at 15/9.

Model B.3. P.P. This model is the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/- (plus 7/6 carr. and ins.) or £5/5/- deposit, 12 months at 19/8.

Model B.3. P.P./R.F. This model is similar in appearance and has same waveband coverage as the Model B.3, but in addition it incorporates an R.F. STAGE together with PUSH-PULL OUTPUT, employing a total of 7 valves with two type 6BW6 in Push-Pull. This makes for a really sensitive receiver with genuine quality reproduction. Price £18/18/- (plus 7/6 carr. and ins.) or £6/6/- deposit, 12 months at 23/7.

A NEW DESIGN FOR HOME CONSTRUCTORS
The STERNS "SUPER SIX"



A compact and highly efficient Superhet Radio—Radiogram Chassis of outstanding quality, far above any other design yet offered to the HOME CONSTRUCTOR. YOU can build it for

£10/7/6

It is designed to the very latest specification, great attention having been paid to the quality of reproduction which gives excellent clarity of speech and music on both radio reception and record playing. A few brief details:—

- Covers 3 Wavebands 18-50 metres, 190-550, 800-2,000 metres.
- Employs 6 Valves having PUSH-PULL for 5-6 watts OUTPUT.
- DELAYED A.V.C. on all WAVEBANDS.
- PRE-SELECTIVE FEEDBACK.
- 4 POSITION TONE CONTROL.
- REAL QUALITY ON BOTH RADIO AND GRAM.
- PROVIDES INDEPENDENT MAINS SUPPLY FOR RECORD PLAYER (if required).
- FOR A.C. MAINS SUPPLY 200-250 Volts, 50 Cycles.
- Size of assembled CHASSIS 12in. long × 8in. × 8in. Dial Aperture 8¼in. × 4¼in.

THE ASSEMBLY MANUAL IS AVAILABLE FOR 2/-. This gives very detailed practical drawings and layouts and includes a component price list.

THE COMPLETE RECEIVER CAN BE BUILT FOR £10/7/6 with the OCTAL VALVE LINE UP or for £12/7/6 with Miniature Valves.

A Replacement RADIO-RADIOGRAM CHASSIS

- MODEL AW3-5. A 5-Valve Superhet Receiver covering the standard 3 wavebands, 16-50, 190-550, 900-2,000 metres.

PRICE COMPLETELY ASSEMBLED AND READY FOR USE (plus 7/6 carr. and ins.). **£10/10/-**

H.P. Terms £3/10/- Deposit and 10 Months at 15/9. This receiver is for operation on A.C. Mains 200-250 volts. It contains the latest MULLARD VALVE LINE UP, being ECH42 (Freq. Ch.), EF41 (I.F.), EBC41 (Det. 1st Audio), EL41 (Output) and EZ41 (Rect.). It incorporates Negative Feedback and delayed A.V.C., the four controls being (1) Tuning, (2) Wavechange and Gram. Switch, (3) TONE, (4) VOLUME-OFF. It provides really good reproduction on both Gram. and Radio and gives an exceptionally good range of station selection. Overall size 13½in. × 7in. high × 6in. deep. Dial aperture 10in. × 4¼in.

This AUTOCHANGE UNIT by a famous Manufacturer is offered for £10/10/0 (Plus 7/6 Carr. and Ins.)

Hire Purchase Terms £3/10/0 Dep. and 10 Months at 15/9.

(Normal price £16/10/-.)

- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 14in. × 12½in., with height above 5½in. and height below baseboard 2¼in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The COLLARO 3RC/521 3-SPEED AUTO CHANGE UNIT

£9/19/6 (Plus 7/6 Carr. and Ins.)

H.P. Terms £3/6/0 Deposit and 10 months at 15/-.

Normal price £18/10/-.

- Complete with High Fidelity Crystal "Turnover" Head which incorporates separate stylus for L.P. and 78 r.p.m. Records.
- Will autochange on 7in., 10in. and 12in. records not intermixed.
- Minimum Base plate size 15in. × 12½in., with height above 4¼in. and below baseplate 3in.
- Brand new in Maker's Cartons, complete with Mounting Instructions.

SPECIAL REDUCTIONS FOR COMPLETE EQUIPMENT

SUMMARY

Select a RECORD PLAYER and CHASSIS, and we will supply it TOGETHER WITH AN 8inch or 10inch P.M. SPEAKER as follows:

	CASH PRICE	DEPOSIT	MONTHLY
THE £10/10/- AUTOCHANGER WITH A SPEAKER AND :—			
(a) With Model B.3 Chassis	£23/15/-	£7/18/4	12 of £1/9/8
(b) ,, ,, B3PP ,,	£27	£9	12 of £1/13/9
(c) ,, ,, B3PP/RF ,,	£30/2/-	£10/2/-	12 of £1/17/6
(d) ,, ,, Super Six ,, (Assembled chassis only)	£27	£9	12 of £1/13/9
(e) ,, ,, AW3-5 ,,	£21/15/-	£7/5/-	12 of £1/7/2
THE COLLARO AUTOCHANGER MODEL 3RC/521 WITH A SPEAKER AND :—			
(a) with Model B3 chassis	£23/6/-	£7/15/6	12 of £1/9/2
(b) ,, ,, B3PP ,,	£26/9/-	£8/16/6	12 of £1/13/1
(c) ,, ,, B3PP/RF ,,	£29/12/-	£9/17/-	12 of £1/17/0
(d) ,, ,, Super Six ,, (Assembled chassis only.)	£26/9/-	£8/16/6	12 of £1/13/1
(e) ,, ,, AW3-5 ,,	£21/4/-	£7/1/4	12 of £1/6/6
THE COLLARO 3-SPEED UNIT MODEL 3/514 WITH A SPEAKER AND :—			
(a) With Model B3 chassis	£21/6/-	£7/3/4	12 of £1/6/6
(b) ,, ,, B3PP ,,	£24/9/-	£8/3/6	12 of £1/10/1
(c) ,, ,, B3PP/RF ,,	£27/12/-	£9/4/-	12 of £1/14/6
(d) ,, ,, Super Six ,, (Assembled chassis only.)	£24/9/-	£8/3/6	12 of £1/10/1
(e) ,, ,, AW3-5 ,,	£19/4/-	£6/8/-	12 of £1/4/0

An Additional Charge of 10/- is made in each case to cover Carriage and Insurance.

The COLLARO MODEL 3/514 3-Speed Non-Auto Change Unit

£7/19/6 (Plus 6/- Carr. and Insur. Normal Price £12/17/6

- Complete with High Fidelity Crystal "TURNOVER" Head which incorporates a separate stylus for L.P. and Standard Records.
- Will play 7 inch, 10 inch and 12 inch Records.
- Brand New and Complete with mounting instructions.

When submitting orders, please include post and packing

STERN RADIO Ltd.
109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

SELENIUM RECTIFIERS

L.T. Types		H.T. Types H.W.	
2/6 v. ½ a.h.w.	1/9	70 v. 20 mA. ...	2/11
F.W. Bridge Types		90 v. 20 mA. ...	3/6
6/12 v. 1 a. ...	5/9	120 v. 40 mA. ...	3/11
6/12 v. 2 a. ...	9/9	250 v. 50 mA. ...	5/9
6/12 v. 4 a. ...	14/9	250 v. 80 mA. ...	7/9
6/12 v. 6 a. ...	19/9		

CO-AXIAL CABLE. 75 ohms ½in., 7d. yard.

RHEOSTATS (VARIABLE RESISTORS)
2 ohm. 6 amps., 5/9; 0.4 ohms. 25 a., 8/9; 150 ohms. 1.5 amps., 14/9. All complete with control knob.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000pfd. (.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.

ELECTROLYTICS (Current production.) NOT ex-Govt.

Tubular Types		Can Types	
8μF 450 v. ...	1/11	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	8-8μF 350 v.....	3/9
32 mfd. 500 v.	5/9	8-8μF 450 v.....	3/11
8-16μF 500 v.	4/11	8-8mfd. 500 v. ...	4/9
25μF 25 v.....	1/3	8-16μF 450 v....	2/11
50μF 12 v.....	1/3	16-16μF 450 v....	4/11
50μF 50 v.....	2/3	16-32μF 350 v....	4/9
Can Types		16-32 mfd. 450 v.	4/9
8 mfd. 450 v.	2/3	32-32μF 350 v....	4/9
8 mfd. 500 v.	2/9	32-32μF 450 v....	5/11
16 mfd. 350 v.	1/11	60-100 mfd. 450 v.	7/9

MISCELLANEOUS EX-GOVT. ITEMS
Slydelock Fuses, 15 amp., 1/9. Bulgin octal type moulded Bakelite, 5-pin or 7-pin Plugs and Sockets, 1/11 pair. Earphones (Single), low resistance, 1/3.

VOLUME CONTROLS with long spindles, all values less switch, 2/9; with S.P., switch, 3/9.

WIRE WOUND POTS: 30 ohms, 500 ohms, 1,000 ohms, 5K, 20K, 50K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K, 50K Preset type, 1/9 ea.

AMMETERS. Moving coil. G.E.C. 0—5 amps., 2in. scale, 11/9.

EX-GOVT. E.H.T. SMOOTHING CONDENSERS

.02 mfd. 5,000 v. Bakelite Tubulars	1/6
.02 mfd. 8,000 v. Cans	1/11
.25 mfd. 4,000 v. Blocks	4/9
.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, or 3 in wood carrying case 9—7—5in., 14/9, plus 2/6 Carr.

EX-GOVT. BLOCK PAPER CONDENSERS

4 mfd. 500 v. ...	2/9	10 mfd. 1500 v.	7/9
4 mfd. 1500 v.	4/9	11-7 mfd. 500 v.	8/9

4 mfd. 400 v. plus 2 mfd. 250 v., 1/11.

EX-GOVT. TRANSMITTER-RECEIVER TYPE TR9D, complete with all valves, only 47/9, plus carr. 5/-.

EX-GOVT. AUTO TRANSFORMERS 50 c/s.

Double Wound 10-0-200-220-240 v to 10-0-270-290-310 v. 200 watts	25/9
Double Wound 100 watts, 5-0-115-125 v. to 10-0-10-210-230 v. or reverse	18/9
15-10-5-0-195-215-235 v. 200 watts	25/9
0-110-190-230 v. 400 watts	49/6
Double Wound 220/240 v. input. Output 55 v. to 250 v. 21 amps. in steps of 11 v. ...	89/6
Double Wound 10-0-200-220-240 v. to 10-0-275-295-315 v. 500 watts	69/6

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola-field 700 ohms, 11/9. 10in R.A. field 600 ohms, 23/9. 10in. R.A. field 1,500 ohms, 23/9. 10in. R.A. field 1,000 ohms, 23/9.

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
300-0-300 v. 60 mA., 12 v. 1.5 a., c.t.	18/11
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. for R1355 conversion	31/6
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a....	33/9
350-0 350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a., for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a., c.t., 6.3-4 v. 4 a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	49/9
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6

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. 3 a., 5 v. 2 a. ...	14/11
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a....	16/9
350-0-350 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....	23/9
300-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

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 or ACR2X 36/6
5,000 v. 5 mA. 2 v. 2 a. 39/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 2 a.	7/6
6.3 v. 3 a.	9/6	0-4-6.3 v. 2 a....	7/9
12 v. 1 a.	7/11	6.3 v. 6 a.	17/6
0-2-4-5-6.3 v. 4 a.	16/9	12 v. 3 a. or 24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s Primaries: 0-9-15 v. 1.5 a., 12/9; 0-9-15 v. 3 a., 16/9; 0-9-15 v. 6 a., 22/9; 0-9-15-30 v. 3 a., 23/9.

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, 5,000Ω to 3Ω	3/9
Standard Pentode 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	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 3Ω or 15Ω...	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 20 Watts high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω ...	47/9

SMOOTHING CHOKES

250 mA., 7-10 H. 200 ohms Shrouded	16/9
250 mA., 3 H. 50 ohms	11/9
100 mA., 5 H. 350 ohms	7/6
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

MICROPHONE TRANSFORMERS
100 : 1 ..... 5/9

BAKELITE AND WALNUT VENEERED CABINETS

Size approximately 12in. × 6¼in. × 5in. Bakelite type available in Brown or Cream. Price of Cabinets, 17/6 ea., carr. 2/6.

Suitable fully punched T.R.F. 3-valve and rectifier chassis.....	3/9
Suitable fully punched superhet chassis (4 valves and rect.)	4/9
Dial Scales, 2 colour, 2 waveband, station named, glass	1/6
Dial Scales, 3 colour, 3 waveband, station named, glass	1/9
Suitable coloured Metal Backplates	1/3
Pointers, Double ended	4d.
T.R.F. Coils, 2 wavebands with circuit.....	6/9
Drum Drives, complete	2/6

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 any 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. 3½in. Goodmans (Ex New Units), 10/9 5in. Goodmans, 15/6. 6½in. Goodmans, 16/9. 8in. Plessey, 15/9. 8in. R.A. Heavy duty, 18/9. 10in. Rola, 27/9. 10in. Plessey, 18/6. 10in. Rola with Trans.. 29/6. 12in. Truvox, 49/9.

EX. GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s input.

250-0-250 v. 40 mA., 6.3 v. 2 a., 5 v 2 a.	9/11
8.8 v. 4 a.	9/9
48 v. 1 a.	9/6
175 v. 100 mA.	9/9
0-11-22 v. 15 a.	35/9
0-11-22 v. 30 a.	72/6
16/20 v. 35 a.	79/6
7.7 v. C.T. 7 amps 4 times	25/9
460 v. 200 mA., 6.3 v. 5 a.	27/9
300-0-300 v. 150 mA., 610-0-610 v. 150 mA., 1220 v. 350 mA.	29/9

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. Potted	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
90/100 mA. 10 H. 100 ohms. Potted	8/9
50 mA. 5-10 H.	2/9
L.T. type 1 amp.	2/9

EX-GOVT. T.V. TYPE TRANSFORMERS. All 230 v. 50 c/s input.

1100-0-1100 v. 250 mA.	25/-
2800 v. 30 mA.	22/9
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

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. 25 WATT "PUSH PULL" AMPLIFIER

Now firmly established and proving extremely popular, our A11 Quality Amplifier we consider to be the best value in amplifiers offered to-day. The volume of its high fidelity reproduction is completely controllable, from the sound of a quiet intimate conversation to the full glorious volume of a great orchestra. Its sensitivity is so high that in areas of fair signal strength it can be operated straight from a crystal receiver. Entirely suitable for standard or long playing records in small homes or in large auditoriums. For electronic organ or guitar or for garden parties or dance bands.

The kit is complete to the last detail, and includes easy to follow point-to-point wiring diagrams.

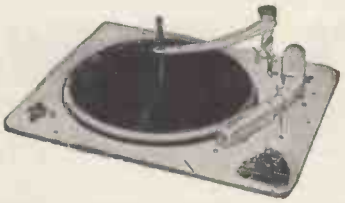
Twin volume controls with twin input sockets allow SIMULTANEOUS INPUTS for BOTH MICROPHONE and GRAM, or TAPE and RADIO. SEPARATE BASS and TREBLE CONTROLS giving both LIFT and CUT. FOUR NEGATIVE FEEDBACK LOOPS with 15 db in the main loop from output transformer to voltage amplifier. Frequency response ± 3 db 50-20,000 c.p.s. Hum and distortion LESS THAN 0.5 per cent. measured at 10 watts. This is comparable with some of the highest priced amplifiers. Six B.V.A. valves, Marconi-Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/s. input. 420 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZE 12 × 10 × 9in. approx. Output impedances for 3 and 15 ohms speakers.

Available in kit form at the amazingly low price of **9 gns.** Plus carriage 5/-

Or ready for use 50/- extra.

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.**

CONNOISSEUR HIGH FIDELITY LIGHTWEIGHT MAGNETIC PICK-UP, COMPLETE WITH MATCHING TRANSFORMER. A fortunate purchase enables us to offer limited supplies. Brand New Boxed and Perfect at a fraction of normal price. Buy Now at only **26/6.**



COLLARO 3-SPEED AUTOMATIC RECORD CHANGERS (brand new), type RC3521, complete with 2 plug-in Crystal P.U. heads for long playing or standard records 7, 10 or 12 in. Not intermixed. Mains input 200-250 v. Limited number available at only **£9/19/6,** plus carr. 5/-.

COLLARO TAPE DESK MOTORS. Shaded pole type. Clockwise or anti-clockwise. Mains input 110-200-250 v., **31/6.**

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.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6

plus carr. 2/6

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. 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 descriptive leaflet 7d.

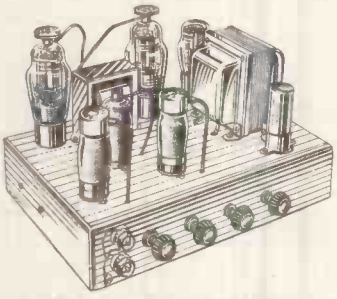
R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen—Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring 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. CHASSIS IS NOT "ALIVE." Ideal also for use as "Baby Alarm." Sound amplification 4 watts Price only **£5/19/6.** "Listen—Talk Back Unit" 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 unit 5½-4-1½in.

BATTERY SET CONVERTER KITS. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only 48/9. Supplied ready for use for 7/9 extra.

R.S.C. 10-watt "Push-Pull" HIGH-FIDELITY AMPLIFIER A3



Complete with integral pre-amp. Tone control stage (as A11 amplifier), using negative feedback, giving humproof individual bass and treble lift and cut tone control. **Six Negative Feedback Loops.** Completely negligible hum and distortion. Frequency response ± 3 db. 30-20,000 c.p.s. Two independently controlled inputs. Six B.V.A. valves. A.C. mains 200-230-250 v. input only. Outputs for 3 or 15 ohm speakers. Kit of parts complete in every detail, **£7/19/6,** plus 5/- carriage, or ready for use, 45/- extra. Descriptive leaflet 1/-.

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.

R.S.C. TONE CONTROL-PRE-AMP. UNIT. A complete set of parts for the construction of a very efficient but simple pre-amplifier and tone control unit. For use with any amplifier and pick-up. Fil. supply self-contained. Size 7¼-5-5½in. approx. Descriptive leaflet 9d. Price, inc. wiring diagrams, 37/6. Ready for use, 15/- extra.

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.

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.

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1

MUSeum 5929/0095.

All goods specially selected for quality and value. Prompt service—Money-back guarantee—It will pay you to visit our new rebuilt shop premises. Situated 50 yds. only from Tottenham Court Road Tube! (Genuine.)

THE R.C. "RAMBLER" ALL-DRY PORTABLE

A postcard will bring fully descriptive illustrated leaflet, including itemised price list, on our latest winner! Up to the time of going to press, all details had not been finalised, but are now ready! Full constructional data for the assembly of a professional 4-valve superhet "all-dry" Medium and Long Wave Portable. Housed in an attractive cream and grey attache case-type cabinet, measuring 9in. × 7in. × 5½in. deep, and built around a 5in. P.M. speaker. This set really has everything. Built-in frame aerial in the lid, high quality, extremely sensitive —professional in appearance. Full assembly details, with practical and theoretical diagrams can be supplied at 1/6 post free. All required components, including cabinet, are available from stock. Send a postcard immediately, and build your receiver in time for your holiday!!

EX-W.D. CATHODE RAY TUBES. Guaranteed full picture. VCR97 at 40/-, VCR517C at 35/-. Also VCR139A—ideal for oscilloscope. 2½in. screen, at 35/-. We also have VCR97 with slight cut-off, very suitable for oscilloscope, testing purposes, etc., at **16/6 only.** All these tubes are brand new in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in. Type 24. 20-30 Mc/s., 15/-. Switched Tuning. Type 25—40-50 Mc/s., 19/6. Switched Tuning. RF26 at 45/-. We also have some RF26, not new, but in perfect condition, at 35/-. Type 27—64-85 Mc/s., 45/-. Variable Tuning.

We have a limited supply of RF27 new condition and complete, but tuning dial damaged. Price 30/- each only. ALL these units Post Free!!

LATEST PLESSEY 3-SPEED AUTO-CHANGER. We have just purchased a very limited quantity only of these small A.C. Mixer changers. Require only 5in. above and 2½in. below motor board. Complete with turnover crystal head, **£9/19/6** only, tax paid.

ANOTHER BARGAIN IN RECORD CHANGERS. The very latest type 3-speed mixer changer (as illustrated) in cream or brown, with turnover crystal head. Motor board measures only 12½in. × 10½in. Requires only 3½in. above board, and 3½in. below. Absolutely brand new in sealed cartons at **£10/10/-** each, tax paid, plus 5/- packing and carriage.

COIL PACKS. MANUFACTURERS' SURPLUS. Few only, iron-cored, 7 waveband (2 medium, 5 short waves), comprising 14 coils, trimmers, wave-change switch, etc., etc., complete with copy of manufacturers' original circuit. 50/- only, tax paid. Completely assembled.

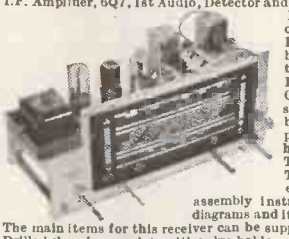
DECCA LIGHTWEIGHT PICK-UP. Complete with standard crystal insert, **32/6** only! Spare inserts for either Standard or L.P. at 21/-.

SINGLE PLAYING UNIT, by very famous manufacturer, cream, 3-speed, complete with Decca X.M.S. plug-in C. and D. heads for L.P. and Standard. **£9/9/6** only!

G.E.C. RECORDING TAPE. 1,200ft., on metal spool, at bargain price of **17/6** per spool.

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: 13½in. × 5½in. × 2½in. Dial size: 10in. × 4½in. Assembly is simplified by the use of a 3 waveband coil pack, and pre-aligned 465 Kcs. 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 Kcs. 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 are 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.

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.P.	50/-
250 microamp	D.C. 2½in.	M.C.	F.R.	40/-
500	D.C. 2in.	M.C.	R.P.	13/6
500	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F. Sq.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (scale calib. 1.5 kV.)	15/-
1 mA.	D.C. 2½in.	M.C.	F.R.	22/6
1 mA.	D.C. 2½in.	M.C.	Desk Type	27/6
5 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
10 mA.	D.C. 2½in.	M.C.	R.P.	8/-
10 mA.	D.C. 2½in.	M.C.	F.R.	10/-
15 mA.	D.C. 2in.	M.C.	F.R.	7/6
20 mA.	D.C. 2in.	M.C.	F.R.	7/6
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
200 mA.	D.C. 2½in.	M.C.	R.P.	10/-
500 mA.	D.C. 2in.	M.C.	R.P.	6/6
500 mA.	D.C. 2½in.	M.C.	F.R.	8/6
0.5 amp.	R.F. 2in.	Thermo	F. Sq.	4/6
1 amp.	R.F. 2½in.	Thermo	R.P.	10/-
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	Thermo	F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
50-0-50 amp.	D.C. 2in.	M.C.	F. Sq.	7/6
10 volt	D.C. 2in.	M.C.	R.P.	8/6
15 volt	A.C. 2½in.	M.C.	F.R.	10/-
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
150 volt	D.C. 2in.	M.C.	F.R.	15/-
300 vol	D.C. 2in.	M.C.	F. Sq.	8/6

R.P. = Round projection. F. Sq. = Flush Square. F.R. = Flush Round.

Thermo = Thermo-couple. M.C. = Moving Coil. M.I. = Moving Iron.

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. Valves line-up: 2 6SG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size: 10½in. high × 10in. wide. Maximum depth at base, 5in., tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete Instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6, post free. Our price for complete kit, **£6/9/6!!!** Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and back, drilled chassis 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!

TAPE RECORDER CABINETS. We can offer a well-constructed cabinet handsomely finished in grey or brown rexine, made specifically to take Truvox or Wearite Tape Decks. Measures 22in. × 14in. × 9½in. deep. Completely portable, shows attractive speaker grille at end, and made to take up to 8in. Speaker. We guarantee satisfaction and will be pleased to refund cash if dissatisfied. Ample room for suitable amplifier. Price 79/6, plus 2/6 packing and carriage. N.B.—We can supply from stock the latest Truvox and Wearite Tape Decks at 22 guineas and £35 respectively. Reduction of 20/- on cabinet if purchased at the same time as either of these tape decks!! **JUST ARRIVED!** Tape recorder cabinet as above but adapted to take the Elpico AC/54 Mk. II amplifier. This amplifier is available from stock at 16 gns. complete, and has been approved by Truvox Engineering Ltd. for use with their Tape Deck. Price 79/6, plus 2/6 packing and carriage.

INTRODUCING L.T. RECTIFIERS TYPE R.K. A newly manufactured range, fully guaranteed for 12 months.

6 or 12 v. 1 a. F.W. bridge type	7/6
6 or 12 v. 2 a. F.W. bridge type	11/3
6 or 12 v. 3 a. F.W. bridge type	12/6
6 or 12 v. 4 a. F.W. bridge type	15/-
6 or 12 v. 6 a. F.W. bridge type	23/6
6 or 12 v. 10 a. F.W. bridge type	37/6

CHARGER TRANSFORMER. High grade wax dipped, 220/240 v. input, 6/12 v. 2 a., at 11/9 only. Also 6/12 v. 4 a., at 17/6; 6/12 v. 6 a., at 25/-.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up: 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component braud 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 kits purchased later —Please, 2/6 packing and carriage for complete kit.

24 VOLT ROTARY CONVERTER. Input 24 v. D.C. Output 200/250 v. A.C. 100 watts. Complete in black steel box 18½in. × 11½in. × 8½in. Weight approx. 30 lbs. Completely smoothed, incorporates Sodium Lamp transformer. Brand new. 92/6.

LIGHTWEIGHT CRYSTAL HEADPHONES. Brand new, by Rothermel. List price 70/-. Our price 25/-!! Limited supply.

HEADPHONES. Brand new, ex-Govt., by S. G. Brown. Type CLR. Low resistance, 7/6 per pair. Type CHR high resistance, 12/6 per pair. We can also supply very special brand new American ex-Govt. lightweight high resistance phones by Trimm at 15/- per pair.

TESTMETER—EX-ARMY. Direct readings 15 v. and 3 v. D.C. 6 mA. and 60 mA. D.C. current, 500 ohm and 5,000 ohm resistance ranges. Complete in bakelite case with web carrying strap. 19/6, plus 1/6 p. & p.

VIBRATOR PACK. Brand new, by Mallory. 12 volt input, 150 v. 40 mA. output. Complete with synchronous vibrator, 27/6.

T1154 TRANSMITTER UNIT. Medium/high powered for C.W.-M.C.W. R/T. 3 ranges, 10-5.5 Mc/s., 5-3.3 Mc/s., 500-200 K/cs. Absolutely complete; 4 valves, 2 meters, hundreds of resistors, condensers, etc., in wooden transit case. Price 39/6, plus 7/6 carriage and packing.

EX-ARMY 38 SET "WALKIE-TALKIE" TRANSMITTER/RECEIVER. Absolutely complete station, junction box, headphones, sectional aerial, throat mike, complete in canvas bag. Range approx. 5 miles. Frequency 7.4-9 Mc/s. New condition. All units have been overhauled and guaranteed serviceable. **£4/10/-** each, complete.

TELESCOPIC AERIAL MAST. Ex-R.A.F. dinghy transmitter mast. Total length when extended, 17ft. Collapses into two sections each approx. 24in. Complete with dies and lashings, lightweight duralumin construction, diameter at thickest point, 1½in. approx. tapering to ½in. New condition. 32/6. plus 2/- post and packing.

METER SPECIAL! We have a limited quantity of aircraft electrical thermometers. Brand new, by Weston. 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full scale deflection is approximately 150 microamps! Price 12/6 each only, plus 1/- P. & P.

VALVES. We have a very comprehensive stock of special purpose surplus valves at competitive prices. A stamp will bring Valve Price List.

Please add postage under £1. C.O.D. or Cash with order. C.O.D. charge extra—Open 9 a.m.—6 p.m., Monday to Friday. Sorry but we close at 1.0 p.m. on Saturday.

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-.

300-0-300 100 mA., 6 volt 3 amp., 5 volt 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/-.

Pri. 230 v. Sec. 200-0-200 35 mA., 6 v. 1 amp., 8/6.

Drop thro' 280-0-280, 200 mA., 6 v. 5 amps., 5 v. 3 amps., 27/6.

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.

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 amps., 5/-.

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, 15/-, post paid.

P.M. SPEAKERS (closed field):

	with trans.	less trans.
2½in.	—	15/6
3½in.	—	13/6
5in.	16/6	12/6
6½in.	16/6	12/6
8in.	18/6	15/-
10in.	—	19/6

Truvox BX11. 12in. P.M. 3 ohm speech coil, 45/-. P. & P. 3/6.

6½in. M.E. Speaker, 1,000 ohm field, 15/-.

R. & A. T.V. Energised 6½in. Speaker, field coil 175 ohms. Requires a minimum 150 mA. to energise, maximum current 250 mA., 8/6. P. & P. 2/6.

Extension Speaker Cabinet, in contrasting walnut veneer, size 15×10½in. Will take 6½ or 8in. speaker, 17/6.

Completely built All-dry Mains Unit by famous manufacturer, 200/250 v. Metal case size 8×5×3in., incorporating Westinghouse metal rectifiers, 3 500 mfd., 16×24 mfd., mains trans., 3 smoothing chokes, output 90 v. 10 mA. 1.4 v., 0.25 amp., 39/6. 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, 7/6.

Line Cord, 2-way 0.3 amp., 60 ohms, per foot, 1/3 per yard.

Twin-Gang .0005 with feet, size 3½×3×1⅝in., 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-cores all-can 2½×½in., 1/6 each.

Used Metal Rectifier. 250 v., 150 mA., 6/6.

Metal Rectifier. 250 v., 250 mA., 12/6.

Metal Rectifier. 230 v., 45 mA.. 6/-.

PERSONAL SHOPPERS ONLY. 9in. Enlarger 17/6 ; 12in. 27/6.

Germanium Crystal Diode, 1/6, post paid.

Television Masks. White Rubber 9in. with glass, 7/6. Cream Rubber, 12in., with armour-plate glass, 15/-.

T.V. Width Controls, 3/6.

T.V. Sub Assembly, all-chassis, 12in.×3½in., with frame osc., line osc., 12 mfd. 275 wkg., Metrosil, 8 condensers, 4 resistors and tag panel, 15/-.

Amplifier Case, black rexine covered, leather carrying handle, chrome plated corners, rubber feet, felt lined, detachable lid. External dimensions 13½×13½×9½in., £1. P. & P. 2/6.

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.

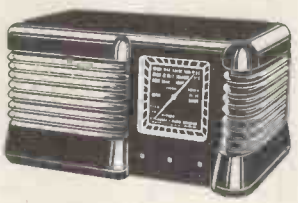
SPECIAL NOTE : NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.

23 HIGH STREET (Uxbridge Road)
ACTON, W.3 Telephone : ACOrn 5901.

Hours of Bussiness :
Saturday 9 — 5 p.m. Wednesday 9 — 1 p.m. Other days 9 — 4.30 p.m.

Used 12in. C.R. Tube, aluminised, E.H.T. maximum 10 Kv., heaters 2-volt, with heater cathode short, guaranteed for 3 months. Complete with rubber mask, Elac P.M. focus unit, scan coils, low line, low frame and frame o.p. trans. £5/10/-, P. & P. 7/6.

HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer. 600ft. on aluminium spool, 8/-. 1,200ft. on aluminium spool, 17/6, post paid.



CABINET, as illustrated, 11½×6½×5½in., in walnut or cream, complete with TRF chassis, 2 waveband scale, station names, new waveband, backplate, 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., 35/-. P. & P. 3/6, with superhet chassis, 36/-. P. & P. 3/6. Used metal rectifier, 230 v. 50 mA., 4/6 ; gang with trimmers, 6/6 ; M. & L. TRF coils, 5/- ; 3 obsolete ex-Govt. valves, 3 v/h and circuit, 6/6 ; 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/-.

M. & L. Superhet Coils with circuit, 6/6 ; iron-cored 465 I.F.s 7/6 ; min. gang, 5/6 ; volume control with switch, 4/-; wave-change switch, 2/6; heater trans., 7/6; 4 v/h, 1/6; 4 obsolete ex-Govt. valves, metal rectifier and Xtal diode with circuit, 14/6 ; 25×25 mfd., 1/- ; 16×16 mfd., 3 3 ; condenser kit (17), 7/6 ; resistor kit (14), 3/6.

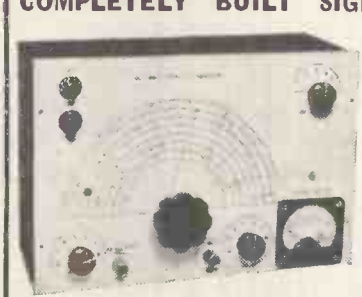
FULLY SHROUDED MAINS TRANSFORMER, input 110/250, sec. 350-0-350 175 mills., 6.3 v. 7 amp., 5 v. 3 amp., 35/-. P. & P. 3/-.

FULLY SHROUDED CHOKE, 15 Henry 180 mills., 15/-. P. & P. 2/-.

FULLY SHROUDED CHOKE, 5 Henry 120 mills., 8/6. P. & P. 2/-.

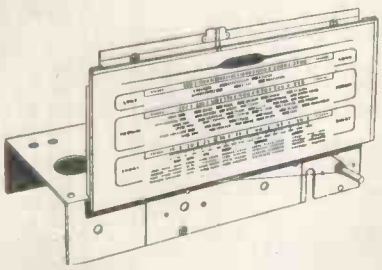
USED C.R. TUBES. Heater cathode short, 9in., 45/- ; 12in., 75/-. Ion burn, 9in., 35/- ; 12in., 55/-. P. & P. on each 7/6.

COMPLETELY BUILT SIGNAL GENERATOR



Coverage 120 Kc/s.-320 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8.5 Mc/s.-25 Mc/s., 17 Mc/s.-50 Mc/s., 25.5 Mc/s.-75 Mc/s. Metal case 10×6¾×4½in. Size of scale 6½in. x 3¼in., 2 valves and rectifier. A.C. mains 230/250 v. Internal modulation 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated. R.F. output continuously variable 100 millivolts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crackle finished case and white panel, £4/19/6. Or 34/- deposit and 3 monthly payments of 25/-. P. & P. 4/- extra.

CONSTRUCTOR'S PARCEL No. 1 comprising chassis 12½×8×2in., cad. plated 18 gauge, v/h., I.F. and trans., cut-outs, backplate, 2 supporting brackets, 3 waveband scales, new wavelength station names. Size of scale 11½×4½in., drive spindle drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs and pair of 465 IFs, 16/6.



AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 60 mA., 6 v. 3 amp. Pri. 200-250, and twin-gang, 31/6. P. & P. 3/-.

CONSTRUCTOR'S PARCEL. As No. 1, plus 16×16 mfd. 350 wkg., semi-shrouded drop-thro' 250-0-250 60 mA., 6.3 v. 3 a., 5 v. 2 a., twin gang, and 6 L.M.S. superhet coils complete with trimmers and tracking condensers with circuit. £2/5/-, plus 3/6 post and pkg.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., 13/6.

350-0-350 70 mA. 4 v. 5 a., 4 v. 2.5 a. C.T., 18/6. P. & P. on the above transformers, 2/-.

500-0-500 125 mA. 6.3 v. C.T. 4 a., 6.3 v. C.T. 2 a., 5 v. C.T. 2 a., 27/6.

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.

P. & P. on the above transformers, 3/-.

Line and E.H.T. transformer 9KVA, using ferrocart core complete with built-in line and width control. Mounted on small all-chassis. Overall size 4½×1⅞in., EY51 rec. winding, 27/6. Scan Coils, low line low impedance frame, complete with frame transformer, to match above, 27/6. P. & P. 2/-.

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.

32 mfd., 350 wkg.	2/-
16×24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 450 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., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
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.

Combined 12in. mask and escutcheon in lightly tinted Perspex. New aspect, edged in brown. Fits on front of cabinet, 17/6.

Frame Oscillator Blocking Trans., 4/6. Tube Mounting Bracket, size 9½×4½in. 12in. tube clamps, 2/-.

Smoothing Choke, 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.

465 Kc. I.F.s, size 2½×1⅜in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored I.F.s, 4×1½×1½in., per pr. 7/6. Wearite standard iron-cored 465 Kc. I.F.s, 3½×1⅞×1⅜in., per pr. 9/6.

Iron-cored 465 Kc. Whistle Filter, 2/6.

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. P. & P. 3d.

465 KC. MIDGET I.F.s. Q.120 size 1½in. long, 1in. wide, ⅝in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.

Mains Droppers. 0.3 amp., 460 ohms, tapped 280 and 410, 1/6 ; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6 ; 0.3 amps., 950 ohms, tapped 700 and 825, 2/6 ; 0.2 amp., 1,000 ohms, vitreous, tapped, 2/6 ; Vitreous, 0.3 amp. 700, tapped 680, 640, 600, 3/6. P. & P. on each 3d.

IRON LEADS suitable for all modern types of flat irons, standard length, bonded ends, 1/3 each.

PORTABLE RECORDING OR PROJECTOR CASES. Rexine covered. (Ready for carrying 15in. × 9½in. × 13in.). Internal dimensions, 14in. long, 11½in. deep, 5½in. front height, 8½in. rear height. Weight 8½lb. Price 13/6 each. Postage and Packing 2/-.

RECTAFORMA BATTERY CHARGER. 12 and 6 volts 4 amps. Complete with fuse and meter. Changeover switch from 6 to 12 volts, in an attractive grey crackle cabinet, mains lead and output leads and two battery bulldog clips, 84/- each, carriage 2/6.

CONDENSERS. STANDARD CAN TYPES. ALL BY WELL-KNOWN MAKERS.
12 × 4 mfd. 450 v., 2/- each. 24 × 8 mfd., 350 v., 2/9 each. 16 × 8 mfd. 350 v., 3/6 each. 32 × 32 × 8 mfd. 350 v., 6/9 each. 32 × 32 mfd. 350 v. 25 mfd. 25 v., 6/6. 64 mfd. 350 v., 2/- each. 16 × 16 mfd. 350 v. 2/9 each. 20 × 20 mfd. 500 v. 4/3 each. 32 × 16 mfd. 350 v., 3/9 each.

MIDGET CAN CONDENSERS.
8 mfd. 500 v., 3/6 each. 250 mfd. 12 v., 1/9 each. 8 mfd. 350 v., 1/1 each. 100 mfd. 25 v., 1/9 each. 16 × 16 mfd. 450 v., 4/6 each.

CLEM TRAVELLING IRONS. Suitable for all voltages 100/250 volts A.C./D.C. Supplied with flexible lead and bayonet cap adaptor. Ready for use. Price 21/- each, an ideal present.

CARDBOARD COVERED WIRE ENDED CONDENSERS
8 mfd. 500 v., 2/3 each; 16 mfd. 500 v., 3/6 each; 20 mfd. 500 v., 3/6 each; 25 mfd. 25 v., 1/9 each. 50 mfd. 50 v., 2/3 each. 8 × 8 mfd., 500 v., 4/-. each.

ELECTRON TRANSFORMERS.
Type LV9
Ratio 1/1.25 giving 25% boost on tube heater. Capacity between windings 16 pF. Secondary to frame, 6 pF. Suitable for High Definition Receivers.
LV9/A 2 volts ..... 12/6 ea.
LV9/C 6.3 volts ..... 13/6 ea.
LV12. A low capacity Heater Transformer with mains input and universal output. Suitable for use with all C.R. Tubes. In medium definition receivers. Input 0-220-240 volts. Boost 1-Boost 2. Output 0, 2, 4, 6.3, 7.3, 10, 13 volts. Price 22/9.

O.P.4. Dual purpose 12-watt output Transformer. Primary tapped for 2-6V6 or 2-6L6 in Push-Pull. Secondary, 3, 8, 15 ohms, 23/6. each.

MOULDED BAKELITE H.V. CONDENSERS

.1 mfd. 1,000 volts, 1/- each. .01 mfd. 4 kV, 1/6 each. .001 mfd. 4 kV, 1/- each. .001 mfd. 6 kV, 3/6 each.

HEADPHONES
Type CLR Low resistance 120Ω, 7/6 pair.
Type CHR High resistance 4,000Ω, 11/- pair.
Type DHR, a super job, 13/9 pair.
Headbands, wide type, 1/9 ea.
Headphones, by Trimm Radio Mfg. Co., Chicago, U.S.A., 1,200Ω each earpiece light headband complete with lead and Igranic jack plug, 13/6 pair.

AIRSCREW ANTICER CONTROLS, 44Ω resistance, suitable for train sets and chargers, 4/9 ea.

TERMINAL BLOCK, 20-way, 1/6 ea.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/- unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

MAIL ORDER ONLY

MAINS TRANSFORMERS
3-way Mounting Type.
MT1. Primary 0-210-230-250 v. Secondary, 250-0-250 v. 80 mA., 6.3 v. 4 amps., 5 v. 2 amps., with taps at 4 v. on filament winding. Price 17/6 each.
MT2. Primary 0-210-230-250 v. Secondary 250-0-250 v. 80 mA., 6.3 v. 4 amps., 5 v. 2 amps. Both filament windings tapped 4 v. Price, 17/6 each.
MT3. 30 volt 2 amp. tappings as follows: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 v. 17/6 each.

VOLUME CONTROLS
WIREWOUND CONTROLS
5Ω, 200Ω, 2KΩ, 5KΩ, 10KΩ, 10KΩ Double, 20KΩ, 25KΩ, 50KΩ, 30KΩ. All 2/4 each.

COLVERN CLR801, 1,000Ω, 1/9 each.

COLVERN SLIDER TYPE CLR801, 3KΩ and 5KΩ Double Unit, 1/9 each; 20KΩ, 20Ω, 1/3 each.

CONTROLS WITH DOUBLE-POLE SWITCH
25KΩ, 2 MegΩ, ½MegΩ, 1 MegΩ Log, ½ MegΩ, 1 MegΩ, 50KΩ, 20KΩ. All 4/9 each.

EX-GOVT. CONTROLS, ALL CARBON TRACK
500Ω, 600Ω, 1,500Ω Double type, 2KΩ, 5KΩ, 10KΩ, 20KΩ, 25KΩ 50KΩ, 200KΩ, 100KΩ, ½ MegΩ ½ MegΩ, 1 MegΩ, 2 MegΩ, 25KΩ Double type, 50KΩ Double type. All 1/2 each.

VOLUME CONTROLS SINGLE-POLE SWITCH
500Ω, Wirewound, 2/10 each.
5KΩ, 10KΩ, 100KΩ, ½ MegΩ, ½ MegΩ Log, ½ MegΩ, 1 MegΩ 1 MegΩ Log, 2 MegΩ. All 3/9 each.

STANDARD CONTROLS (LESS SWITCH)
50KΩ, ½ MegΩ, 1 MegΩ. All 2/6 each.

Special Purpose VALVES

CV509	7/6	VU111 ..	3/6
VR54	2/6	9001	6/3
7Q7	8/6	VU39	8/6
V868	4/-	VR65A ..	3/6
6G6G	6/6	956	3/6
9004	6/3	9003	6/9
VR136 ..	7/-	2X2	5/6
VR66	3/9	VR65	3/9
VU120A ..	3/6	6887	8/-
9002	6/3	1A5GT....	7/6
VR53	7/6	220V8G ..	6/9
VR91	6/-	931A	6/9
807	8/-	2A7	6/-
5Z3	8/6	6A3	6/9
955	4/-	7475	4/9
TT11	6/6	19	6/-
VR116 ..	4/-	26	6/-
VR56	7/-	27	6/-
954	2/-	30	6/-
CV71	1/-	36	6/-
VR137	5/-	84	6/-
VR55	7/3	6L5	6/-
6SA7	9/-	2A5	6/-
ATP4	6/9	CV287	6/-

YAXLEY SWITCHES.
2 bank (1 bank 3P 2-way, 1 bank, 1P, 3-way) 1/6 ea.
1 bank 2 pole 5 way, 1/6 ea.
1 bank 4 pole 1 way, 1/6 ea.
2 bank 4 pole 3 way, 1/6 ea.
1 bank switches 2 pole 2 way and 2 pole 1 way plus mains one pole on/off switch, 1/6 ea.
2 bank 2 pole 7 way, 1/6 ea.
1 bank 3 pole 4 way, 1/6 ea.
1 bank switching 2 pole 2 way and 1 pole 1 way. This switch has a ¾in. locating spindle and would be suitable for adding extra wafers. 1/6 each.
3 bank 3 pole 3 way, 1/6 ea.
1 pole 8 way, 1/9.
2 pole 4 way, 1/6.
2 pole 2 way, 1/6.
1 bank 4 pole 3 way, 1/6.

SLEEVING. 4 mm. Permanoid 4d. yd.

CONCORDIA BELL TRANSFORMER, Bakelite case. 6 v. 1 amp., with taps at 3 v. and 5 v., complete with fuses, 7/6 ea.

HYDROMETERS by Exide Canada, complete in wood case, 7/6 ea.

BURGESS MICRO SWITCH, interrupter type, Ref. 5C/1910, 3/6 ea.

DIAL BULBS. 6.5 v., .15 a. MES, 15 mm. Ball, 6/6 doz.

ALPHA ★★★

OUR CATALOGUE IS A MUST FOR EVERY CONSTRUCTOR — SEND FOR YOURS TODAY

HAND MICROPHONE by "REGENT," complete with screened lead and plug—Crystal insert, nickel chrome plated head, listed at 2 gns. Our price, 21/- each.

RECEIVER 1132A

Contains EK32 ; 4 EF39 ; 6H6 ; 6J5 ; 3 SP61 ; P61 in good condition. Fitted with tuning meter. Slow-motion drive calibrated dial complete with circuit diagram. 49/6 each. Carriage and packing 7/6.

ENGRAVED KNOBS.
Control Knobs, clearly engraved in gold.
Size "A" diameter 1¼in.; Size "B" diameter 1½in. Both in two colours, Walnut or Cream. Inscriptions available:
RADIO : "Volume," "Vol./On/Off," "Wavechange," "On/Off," "Tuning," "SML Gram.," "Radiogram.," "Tone."
TELEVISION : "Contrast," "Brilliance," "Brilliance On/Off" "Focus," "Brightness."
AMPLIFIER : "Treble," "Bass" (Plus any above).
TAPE RECORDER : Record/Play.
Prices: Size "A," 1/6; "B," 1/2. Plain knobs can be supplied in either size, 1/- each and 8d. each respectively.

Goodmans Heavy Duty
15Ω 12in. SPEAKER
A super job £5 5 0 each.
Carriage 2/6 each.

THE "EKE" QUALITY 3-WATT AMPLIFIER VALVES 6B8G, 6V6GT, 6X5GT, Neg. feedback (voltage and current). Controlled tone and volume. Dual input network for modern crystal or HIFI magnetic. Less than 1% total 2nd and 3rd Harmonic distortion at 3 watts output from 1,000 C.P.S.
REALLY LOW HUM LEVEL AND EVEN FREQUENCY RESPONSE.
Complete in every detail.
PRICE 79/6 ea., plus 2/- post.

LOUDSPEAKER UNITS.
3in. Plessey Round type for portables, 12/9 each.
Elac, 3½in. Square type speaker, 2 to 3Ω, 13/6 ea.
Plessey 5in. unit, 13/6 ea.
Elac 4in. unit with 5in. fitting, 13/6 ea.
Elac 6½in. unit, 14/6 ea.
Lectrona and R. & A., 8in. units 16/6 ea.
10in. Plessey lightweight, 19/6 ea.
10in. Elac, 22/6.
10in. Goodmans, 29/6.
8in. Lectrona, with output transformer, 20/-.
Truvox BX11, 12in. unit, 49/6.
Truvox wafer speaker, 6½in., 20/-.
Plessey 8in. mains energised, 1,500Ω field, 21/-.
6½in. unit with 1,500Ω field, 17/6.
5in. Goodmans PM unit, 14/9.

FIXED WIRE WOUND RESISTORS.
3 WATT.
150Ω, 1/- ea.
750Ω, 1/- ea.
680Ω, 9d. ea.
1,250Ω, 9d. ea.
1,250Ω, 9d. ea.
5,000Ω, 1/- ea.
2,000Ω, 1/- ea.

20 WATT CLIP IN TYPE
1,491Ω, 1/6 ea.

5 WATT WIRE WOUND.

400Ω	1,000Ω	800Ω	500Ω
3,000Ω	300Ω	200Ω	175Ω
15,000Ω	9,000Ω	225Ω	600Ω
130Ω	270Ω	250Ω	750Ω

All 1/- each.

HEATER TRANSFORMERS by **RELYANCE**
220 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/-.
250 v. Input 12 volt .75 amp., 5/-.
230 v. Input 6.3 volt 1.5 amp. and 5 volt 2 amp., 14/3.

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We have small quantities of equipment which has been removed from Ex-Government surplus gear. It would not pay us to advertise these items so we offer them in parcels at 10/- each. Each parcel contains Resistors, Condensers, Tags, Vol. Controls, Transformers, etc., etc.

WE CAN SUPPLY COMPONENTS FOR :
"VIEW MASTER"
"SOUND MASTER"
PRACTICAL T.V. "SIMPLEX," ETC., ETC.

1¼-METRE SUPERHET
10-Valve 1¼-metre Superhet. Ideal for T.V. conversion. I.F. 12 MEGS. Band width 4 MEGS. Co-Axial input and output. Mazda valves with 6.3 v. Filaments, 55/- each. Carriage 5/6.

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available in the following colours :

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- MAROON
- BLUE
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complete with facia board and removable insert in lid for frame aerial.

PRICE
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ONLY

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5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

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Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Number: 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day: July 1954 issue, Monday, May 31st. No responsibility accepted for errors.

WARNING

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

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

MIDGET sensitive T.R.F. receiver ("Wireless World," April 1954), special coils, etc., available (Dept. WW1).—Osmor Radio Products, Ltd., 418, Brighton Rd., South Croydon, Surrey. Cro. 5148-9. [2855

WILLIAMSON amplifiers built to author's specification; £29/10; capacity available for wiring and constructional work; write for quotation.—A. J. J., 50, Camrose Ave., Edgware, Middx. [2889

ALL types of audio equipment designed and built to order, tone compensation units. Williamsons, ultra-linear, pre-amps, electronic mixers, and all amplifiers up to 1kw. Extended payments available above £20.—Bernard J. Brown, 33, Goldhawk Rd., London, W.12. [0024

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Bickford Rd., Witton, Birmingham, 6 (Eas. 0435), the Midlands specialist manufacturers of high fidelity sound reproduction equipment for the world-famous Williamson amplifier and associated accessories, including tone control stages, loudspeaker crossover units, distortionless contrast expenders and radio feeders; send for details and prices. [0105

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

G.E.C. BRT400B receiver; £90.—Box 4638. [2793

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 252, Grove Green Rd., London, E.11. Ley. 4986. [0053

R.F. Units, types 26 @ 37/6, 25 @ 17/6, 24 @ 12/6, brand new in original cartons. —E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [2877

LOVELY walnut console cabinet, 41in tall× 20in×18in, with 9-valve feeder unit and Goodman Audiom 150 12in speaker, Williamson amplifier.—Ormerod, 10, Arnside Rd., Southport, Lancs. [2841

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND WANTED

CHALLICRAFTER communication receiver model S.27 in any condition.—Box 5034. [2862

LOUDSPEAKERS—SURPLUS AND SECONDHAND

3 G.E.C. 42in horn speakers with pressure units and line transformers in very good condition; £5 each, or offers.—Box 5149. [2893

6 VITAVOX cass "B" Type units; 6 46in Monoplanor Horns Car/Mtg., perfect, £50. Broster, Whitburn Street, Bridgnorth. [2853

ENERGIZED loudspeaker units, 6v d.c. Voigt, Hartley Turner. E.M.I. 230v a.c. Magnavox B.T.H.; cheap; offers.—Box 4886. [2828

TEST EQUIPMENT—SURPLUS AND SECONDHAND

SIGNAL generator, as new, Taylor; would exchange for Avo No. 7 universal, similar condition.—76, The Triangle, Malmesbury, Wilts. Tel. 3208. [2838

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

METERS WANTED

WE urgently require meters of all types, meter components, test equipment, etc.; any quantity large or small; prompt cash or offer by return.
ANDERS Electronics, Ltd., 91, Hampstead Rd., London, N.W.1. Euston 1639. [2778

NEW DYNAMOS, MOTORS, ETC.

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.

ALTERNATORS, 230/1/50, 400VA. self-energised 3,000rpm, ball bearing, £23/15 del., also special television model same price; voltage regulator 30/- extra.
J.A.P. No. 2A 1.2hp petrol engine, air-cooled, 4-stroke, starting rope, tools; £17/10 delivered for above alternators.
SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va. out, 24v, 32v, 50v, 110v, 230v d.c. 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 9½amps, picture and sound were perfect and completely free of interference or flutter.
THE above are the latest products of British manufacture, and are guaranteed for one year; fullest details of plant, alternators or 400AV alt. or rotary converters, by return post; state which required; terms c.w.o. pro forma invoice c.o.d. (post goods only).
T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.
DIESEL Electric generating plants, 3kva, 230v, with push-button remote control, starting equipment ready for use; £225.
CHAS. F. WARD, Lordscroft Works, Haverhill Suffolk. Tel. 253. [0039

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

CONVERTERS, rotary 100v d.c. to 230v a.c. 400w, E.D.C. 36v d.c. to 400v d.c. 125ma, vibrator 50v d.c to 240v d.c. 200w; cheap; offers.—Box 4887 [2829

ROTARY Converters, guaranteed, 80-3000 watts, 200/230 volts D.C. in/ 230 volts A.C. out; £8-£35.—H. J. Mugdan, Ltd., 23, Brook Mews North, W.2. Pad. 2967. [2870

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. [2314

BUYING a new amplifier or rebuilding the present one? See Bernard J. Brown's adverts under New Receivers and Amplifiers, also Repairs and Service. [0029

PRE-AMP/RECORD units for use with Leak, Q.U.A.D., etc., with meter level ind. to suit Bradmatic, Truvox, etc., now £16; to suit Wearite, 17gns; this unit gives you first-class recording with playback via your Hi.-Fi. amp. AMPS. to suit Wearite 2A (EL84), 5 watts output. 21gns. and £32 for 12 watts P.P. with meter and Partridge out. trans.
MOTEK amp. to spec., £11; others for Truvox, etc., 12 watts P.P., £21
HARDING ELECTRONICS, 120a, Mora Rd., London, N.W.2. [2842

NEW E.M.I./H.M.V. Battery Tape Recorder. Makes on the spot recordings, without mains electricity; complete with carrying case, lapel microphone, earphones, loudspeaker, spare batteries and 36 reels of tape; original total cost £120, will accept £85. Tel. Boxmoor 3636, or write Multicore Solders Ltd., Hemel Hempstead. [2845

HIGH fidelity, v.h.f., F.M. tuner units, a new receiver, entirely self-contained, mains driven, 8-valve miniaturized chassis, 2 watts output at extreme ranges, price includes aerial and new type H.F. 810 W.B. speaker; £25; demonstration daily; see also display advert.—Bel, Marlborough Yard, Archway, N.19. Arc. 5078. [0185

FOR SALE AND WANTED ADVERTISEMENT FORM
TURN TO PAGE NO. 155

NEW GRAMOPHONE AND SOUND EQUIPMENT

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., 60, Aylward Rd., London, S.W.20 (Liberty 2426). Callers by appointment only. [0209

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

DISC recording; Presto K.8 portable, complete, £55; Presto K.10 portable, complete, £65; each with spares, valves, etc.; £110 the 2. JOHN KING (FILMS), Ltd., Film House, East St., Brighton. [2834

H.M.V. portable disc recorder, model 2300H, complete microphone, dics, etc., perfect condition; offers.—1801, London Rd., Leigh-on-Sea, Essex. [2839

TRANSMITTING EQUIPMENT

SCR522, ET4332B T.U.s for BC375, T1131, TR1430 TR1143A offered.—E.W.S. Co., 69, Church Rd., Mose.ey. Birmingham. [2708

NEW TV COMPONENTS

TELEVISION ¾in canned formers, 2/3 each; TV coil sets, transistors, Mullard; ring for a demonstration as completed receiver.—Bel, Marlborough Yard, Archway, N.19. Arc. 5078. [0187

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new; 15/6, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

FLUORESCENT fittings. Special reduced price offer, 4ft 40w white stoved batten complete with ballast starter and tube, ready to plug in, 210/240v a.c. 39/6; these are neat compact fittings suitable for home and workshop.—Malden Transformer Supplies, Malden Rly. Station, New Malden, Surrey. Mal. 2655. [0038

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/-; 500+500, 6v, 1×3, lug, 2/6; 40+40, 150v, 1⅛×2, clip, 2/9; 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; 60+100, 275v 1⅝×3, lug, 4/6; 100, 275, 350v, 1⅛×2, clip, 3/6; 32+12, 350v, 1⅝×2, clip, 4/-; 16+16+16, 350v, 1⅝×2, clip, 1⅝×2, 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; 30+30, 450v+20mf 25v, 1⅜×3, lug, 5/-; 15+15, 450v+20mf 25v, 1⅛×3, lug, 4/6; 200, 6v, ⅝×1¾, clip, 1/6; 100, 12v, ¾×1¾, clip, 1/9; 8, 450v, 1×2 clip, 2/-; 50, 12v, ¾×1¾, tag, 1/6; 150, 25v, ¾×1¾, clip, 2/-; 250, 12v, ¾×1¾, wire 2/3; 350, 25v, 1×2¼, clip, 2/6; 16+16 450v, 1¼×2, clip, 4/-; 40+40, 275v, 1⅝×2, 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; 100+175, 275/350v, 1⅜×4½, clip, 6/6; 32+32, 350/425v, 1⅜×2, clip, 5/-; 8+16, 450/525v, 1×2, clip, 4/-; 2, 450/525v, ⅜×1¾, tag, 1/6; 2, 350v, ¾×1¾, tag, 1/3; 8, 450v, ¾×2, clip 1/9; 32+32, 450/525v, 1⅛in×3in, wire ended, 5/6; 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. 1,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post, diagram of line trans. supplied.
PERSONAL receivers, 3 valve T.R.F. using 1T4s, contained in handsome bakelite case with lift-up lid, size 7×6½×5in with lid closed, plastic carrying handle fram, AE in lid, these receivers cover the medium waveband and operate from self-containe.. dry batts., standard types, W1435 and U2, output to a pair of lightweight 'phones (H.R.), controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids, hos. patients, etc., these receivers are not Govt. surplus and are offered ready to play; carr. paid £4/10.
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, Gardner 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; 8/- post paid.
MAINS trans., 250-0-250v, 80ma, 6.3v. 2.5A. 6.3v, 0.6A, Pri. 0-210-230-250v, 12/- post paid.
MAINS trans., Pri. 200/250v, sec., 305-0-350v, 80mA, 300v 5mA, 6.3v 4.2A 6.9v 0.4A, 2v 2A, 4v 1.1A, 5v 2.3A; these trans. have been taken from ex-Govt. equip.; some may have tag panels broken, but guaranteed O.K.; 13/- post paid; ideal for scopes.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

COMPONENTS—SURPLUS AND SECONDHAND

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. Ilf. 1260. Est. 18 years.
RADIO and television component bargains at the right price.
EARTH rods, copper tube type, 18in long, our price 1/8 ea.
STEEL chassis, ready punched, for superhet layout, 14in×6in×3in, amazing bargain at 2/6 ea.
POPULAR value, ¼ and ½w resistors 3d ea. or 2/6 per doz, or ass. doz.
WONDERFUL buy! Crystal sets, in brown Bakelite case, 3¼in×2¾in×1⅝in, wired ready for use, 7/6 ea.
FILAMENT trans.: Primary 0-250v; sec. 6.3v at 1½ amp, 5/9 ea., or 3 amp type, 8/9 ea.
ALL types of condensers, vol/controls, speakers, etc., always in stock at the very keenest prices.
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

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 149. [0016

ELECTRONIC Components. Send stamp for interesting comprehensive bargain list. A. McMillan, 5, Oakfield Rd., Bristol, 8. [2846

WE have been fortunate in securing a very limited number only of heavy duty potted mains transformers at special clearance prices, ideally suitable for recording, amplifying or any use where a "super" transformer is required; three types only available:—
A.—Input: Standard mains.
SEC. (1): 265-0-265v, 175m/a.
(2): 6.7v—7amps
(3): 4.1v—2.5amps.
SIZE: 6in×5in×8½in, weight 20lb approx.; 25/- each plus 2/6 carriage.
B.—Input: Standard mains.
SEC. (1): 365-0-365v, 120m/a.
(2): 6.9v, 0.42amp.
(3): 4.1v, 2.5amp.
SIZE: 5in×4½in×7in weight 13½lb; 22/6 each plus 2/- carriage.
C.—Input: Standard mains.
SEC. (1): E.H.T. 1,540v, 1.75m/a.
(2): 2.05v, 2amp
(3): 4.1v, 8amp (for VCR 97, etc.).
SIZE: 5in×4½in×7in, weight 13½lb; 25/- each plus 2/- carriage.
WALTON'S WIRELESS STORES, 48, Stafford St., Wolverhampton. [0010

BENTLEY, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. Offer:—New mansbridge type condensers, 200vdc working, 0.5mfd, 6d; electrolytics, all all cans, 16×8×8mfd 500v 3/6, 8×8×8mfd 400v 3/-, 8×8×4mfd 500v 3/-, 16mfd 500v 2/9, 8mfd 500v 2/6, 32mfd 350v 2/-, 24mfd 350v 1/9; 4mfd 200v micro pack 1/-, 12mfd 50v micropack 9d; l.f. chokes, 500 ohm, 3/-; X-Govt. new semi-midget multi-ratio output transformers, 2/-; 550 ohm wire wound, pre-set potentiometers, 1/6; volume conrols, 50K, less switch, 1½in spindle, 1/-; westectors, WX6 and W1, 9d; 7-way soiled press button units, 1/-; metal cased condensers, 0.01, 0.002, 0.005mfd 4/- doz, 0.1mfd 350v mica mould 6/- doz; ex-unit bargains: relay actuating gear train and contacts, 2/6; component assembly consisting of 5 condensers, 6 resistors and transformer, 2/-; ditto, but iron cored coil in enclosed former, easily rewound, transformer, several condensers, resistors and choke, 2/-; new wire wound viterous resistors, 10w, 40, 70, 75, 90, 130, 150, 270, 500, 680, 800, 1K, 1.5K, 2K, 2.2K, 2.7K, 3.2K, 3.5K, 4.3K, 4.7K, 5K, 6.8K, 7.5K, 15K, 20K, 25K, 30K, 35K, 39K, any size, 1/-; 20w, 100, 400, 500, 850, 1K, 10K, any size 2/-; valve holders, English 5-pin, moulded, 3d; English 7-pin, ceramic, 9d; EF50 type, ceramic, 1/-; B7G paxolin 5d, moulded 7d, B9A moulded 7d, Ocatal moulded 6d; selenium rectifiers, RM4, 250v 275ma 12/-, 260v 80ma 5/6; glass dials, SW 6d, M & L, 5-wave, 3-wave, all 1/-; giant 9-wave with provision for magic eye, 1/6. Valves: VR91 @ 5/-, CV455 7/-, CV491 10/-, CV492 7/-, CV1945 8/-, CV1941 5/-, CV1863 8/6, CV1071 8/-, OZ4 5/6, VR136 5/6, VU120A 3/-, 9002 5/6, 9003 5/6, VR53 new 6/6, ex-unit 5/-, 807 7/6, 83 8/6, 6Y6 8/-, VR116 3/6, VR56 5/6, VR55 7/-, VU111 3/-, 2X2 4/6, 6SS7 7/6, 1A5 5/6, 1299A 5/6, 1LN5 4/6, 1LD5 4/6, VT61A 2/-, VR65A 3/-, CV6 1/6, AR8 6/6, VR102 7/6, CV73 4/-, VR66 2/-, ARP9 6/-, CV1673 2/-, CV1893 4/-, CV1301 2/6, CV1985 8/-, CV1988 8/6, 6L7 7/-, 6U5 7/-, 1629 7/6, 6SH7 5/-, CV1982 6/6, CV1074 5/-, CV1978 7/-, CV1963 8/-, CV1966 7/6, CV588 8/6, KTW62 5/-, X66 8/-, CV558 8/6, CV764 8/6, CV2500 8/6, CV3758 10/6, CV187 10/-, CV552 8/6, CV561 7/6, CV571 8/-, 7OL7 15/-, CV525 6/6, CV910 15/-, CV544 6/-, CV546 8/-, CV2808 10/6, 9002 5/6, 9003 5/6, CV1037 5/-, CV1732 6/6, CV548 4/-, CV2979 7/6, CV3502 3/-, CV2129 8/6, CV1401 13/6, CV394 11/6, CV453 7/-, CV3571 6/6, CV1129 5/-, CV895 7/-, CV900 8/-, VR108 2/6, VR106 3/-, VR109 3/-, 43 8/-, VR35 7/-, 12Z3 8/6, CV661 6/-, 6F8 7/-, 6F7 8/6, CV609 8/-, 6K6 7/-, 6N7 7/-, CV1463 17/6, AC/P (6 volt) 5/6, CV805 8/6, CV1329 10/6, CV522 7/-, CV1777 8/-, CV216 8/6, 3D6 2/-, 12SR7 7/6, CV703 8/-, 1G6 6/-; terms cash with order or c.o.d., postage and packing extra; 24-hr postal service; s.a.e. for free list. [2880

WANTED, EXCHANGE, ETC.

WANTED, Wilcox Gay V.F.O. units in new or modified condition. McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9 [0194

WANTED, EXCHANGE, ETC.

VHF test equipment.

TS47AP, TS174, TS175/U, TS148 or TSX-4SE; analysers; BC221 freq. meters, TS69, and any U.S.A. test gear; Klysrons 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, R.C.A. transmitters, all types or any R.C.A. components, including chassis and metal work.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9. [0196

WANTED, Tuning units, TN17, TN18, TN19, for R54/APR4; £50 each offered.—Box 4963. [0261

WANTED, service sheet for receiver R103A. —Write E. W. Bonson, 70, Kensington Ave., Manor Park, E.12. [2887

WANTED, G.E.C. Wobbulator; good price paid.—Reynolds, 48, Melford Rd., London, E.11. [2809

WANTED, TCS/6 or TCS/12 transmitters in mint condition; also control boxes for same.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9. [0195

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., 5, Fitzroy St., London, W.1. Tel. Museum 4389. [2703

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Tel. Gerrard 2504. [2661

WANTED, BC610 Hallcrafters, ET4336 transmitters, AR88s receivers and spare parts for above; best prices.—P.C.A. Radio Office & Works, Beavor Lane, Hammersmith, W.6. Riv. 8006. [0080

ALTHAM RADIO Co. pay highest prices in the trade for all American equipment, including test sets, transmitters, receivers, etc.—Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0228

WANTED, R.C.A. speech amplifiers, type MI-11220, J or K, and aerial tuning units BC 939a.—Offers, stating quantity and price, to P.C.A. Radio, Office and Works, Beavor Lane, Hammersmith, W.6. Tel. Riv. 8006. [0079

WANTED, good quality communication rxs., domestic radios, test equipment, etc.; top prices paid, established since 1937.—Miller's Radio, 38a, Newport Court, 1 min. from Leicester Sq. Tube. Tel. Ger. 4638. Call, write or send. Hours of business 10-6 p.m. Open all day Saturday. [0199

WANTED, signal generators types 30, 31, 51, 53, 54, 56 and 101; also any American test equipment with prefix TS or BC; American receivers types AR88, APR4 or similar.—Send price and details to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779/9857. [0037

WILL buy ART/13-T47A or T47 type transmitter; R5/ARN7 radio compass receiver; BC348 receiver; ARC3 radio complete; R77 receiver; BC312 and BC342 receivers; APN9 Loran transceiver; R89B Glidepath; 788C altimeter receiver; IE152C scope; RA20 power units; T17 microphones; TS67 test sets.—Write H. J. Burke Co., 49, Washington Avenue, Little Ferry, N.J. [2843

VALVES

500 valves, type DET12 (VT62), for sale, 11/- each.—Pype Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. [2786

VALVES WANTED

ALL types valves wanted; state price and quantity available.—Box 4441. [2710

ALL types of valves required for cash; state quantity and condition.—Bentley, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [2715

60/- paid for 723A/Bs, 45/- 813s, also required types 808, 707B, 832, etc., any quantity.—Write/tel. Pype Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. Erdington 4942. [2456

CONTACT LENSES

MODERN CONTACT LENS CENTRE, 7(J.1), Endsleigh Court, W.C.1. Deferred terms. Booklet sent. [0211

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 151. [0224

WALNUT radiogram cabinets; details.—Cabinetware, 1a, Heyes St., Blackburn.

WALNUT radiogram and television cabinets, soundly constructed; stamp for details.—R. Shaw 69, Fairlop Rd., Leytonstone, E.11. [2462

CABINETS

CABINETS made to order. Send details for quotations.
BASS Reflex Cabinets, finished in period or contemporary styles; see display advertisement, page No. 155.
CABINETS for Goodmans and other Loudspeakers
YOU can see your cabinet being made in our cabinet making shop. Open till 5.30 Saturdays. A. DAVIES & Co. (Cabinet Makers), 3, Parkhill Place, off Parkhill Rd., Hampstead, N.W.3. Gulliver 5775. [2844

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0113

LOUDSPEAKERS repaired promptly.—Model Loudspeaker Service, Bullingdon Rd., Oxford. [2837

SERVICE sheets for hire or sale, over 2,000 models, radio and television; s.a.e. enquiries.—W. Gilbert, 24, Frithville Gardens, London, W.12. [2874

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

MAINS transformers, E.H.T. line outputs, chokes and field coils, etc., promptly and efficiently rewound or manufactured to any specification; 12 months' guarantee.
LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., Kensal Rise, N.W.10. Lad. 0914. [0222

ELECTRICAL test instruments repaired and standardized, all types British or American, ammeters, voltmeters, ohmmeters DC/AC multi-range meters, etc.; meters converted to specification.
THE ELECTRICAL INSTRUMENT REPAIR SERVICE, 329, Kilburn Lane, London, W.9. Tel. Lad. 4168. [2821

AUDIO Equipment repaired/rebuilt or modified, disk or tape recorders/amplifiers/sound projectors, quotations without obligation, extended payments available above £15.—Bernard J. Brown, 33, Goldhawk Rd., London, W.12. [0025

24-HOUR service, 6 months' guarantee, any transformer; rewind, mains outputs and l.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

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. Design of tape equipment a speciality. Circuits designed, repairs and modifications carried out quickly. Advice freely given. See also below:—
COMPREHENSIVE service to trade and amateur; design, manufacture and repair of electronic equipment carried out by specialists; equal attention given to small or large orders. See also below:—Autochangers, 48-hour service, cleaning and adjusting at fixed price of 45/- plus carriage; also all repairs carried out; trade enquiries invited; callers by appointment only please.—Ariel Sound, 57, Lancaster Mews, London, W.2. Tel. Paddington 5092 (2 lines). [0026

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

BUSINESS AND PROPERTY

HAROLD E. LEVI & Co., Auctioneers, Surveyors & Estate Agents, 760, Lea Bridge Rd., Leyton, E.17. Ley. 1171/4117.
FOREST Gate, modern freehold factory, approx. 5,000 sq ft, steel framed building with concrete floors, office and caretaker's accommodation, canteen, boiler house and garage, all main services; £14,000.
APPLY Harold E. Levi & Co., 760, Lea Bridge Rd., Leyton, E.17. Ley. 1171/4117. [2861

RADIO and TV servicing workshop (Trade and Public); elect. installation contractor; 6 years estab. retailing and wholesaling; going concern, S.W.1; £800 plus s.a.v.—Box 4520. [2777

FOR Sale.—Goodwill, equipment and stock of Gui de Buire, Ltd., specialists in sound recording.—Address enquiries to Receiver for Debentureholders, 121, Queen Victoria St., London, E.C.4. [2871

BUSINESS OPPORTUNITIES

OLD-ESTABLISHED firm of exporters in the electronic field, invite manufacturers seeking overseas sales to communicate Box 0239.
ADVERTISER desires contact suitable sales-experienced party with small capital for organizing direct sales of radios, radiograms and tape-recorders to consumers; partnership basis; all other arrangements completed; please give full details of sales experience.—Box 4689. [2805

FINANCIAL & PARTNERSHIP

RADIO, Television and Public Address . . . addressed to progressive Television and Radio engineers. One half of the shares of a Limited Company in old established business for sale, including valuable stock in trade, and all assets; no liabilities; Lancashire coast town; balance of shares held by working electronic engineer of high standard; an assured livelihood; long lease.—Box 5116. [2888

WORK WANTED

ASSEMBLY, wiring of all types of electronic eqpt., control panels, switchboards, etc.—R.A.E., 377, High Rd., London, N.2. [0219

AID approved contractors for machining, assembly coilwinding, speciality, distrene work, and toroidal winding.—Bel Sound Products Co., Marlborough Yard, N.19. [0183

WE have excellent facilities including coil-winding and machining for short-assembly runs and prototypes.—Coilwinding Services, 26a, Wadham Road, London, S.W.15. Putney 2667/8930. [2868

ELECTRONIC sub-contracts and prototypes; modern miniature technique, exp. government work, skilled labour only.—Astra Radio and Television, Electra House Haslemere, Surrey. Tel Haslemere 1134 [2835

MISCELLANEOUS

COIL winding machines; from £15.—Hawkins, 170, Witton Rd., Birmingham, 6. [2879

METALWORK, all types cabinets, chassis, racks, etc., to your own specifications; capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd. (G4BI), Chapman St., Loughborough. [0208

YOUR own tape recording transferred to disc.—Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [2507

"W.W." 1944 April/Dec., volumes 1945 to 1952 (Feb., 1945 missing) best offer; Haynes R10 E.H.T. unit 70/-; Haynes S112 Scanning unit (imperfect) 20/-; Elac R25 Mk II focus unit 25/-.—Box 5051. [2869

PLYWOOD.—Hardboards. Send s.a.e. for free price lists and samples, including ¾16in mahogany ply 10d sq ft, sheets 72in×36in; hardboard all sizes, from 6d sq ft; free delivery (100 miles).—N. Gerver, 2-10, Mare St., London, E.8. Amherst 5806. [0027

ENGRAVING amateurs and trade could take the opportunity of engraving problems in the future by getting in touch with A.G. Engraving, 19a, Windmill Rd., London, S.W.18. Bat. 5793. Brass, bronze, erinoid, Perspex dials; one knob or repetition equally entertained. [0034

HAVE it done by professionals at reasonable rates; surely you can earn a little extra by supplying your clients with discs of thin tape recording; D.S. 10in disc, 15/6; 12in one, 18/6, including trailers; also LPs; s.a.e.—Sound News Productions, 3, Clover Mews, London, S.W.3. Fla. 3706. [2881

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

YOUR tapes to disk (78 & L.P. Microgroove, genuine), tape, disks, accessories; trade terms on above; E.M.I. & Ferrograph Recorders; studio and mobile service, professional standards. "Eroica" Recording Services (Regd. 1949), Peel St., Eccles, Manchester, Eccles 1624, Musical Director Thurlow Smith, A.R.M.C.M. [0121

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

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.

UNIVERSITY OF SOUTHAMPTON.

A TECHNICIAN with an interest in the development of electrical instruments is required in the Department of Mechanical Engineering. The selected candidate will be expected to apply his knowledge to the problems of measurement which occur in general engineering research. Technical education to Higher National Certificate or equivalent standard is required.—Applications in writing giving full details of education, qualifications and experience, together with the names of two persons to whom reference may be made, to the Secretary and Registrar, The University, Southampton, before June 15. [2886

ELECTRONIC engineer required immediately for development work on deaf aids.—Thomas Thirsk, 41, Lodge Rd., Croydon, Surrey. Thornton Heath 2165. [2824

SITUATIONS VACANT

RADIO technician required as SIGNALS Assistant Inspector of Police by Nyasaland Government for one tour of 2-3 years with prospect of permanency; salary, etc., £651 rising to £1,103 a year, commencing salary according to experience, outfit allowance £50, uniform allowance £10 a year, free passages, liberal leave on full salary; candidates must be between 21 and 30 years of age, of good education and physique, not below 5ft 7in in height, normal vision without glasses; they must have a sound knowledge of H.F. & V.H.F. fixed and mobile simplex and duplex radio telephone systems and low power petrol/electric chargers and alternators; knowledge of morse and ability to instruct trainees in radio subjects desirable.
WRITE to the Crown Agents, 4, Millbank, London S.W.1. State age, name in block letters, full qualifications and experience and quote M1/36023/WF. [2816

AERONAUTICAL Radio Engineers.
MARCONI'S WIRELESS TELEGRAPH Co., Ltd., are continually expanding their already wide activities in the field of aeronautical radio. There are posts available for development, project, field and sales engineers on all aspects of airborne and ground communications and radio and radar navigational aids for both civil and military purposes.—Any engineer who is interested in this field should apply in confidence, giving details of his experience, etc., and quoting reference S.A.44, to The Manager, Aeronautical Division, Marconi's Wireless Telegraph Co., Ltd., Dept. C.P.S., 336-7, Strand, W.C.2. [2743

EXPERIENCED Microwave Engineers
ARE invited to apply to Decca Radar, Ltd., to join the Company in its extensive work in a wide field of microwave link and radar development; the Company offers excellent starting salaries and first-rate opportunities for men to exploit their initiative and to rise rapidly to responsible posts; graduates without industrial experience who are prepared to undertake intensive training are also invited to apply for junior posts; applicants must be of British nationality.—Apply, Ref. RLA/14, Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [2509

DE HAVILLAND PROPELLERS, LIMITED.
REQUIRE an Engineer to act as a representative in Australia in connection with guided weapon trials.
THE post is largely administrative but a good practical engineering background with special experience in the electronic field required; several years work in industry essential; men with experience on radar in the R.A.F. or R.N. during 1939-1945 and have since been working in industry on projects incorporating electronic equipment are particularly welcomed to apply; applicants must have personality and organising ability and lie in the age group 28-35; they must be prepared to stay in Australia for several years with periodic visits in the U.K.
WRITE or 'phone: The Personnel Manager (Technical Employment), De Havilland Propellers, Ltd., Hatfield, Herts. [2825

E. K. COLE, Ltd. (Malmesbury Division):
THE Malmesbury Division of E. K. Cole, Ltd., is engaged in the development and production of radar and communication equipment associated with high priority defence projects. Vacancies exist in the Development Department for project engineers, engineers and assistant engineers with training and experience in the following fields:—
PULSE circuits.
Pulse modulators, strobe systems, Video amplifiers, time base generators, etc.
MICROWAVE technique.
Aerial design for radar scanners and waveguide components for high power T/R units H.F. and V.H.F. Communication.
Airborne and ground receivers, transmitters and aerial systems.
TRANSFORMER design.
High frequency power transformers for airborne equipment.
MECHANICAL engineering.
Light mechanisms and structures for radar scanners.
APPLICANTS should have had technical training to Degree or Higher National Certificate standard, and in the case of project engineers and engineers appropriate technical design experience is necessary. Commencing salaries will be dependent on qualifications and experience, and will compare favourably with scales prevailing in the radio industry. Housing accommodation may be available in the near future for successful married applicants. A superannuation scheme is in operation, together with canteen and full welfare facilities. Applicants should apply in the first instance for a technical staff application form to Personnel Manager, E. K. Cole, Ltd., Malmesbury, Wilts. [2792

M.L. AVIATION Co., Ltd., White Waltham, nr. Maidenhead, Berks.
VACANCIES for experienced
AIRCRAFT electrical draughtsmen for a wide range of high priority experimental and development work; salary according to experience
APPLY stating age, experience and salary required to The Chief Draughtsman. [2519

ELECTRONIC Test Engineers and Calibrators; staff appointment and generous bonus scheme.—Apply to Dawe Instruments, Harlequin Avenue, Great West Road, Brentford. [2831

SITUATIONS VACANT

FERGUSON RADIO CORP., 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 departments offering exceptional promotion and long-term prospects.
JUNIOR Engineers of ability for 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 Scheme. Housing assistance considered in appropriate cases. Applications, specifying the post for which application is made and giving full particulars as to age, qualifications and experience, etc., to Employment Manager, Ferguson Radio Corp., Ltd., Gt. Cambridge Rd., Enfield, Middlesex. [2747

NORTHERN POLYTECHNIC. Holloway, London, N.7.
THE Governing Body invite applications for appointment as from September next as full-time Grade "B" teacher of telecommunications engineering for the three-year full-time course in preparation for the Full Technological Certificate of the City and Guilds of London Institute in Telecommunications Engineering; a knowledge of radar and television engineering is desirable; salary on scale £490×£25×£765, together with allowances in accordance with the Burnham Award.
FORM of application, together with full particulars, will be forwarded on receipt of a stamped addressed foolscap envelope.
R. H. CURRELL, A.S.A.A., Clerk. [2802

A ASSISTANT Station Superintendents (M2C/30479/WF) and
B. ASSISTANT Technical Supervisors (M2C/30482/WF) required by the Nigerian Broadcasting Service for two tours of 15 to 18 months each in the first instance. Salary, etc., according to experience in scale £807, rising to £1,269 a year, plus gratuity of up to £150 a year. Outfit allowance £60. Free passages for Officers and wives, and assistance towards cost of children's passages or grant up to £150 a year for their maintenance in U.K. Liberal leave on full salary.
(A) CANDIDATES should have a good theoretical knowledge of radio and good experience in operation and maintenance of radio equipment. They should have had experience at a broadcasting studio or transmitting centre, or at a wireless transmitting and receiving station.
(B) CANDIDATES should have some administrative ability and have had wide theoretical and practical experience of low-frequency amplifiers and radio equipment.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote the reference number against the appointment for which application is made. [2836

APPLICATIONS are invited for the following additional vacancies:—
1. A YOUNG Engineer to work in a team engaged in design and development of electro-mechanical and electronic equipment for aircraft. Qualifications required are: (a) sound technical background in light electrical or electronic engineering. (b) Imagination, initiative and energy. (c) Inter B.Sc. or H.N.C. B.Sc. would be an advantage. Ref. Y.E.
2. A MAN to act as Senior Laboratory Technician in a team engaged in the development of electro-mechanical devices for aircraft. Essential qualifications are: (a) sound practical experience in light electrical, electronic or allied engineering. (b) Ability to express a theoretical design in terms of a good practical layout. (c) Ability to control and supervise laboratory assistants and wiremen in the execution of the above designs. An ex-R.E.M.E., A.S.M. with some civilian experience or a senior radio service engineer with the ability to adapt himself to this more varied type of work would be acceptable. Ref. S.L.T.
3. LABORATORY Technicians with the following qualifications: (a) practical experience in light electrical, electronic or allied engineering; (b) ability to wire-up neatly equipment from a theoretical circuit and test same intelligently; radio service engineers with a desire to engage in more interesting and varied work would be acceptable. Ref. L.T.
PLEASE apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, quoting the appropriate reference. [2827

THE ENGLISH ELECTRIC Co., Ltd., have vacancies at
LUTON and in Australia for
JUNIOR Engineers and
LABORATORY Assistants.
APPLICANTS should have a sound knowledge of electronic circuitry with preferably some radar experience.
THESE positions are permanent and progressive and attractive salaries are offered for able and experienced men.
ASSISTANCE with housing for some of the posts may be given, and a staff pension scheme is in operation.
APPLICATIONS to Dept. C.P.S., 336-7, Strand, W.C.2, quoting reference 456V. [2810

RADIO engineer, licensed, required by Morton Air Services, Ltd., Croydon Airport.—Apply in person or writing. [2754

SITUATIONS VACANT

BUSH RADIO, Ltd., require for their development laboratories at Chiswick, W.4: 1. DEVELOPMENT engineers with at least 5 years' practical experience of domestic radio, television or communications circuit development; should be familiar with mechanical layout for production. 2. ASSISTANT development engineers with 2 years' practical experience of radio or television development and sound knowledge of measurement technique. 3. TECHNICAL assistants. Should have some practical experience and a real interest in radio and television. Preferably with technical knowledge to Inter B.Sc. standard. FOR Grades 1 and 2 it is desirable that applicants hold a degree or its equivalent qualification in engineering. ALL the above positions are progressive and offer excellent prospects to men with ideas and the initiative to carry them out. WRITE, giving full details of career to date and salary expected to: The Chief Engineer, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [2806

DEPUTY Chief Mechanical Inspector required by MARCONI'S WIRELESS TELEGRAPH Co., Ltd., Chelmsford; this is a responsible appointment; applicants must have served an Engineering Apprenticeship and possess a degree in Mechanical Engineering or its equivalent; light engineering factory experience with sheet metal work, welding, machine shop practice, tools and jigs, finishing processes, etc., is essential, together with ability to organize a Mechanical Inspection Department; the appointment which is permanent and pensionable carries excellent prospects.—Please write giving full details of age, qualifications and experience and quoting ref. 911G to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2. [2897

MURPHY RADIO, Ltd., have vacancies in the Electronics Division Laboratories for qualified engineers to design and develop the following:—
1. V.H.F. and U.H.F. communications equipment.
2. Airborne and ground radar equipment.
3. Computing devices and servo systems.
4. Nucleonic equipment and measuring instruments.

The salary range is £600-£1,100 per annum, depending upon experience. Further posts are available to engineers of H.N.C. standard or equivalent having less experience, the salary range being £450 to £650 per annum. These vacancies are at Welwyn Garden City, but one or two vacancies of a similar nature are available at the Ruislip works.—Applications, giving age, full details of qualifications, experience and salary required, should be forwarded to Personnel Department (E.D.L.), Murphy Radio, Ltd., Welwyn Garden City, Herts. [2686

ELECTRONIC Engineers are invited to apply for the following positions with The English Electric Co. Ltd., Luton, for work on Guided Missiles.
(a) SENIOR Electronic Engineer for field trials of a V.H.F. radio link, with previous experience of H.F. communication equipment. Applicants must be prepared to accept responsibility for equipment trials at locations in the United Kingdom other than Luton. Housing assistance may be given.
(b) SENIOR Radar Engineers for work on radar equipment covering a broad field. A good theoretical knowledge and sound practical experience of radar systems is essential. Assistance with housing may be given.
(c) SENIOR Light Current Engineers, Physicists or Mathematicians, with an engineer bias for design and development work on a range of simulators and analogue computing devices. Responsibilities will include the design and supervision of construction of complete computors.
(d) SENIOR Microwave Engineer for investigation of new methods of construction for miniaturisation and weight reduction, design and engineering to the production stage. Degree standard and experience essential. The successful applicant may be appointed in charge of a group. Assistance with housing may be given.
(e) ELECTRONIC Engineer or Physicist to develop equipment and new technique of ground testing. Applicants should be of degree or H.N.C. standard with design experience.
(f) SENIOR Engineers with good fundamental knowledge of Electronics and the ability to apply it to circuit development work. One vacancy exists in a group working on the application of transistors. Assistance with housing may be given.
(g) SENIOR Electronic Engineer for work on radio and radar systems design. Applicants should have a good academic background and an inventive turn of mind, with extensive experience.
(h) JUNIOR Engineers are also required to assist all the above work.
THESE positions are permanent and progressive and attractive salaries are offered for able and experienced men. A staff pension scheme is in operation. Applications to Dept. C.P.S., 336-7, Strand, W.C.2, quoting ref. S.A.38. [2663

FULLY experienced television/radio engineer required by main dealer handling leading makes only; excellent conditions and a permanent well-paid position offered.—Edwin P. Fox, East Molesey Molesey 2721 [0442

TELEVISION & radio engineers required; permanent progressive positions for the right men.—Apply to A. S. White & Sons, Ltd., 132, High Rd., South Tottenham, N.15. Stamford Hill 7861. [2644

SITUATIONS VACANT

D. NAPIER & SON, Ltd., Luton Airport, have the following vacancies in the Instrumentation Department:—

1. TECHNICAL Assistant with practical electronics background in field of instrumentation, familiarity with C.R.O. technique desirable. Higher National Certificate standard or equivalent essential. Ref. 1296.

2. LABORATORY Assistant (electronics). Higher National Certificate standard desirable. Ref. 1297.

3. LABORATORY Assistant (instruments). Higher National Certificate standard desirable, practical background in instrumentation particularly with pyrometry experience. Ref. 1298.

THESE posts offer wide variety of work on instrumentation for flight testing of aircraft and aircraft engines.—Apply, with full particulars of qualifications, training and experience, quoting appropriate reference number, to Dept. C.P.S., 336-7, Strand, W.C.2. [2835

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) DESIGN of R.F. modulators.
(b) INVESTIGATION into valve parameters.
(c) DESIGN of valve test apparatus associated with (b) above.
(d) TRIALS team in connection with guided weapons.
(e) DEVELOPMENT of pulse circuitry techniques for guided weapons.
(f) SERVO-MECHANISMS.
(g) MICROWAVE development.
(h) TEST equipment.
(i) GENERAL radar circuit development.
(j) POWER units including electronic stabilizers and rectifier systems.
(k) Magnetic amplifiers.

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. [2714

FERRANTI, Ltd., Manchester, have staff vacancies in connection with long-term development work on an important radio telecontrol project at their new laboratories at Wythenshawe, South Manchester.

(1) ENGINEERS for research and development work in the following fields:

RADAR, radio and electronic circuits, microwaves, vacuum and/or high voltage techniques, servo control and hydraulic systems and electro-mechanical devices and testing equipment associated with the above.

QUALIFICATIONS include a degree in Physics or Electrical Engineering or Mechanical Science, or equivalent qualifications, and at least two years' previous experience. Salary according to qualifications and experience in the range £500-£1,000 per annum.

PLEASE quote reference WE.

(2) TECHNICAL assistants for experimental work in the fields listed in (1) above.

QUALIFICATIONS required: a degree or Higher National Certificate in Electrical or Mechanical Engineering or equivalent qualifications. Salary in the range of £400-£600, according to age and experience.

PLEASE quote reference WT

PERMANENT staff appointments with pension benefits.

APPLICATION forms from Mr. R. J. Hebbert, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs.

PLEASE quote appropriate reference. [2664

TELEVISION offers careers for young men; previous experience not necessary as training is given.—Apply in writing to Personnel Manager, Pye, Ltd., St. Andrew's Rd., Cambridge. [2689

SERVICE Engineers required for installations and trials of aeronautical and marine navigational equipment. Applicants must be of good appearance, prepared to travel in U.K. and have the following qualifications:—

(a) AERONAUTICAL: under 35 years of age with electrical and radio theory to C. & G. Radio III standard.

(b) MARINE: AC & DC electrical theory to approximately O.N.C. standard. Knowledge of electronics or radar preferable.

GOOD conditions; expense and travelling allowances; pension scheme. Apply with full details including salary, quoting no. 1477 to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middlesex [2847

FIRST-CLASS openings for young men with service or amateur radio experience, on work which introduces them to television technique.—Apply in writing to Personnel Manager, Pye, Ltd., St. Andrew's Rd., Cambridge. [2690

RADIO and television engineers wanted, for Merseyside district. Good job for good men. Staff rate, payment for overtime, Sick Pay and Pension Scheme after qualifying period.

APPLICANTS should give full details of age, training, qualifications and experience. If required for interview expenses will be paid.—Apply Box 4305 [2699

ELECTRONICS Technician required for work on 15 million Volt Linear Accelerator. Experience in pulse technique desirable; salary according to experience in scale £450 to £550, plus London Weighting. Write enclosing two copies of references within 7 days, Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, marking the envelope "Electronics." [2848

SITUATIONS VACANT

FERRANTI, Ltd., Edinburgh, have vacancies for Electronic Engineers in their Test Equipment Laboratory for the following duties: (1) DESIGN of precision test equipment for radar and specialized valves.
(2) TESTING of prototype products.
APPLICANTS should preferably have some radar experience and be of degree or equivalent standard, though experienced applicants with lower qualifications will be considered. Good prospects in an expanding organization. Staff Pension Scheme.—Apply, quoting "EE/TEL," and giving full details of training, qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2741

ELECTRICAL Test Room Assistant required for adjusting and calibrating various types of multi-range test sets, able to read and work to circuit diagrams.
WRITE, E.I.R.S., 329, Kilburn Lane, W.9. [2807

RADIO and television engineer required, fully experienced all makes, for benchwork; good salary and opportunities; references.—Sayer, 5, Heath Rd., Petersfield, Hants. [2840

TELEVISION radio service engineer required, fully experienced all makes, able to drive, good wages, permanent position.—Jones, Ltd., High St., Cobham, Surrey. Tel. Cobham 176. [2890

SERVICE engineer (TV and radio) wanted for out-of-the-ordinary job; some ability as a draughtsman would be an advantage.—Box 4506. [2752

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

AN outstanding opportunity is offered to an electronics liaison engineer in the new electronic equipment division of an old-established electrical company who are expanding to a South Coast area.
THE qualifications for this post are a sound technical background, considerable knowledge and experience of centimetric radar systems, pulse and microwave techniques; applicants should also be capable of co-ordinating the work of design and production authorities, and be able to acept the responsibility for assessing test equipment and specification requirements for radar production projects.
THE salary for this post will be commensurate with ability.—Interested applicants should write giving full details of the above experiences and age to Box 4830. [2817

DRAUGHTSMAN aged 22-25 years required for mechanical and electronic work. Must be neat and accurate and capable of making production drawings from original sketches and ideas.
EXCELLENT working conditions, bus services to Kingston, London, Guildford, pass the premises.
CANTEEN, pension scheme, sports and social club, with recreational facilities.
APPLICANTS must be of British nationality. Full details of experience and salary required should be addressed to:—
THE Joint Secretary, Cottage Laboratories, Ltd., Portsmouth Rd., Cobham, Surrey. [2814

VACANCIES exist for junior engineers and laboratory assistants on work connected with expending programme involving radar and associated devices. Qualifications required are as follows:—
JUNIOR Engineers.—Should be of Graduate standard with preferably some Services or laboratory experience of radar.
LABORATORY Assistants.—Should be of matriculation standard in mathematics and physics and familiar with the use of normal test equipment; a student member would be suitable.
SALARIES according to age and experience. Applications should be made in writing in the first instance to the Chief Development Engineer, Decca Radar, Ltd., 9, Davis Rd., Tolworth, Surbiton, Surrey. [2727

SENIOR and Junior Electronic Engineers required for audio and acoustic projects. Applicants should give full details of qualifications and experience by letter to—Personnel Manager, Pye, Ltd., St. Andrew's Rd., Cambridge. [2812

TEST Room Supervisor required by electronic and radar firm of international repute for appointment which will provide an outstanding opportunity to the successful applicant in an entirely new production group located in the South Coast area.
ESSENTIAL qualifications are:—
(a) GOOD technical background.
(b) EXPERIENCE of the testing requirements associated with the production of microwave radar, servo and pulse equipment.
(c) ABILITY to organise and control staff.
SUPERANNUATION scheme exists and housing assistance may be given. Write fullest details of education, experience and age, to—Box 4907. [2832

DRAUGHTSMEN, Junior or Senior, required for light mechanical engineering in connection with electronics. Experience in this branch not essential. Apply in writing to—R. Y. Pickering & Co., Ltd., Wishaw, Lanarkshire. [2813

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

SITUATIONS VACANT

SUB-EDITOR for technical books; should have experience of book or magazine production as well as technical and scientific knowledge (particularly electricity and electronics); applicants must be members of the N.U.J.—Box 4505. [2753

ELECTRONIC Engineering Company have vacancies for testers, preferably with experience of test gear; rate up to 4/6 per hour, plus bonus, for a 44hr week; accommodation for single men; canteen facilities.—Apply Personnel Officer, Airmec Ltd., High Wycombe. [2899

ELECTRONIC test engineer required for prototype testing to specification; ability to work with minimum supervision and assistance on all types of test gear essential.—Apply The Wayne Kerr Engineering Co., Ltd., Tolworth Close, Surbiton, Surrey. [2796

TELEVISION engineers required for demonstration installation unit (T.V. transmission equipment); must be willing to travel overseas.—Apply by letter in first instance to: Engineer-in-Charge, Demonstration and Installation Section, Pye, Ltd., Cambridge. [2761

ENGINEER required to undertake the development of transformers and iron-cored components; a degree, or equivalent, and some experience of this type of work are desirable. —Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., London, E.17. [2674

DRAUGHTSMEN required; electronic instrument or radio experience; salary according to qualifications; Saturday interview if needed; opportunity to broaden experience with reputable firm; near city centre and all amenities.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [2765

ELECTRONIC Engineer (about 30 years) required by Scientific Instrument Makers for servicing photo-electric instruments. Good prospects for keen man. Camden Town district. Five-day week, superannuation, good welfare facilities.—Please apply, stating age, experience and salary required to Box 5084. [2876

RADIO.—A gentleman to take charge of the technical enquiry department (postal) concerned with radio amateurs and the trade; able to assist in simple development an advantage; South Croydon district.—Box 428, c/o George Murray (Advtg.), Ltd., Brettenham House, Lancaster Place, W.C.2. [2884

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

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 4508. [2755

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 fully experience and salary required, to Personnel Manager, Box 4509. [2756

SENIOR Mechanical Designers and Draughtsmen required for Radio and Television Design Department. Apply in writing, giving full details of age, experience and qualifications, to Personnel Department, Murphy Radio Ltd., Welwyn Garden City, quoting "Design Department." [2852

PARTRIDGE TRANSFORMERS, Ltd., have vacancy for a senior transformer designer, applicants must have considerable experience in the design and development of all types of audio and power transformers, interesting and permanent position.—Written applications to Managing Director, Partridge Transformers, Ltd., Tolworth, Surrey. [2720

ELECTRONIC engineers experienced in design, construction and operation of electronic equipment, required to work on the measurement of vibration of engines, etc.; some mechanical experience, strength of materials, etc., an advantage; degree or Higher National Certificate; salary £400-£700.—Apply Labour Manager (A), Rolls-Royce, Ltd., Derby. [2797

I.B.M. UNITED KINGDOM has a vacancy for a graduate physicist or electrical engineer in its London Patent Department; applicants must have a good knowledge of electronics, preferably with development or research experience; a knowledge of electronic computers is desirable; previous patent experience is not essential.
THIS post offers excellent prospect of advancement to a young graduate interested in electronic computer work or wishing to enter the patent profession; commencing salary will be £550 to £800 depending upon qualifications and experience.
APPLY in writing to Patent Department, 17, Berkeley St., W.1. [2804

TECHNICAL Writer required by telecommunication engineers in Croydon district to assist in the compilation of maintenance manuals for teleprinter and facsimile equipment. Must have a good English style and a sound basic knowledge of mechanics and electricity. A knowledge of engineering drawing, telecommunications or workshop practice would be an asset. Age should be under 50 years. Written applications stating age and salary required to be made to—Box G.E.940, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [2808

SITUATIONS VACANT

DESIGN & Development Engineers for work on electro-mechanical transducers for vibration testing. Experience of vibration phenomena desirable. Electrical and mechanical engineers of H.N.C. standard required. State age, experience, salary. Goodmans Industries, Ltd., Axiom Works, Wembley, Middlesex. [2851

ENGINEER, experience of mechanical design of subminiature electronic equipment. Applicants should be familiar with layout and wiring to interservice standards, design and manufacture of mechanical parts and preparation of working drawings. Degree not essential, preference given to persons with good practical experience. (Ref. 86.)
EXPERIENCED Wiremen for work on experimental subminiature electronic equipment. Applicants should be used to working direct from circuit diagrams and be familiar with workshop practice. Ability to prepare drawings an advantage. (Ref. 87.)
PLEASE write in detail, quoting reference number of position sought, to: The Personnel Manager (Technical Employment), De Havilland Propellers, Ltd., Manor Rd., Hatfield, Herts. [2892

SCIENTIFIC Instrument Makers in North London have a few vacancies for skilled laboratory assistants and wiremen for the development and production of high quality electrical and electronic apparatus. Five-day week, canteen, good welfare facilities.—Please apply, stating age, experience and salary required, to Box 5083. [2875

TECHNICAL Correspondent for leading valve manufacturers in central London; must be conversant with modern valve and electronic technique; C. & G. Radio standard; age 20—30; work involves technical liaison between Factories/Sales Department/Publicity Department/customers; salary depends on qualifications and experience; pension scheme.—Box 5151. [2901

PAPER capacitor development engineer required by a large progressive company for work on impregnated paper dielectrics; applicants should have considerable practical experience, ability to originate prototypes and assess their market potentialities.—Reply, in confidence, stating age, qualifications, summary of experience and salary required, to Box 5110. [2885

REQUIRED in Buckinghamshire, experienced assistant (male) for maintenance of electrical (including electronic and photo-electronic) laboratory equipment; skilled R.A.F. tradesman considered; salary £8 to £11, according to age and qualifications; good working conditions.—Reply, giving age, particulars of education and experience, to Box 4507. [2754

ELECTRONIC engineer required to supervise testing of prototype electronic equipment; an ability to quickly diagnose faults, and a wide experience of modern test equipment are essential qualifications; this is a staff position offering good prospects to the right applicant. —Apply The Wayne Kerr Engineering Co., Ltd., Tolworth Close, Surbiton, Surrey. [2795

MALE trainee, age 25-35, required with sound basic knowledge of electricity and/or electronics for work in connection with specialised electrical equipment and installations in operating theatres, salary according to age and experience.—Apply in writing to the Secretary, The London Hospital, Whitechapel, E.1. [2819

ASSISTANT (Scientific).—The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to 31st December, 1954, but early application is advised as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. The Interview Board will sit at frequent intervals.
AGE at least 17½ and under 26 years of age on 1st January, 1954, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.
CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science subject, and of thorough experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces, covering a minimum of two years in one of the following groups of scientific subjects:—
(i) ENGINEERING and physical sciences.
(ii) CHEMISTRY, bio-chemistry and metallurgy.
(iii) BIOLOGICAL Sciences.
(iv) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
SALARY according to age up to 25: £250 at 18 to £380 (men) or £340 (women) at 25, to £520 (men) or £435 (women); somewhat less in provinces. Opportunities for promotion.
FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1, quoting No. S 59/54. [2856

MINISTRY of Transport and Civil Aviation. —Radio technicians (men only) required at aerodromes and radio stations in U.K., special training courses for keen technicians with basic quals.; interesting work in progress providing electronic aids to navigation; prospect of permanent pensionable posts; rates of pay (London) from £330 p.a. 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 Ministry of Labour and National Service, Chadwick St., London, S.W.1, quoting Order No. 6627. [2798

SITUATIONS VACANT

WANTED, laboratory assistant, H.N.C. standard, for television and radio coil factory, 44-hour 5-day week, salary in accordance with experience.—Apply to Miss K. S. Cowan, Personnel Officer, Mitcham Works, Ltd., Winchelsea Rd., Harlesden, N.W.10. [0106

WIREMAN for modern research laboratory, capable of working to verbal instruction and able to do original layouts; City and Guilds or National Certificate an advantage, at least 3 years' experience imperative.—(Ref. 71) Write in detail, quoting reference No. of position sought to: The Personnel Dept. (Technical Employment), De Havilland Propellers, Ltd., Hatfield, Herts. [2818

JUNIOR electrical engineer required for the electrical testing section of development laboratory of cable makers in the Manchester district; the work involves electrical measurements appropriate to the light current field; some knowledge of measurements at audio and radio frequencies advantageous; salary commensurate with qualifications and experience.—Reply to Box 4831. [2823

ELECTRONIC Engineer required by E.M.I. Research Laboratories Ltd., for responsible work on special problems in connection with Television Receivers. Some knowledge of theory is expected, and practical experience with receivers is desirable. Applicants should not be liable for National Service. Apply stating full particulars, to the Personnel Dept. Electric & Musical Industries Ltd., Blyth Rd., Hayes, Middlesex. [2849

SMALL manufacturers in audio and electronics require young technical assistant primarily on design and development; completed or exempted military service; good qualifications and practical experience; duties may cover wide field, and applicants should be prepared to sacrifice dignity on occasion; directorship to suitable applicant after trial period; commencing salary £500 p.a.; 5-da 40-hr. week.—Box 4888. [2830

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [0198

RADIO engineers required. Must be thoroughly experienced on airborne radio equipment including multi channel V.H.F. of the latest type, American and English W/T, American radio compasses and all ancillary equipment. Experience on Dakota aircraft an advantage but not essential. N.J.C. rates of pay and terms of employment. Permanent positions. Apply B.K.S. Engineering, Ltd., Southend Airport. [2863

TELEVISION and radio service department manager required in Liverpool district; staff appointment, pension scheme; applicants must have first-class qualifications technically and considerable administrative ability; salary £700 to £850; applications should give full particulars of age, training, technical qualifications and experience; letters should be clearly marked "Service Manager"; expenses in connection with interviews will be paid.—Box 4742. [2815

DRAUGHTSMEN; vacancies will be available shortly in West London area for senior and intermediate draughtsmen with good experience in radio or telecommunications equipment; interesting work associated with tooling test gear, and quantity production of latest design airborne transmitter and receiver equipments; posts provide scope for initiative and extending experience in this field.—Reply in confidence, stating age, technical training experience and present salary. Box 4500 [2749

THE GENERAL ELECTRIC Co., Ltd., have vacancies at Stanmore for Electronic and Electrical Engineers for work in development laboratories. There are a few senior positions available to experienced men with a University Degree or an equivalent qualification, and more junior positions for men of O.N.C. standard and/or with previous experience in development work. The work is interesting and there are openings in each of the following fields:—

1. SERVO-MECHANISMS and magnetic amplifiers.
2. MICROWAVE circuits.
3. PULSE circuits.
4. GENERAL radar circuits and C.R.T. radar presentation.
5. PREPARATION of G.W. equipment for trials.
6. STABILISED radar aerials.

APPLICATIONS should be made in writing, stating age, qualifications and experience, and should indicate the specific interest of the applicant. All positions are permanent in ideal working surroundings, and there are excellent welfare and social facilities. Please reply to the Personnel Manager (Ref. WW/MW.2), Brown's Lane Division, The G.E.C. Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middlesex. [2826

ELECTRONIC engineer required by Birmingham company handling wide range of industrial and laboratory instrument; applicants (age 25-40) must have first-class education and degree in electrical engineering or membership of I.E.E.; position entails visiting and advising industrial concerns in the Midlands on the application of electronics and radio-active techniques to industrial processes; commencing salary £750-£1,000 according to age and experience; pension scheme.—Box 5027. [2860

SITUATIONS VACANT

B.B.C. requires qualified Electrical Engineer for work on design, installation and electrical adjustment of aerial systems and associated transmission lines and filter circuits, etc., for medium, high and V.H.F. sound, television and F.M. transmitters. Applicants must be physically able and fit to climb and work on masts up to 750 feet high, and be prepared to travel extensively throughout U.K. Starting salary £645 p.a. rising by 5 annual increments to £880. Apply: E.E.O., B.B.C., London, W.1, quoting ref. E.899. [2865

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires senior and junior electronic development engineers for work on guided weapons and like projects, particularly in the field of microwave and pulse applications; mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, also required for the above projects; salary according to age, qualifications and experience. —Apply by letter, stating age and experience, to the Personnel Manager (ref. R.G.). [0259

RADAR and Telecommunications divisions, Aeronautical Inspection Service. Vacancies exist for Examiners (unestablished) at various provincial locations. City and Guilds Inter. group certificate in telecommunications engineering (or equivalent theoretical knowledge) required, with experience in industry or Services. Salary range £510—£640 (men). Prospects of promotion and establishment. No age limits. Details and forms from Air Ministry S.2(Q), Cornwall House, (W.W.), Stamford St., London, S.E.1. [2873

TECHNICAL Superintendents required for the DEPARTMENT of Information Services (Broadcasting) Gold Coast Local Civil Service for one tour of 18 to 24 months with possibility of re-engagement. Salary in consolidated scale £1,400 rising to £1,750 a year. Outfit allowance £60. Gratuity £150 a year. Liberal leave on full salary. Free passages. Candidates should possess the City and Guilds Intermediate Certificate in Telecommunications Engineering or equivalent qualifications such as the B.B.C. Grade O exam.
M2C/30516/WF. Assistant to Chief Engineer. Candidates must have a thorough knowledge of studio and transmitter equipment and have had at least five years' experience in a broadcasting or allied organization. They will be required to supervise supply of technical equipment and to act as Relief on wired broadcasting systems, studios and transmitters as well as to assist the Chief Engineer.
M2C/30517/WF. Technical Superintendent (wired broadcasting). Candidates must have a thorough knowledge of the administration, operation and installation of wired broadcasting systems and of revenue collection. They should possess a knowledge of modern superhet short wave receivers and should preferably be familiar with tape and disc recording machines.
M2C/30518/WF. Technical Superintendent, in charge Accra studio centre. Candidates should have a thorough knowledge of the administration and technical application of modern broadcasting studio, recording and outside broadcast equipment.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote reference number shown against the post for which application is made. [2891

ELECTRONIC engineer to work within our trials division at Edinburgh; the nature of the work involves conducting trials and evaluating the performance of fire control; navigational and landing systems under development; applicants should possess a physics degree or considerable recent practical experience in this field; good opportunity in expanding department; staff pension scheme.—Apply, quoting Ref. EE/TID and giving full details of qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2799

MINISTRY OF SUPPLY requires Assistant Foreman at Liverpool to inspect telecommunication equipment; quals., British of British parents; recognized engineering apprenticeship or equivalent training in telecom.; O.N.C. or equivalent desirable; good experience inspecting and testing machine telegraphs, security equipment and test gear; salary within £494 (age 26)—£612; not established but opportunities for establishment may arise.—Apply any Employment Exchange quoting Order No. Westminster 1590. [2896

ELECTRONIC engineers to work within our trials division at Edinburgh; the nature of the work involves conducting trials and evaluating the performance of fire control; navigational and landing systems under development; applicants should possess a physics degree or considerable recent practical experience in this field; good opportunity in expanding department, staff pension scheme.—Apply, quoting Ref. EE/TID and giving full details of qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2857

DRAUGHTSMEN are required for permanent posts in the field of Radar Engineering. Excellent opportunities for advancement. Salaries beyond A.F.S.D. rates to suitable applicants. Staff pension scheme and canteen facilities. 5-day week. British Nationality essential. Posts to be filed in the following grades: Senior Section Leader. Checker Draughtsman and Senior Design Draughtsman, intermediate Draughtsman; Circuit Draughtsman, Installation Draughtsman.—Apply, quoting Ref. RLA/21, Chief Draughtsman, Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [2656

SITUATIONS VACANT

ELECTRONIC INSTRUMENTS, Ltd. of Richmond, Surrey, has vacancy for Chief Inspector. Applicants must have sound, practical experience in testing mechanical and electronic apparatus, together with administrative ability. A key post in expanding firm. Application in first instance by letter giving full details of experience and salary. [2867

LABORATORY engineer required for design and development of H.F. testing equipment for coaxial and telephone cables; engineering or physics degree essential and approximately two years' experience desirable; 23-26 years of age; £460-£600 according to qualifications and experience.—Write, stating qualifications and experience, to Personnel Manager, Standard Telephones & Cables, Ltd., North Woolwich, E.16. [2859

THE BRITISH TABULATING MACHINE Co., Ltd., require an electronic draughtsman for their Research Labtoratory at Stevenage, Herts; work consists mainly of drawing circuit diagrams, with some mechanical drawing for chassis and component layout; previous experience desired.—Applications, giving particulars as to age, previous experience and salary required, should be addressed to Personnel Officer, at Letchworth, Herts. [2883

DECCA RADAR, Ltd., invite applications from engineers and technicians with experience of installation or maintenance of radar, for field duties with the Company's Heavy Installations Division on the installation of high-power radar equipments; the appointments will be permanent and pensionable; applications giving details of experience and stating salary required should be addressed to the Personnel Officer, Decca Radar, Ltd., Shannon Corner, New Malden, Surrey, quoting reference HID.3 [2736

BRITISH ACOUSTIC FILMS have vacancies in their Laboratories at Shepherds Bush for Engineers or Physicists to work on sound recording and reproducing equipment, including stereophonic systems; applicants should have good qualifications, preferably an honours degree, or give evidence of exceptional ability and interest in electronics and sound reproduction; five-day week and pension scheme; salary according to qualifications and experience.—Application should be made in writing to the Personnel Manager, British Acoustic Films, Ltd., Woodger Rd., W.12. [2900

RADIO (Meteorological) Mechanics required by Meteorological Office. Qualifications:—Basic knowledge of radio and radar and experience in maintenance/operation of radar equipment including oscilloscopes. Successful applicants serve in United Kingdom and overseas. Commencing London salary £445 at age 25 or over rising annually to £540 subject to deductions for each year below age 25. Provincial salary £20 to £30 lower. Overtime, night duty allowance, etc. Promotion prospects. —Apply to Borough Employment Exchange (Dept. W.W.4), 236, Walworth Rd., London, S.E.17. [2872

TRANSISTORS.—The British Tabulating Machine Co., Ltd., Icknield Way, Letchworth, Herts, has a vacancy for a graduate engineer or physicist for research and development work on the use of transistors in pulse and switching circuits; applicants should possess an honours degree in physics or electrical engineering, and have experience of either transistor circuit techniques or of pulse circuits as used in digital computing, radar, etc.; salary will be based on qualifications, age and experience.—Applications, stating age, experience and training, should be sent to Personnel Officer. [2882

ELECTRICAL engineer required to undertake the development of small motors and other electromagnetic devices using new magnetic materials; applicants should be experienced in the design of small electromagnetic components; the post offers the opportunity of working in collaboration with development and production plants making hard and soft magnetic materials and the main object of the development work is to assist sales engineers to exploit the application of these materials; the commencing salary will be of the order of £800 per annum commensurate with qualifications and experience.—Apply Box 5028.

AIR MINISTRY requires scientific officer (male) at R.A.F. Station near High Wycombe, Bucks, for operational research duties, and theoretical studies in the field of communications and general electronics; qualifications: first or second-class honours degree in physics or electrical engineering; salary within range £445—£815; post unestablished with possibilities of establishment through the Civil Service Commission for successful candidate whilst remaining under age 31; opportunities for promotion to higher-grade posts on staff of Scientific Adviser to Air Ministry.—Application forms, quoting A109/54A, from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1. [2854

MARCONI'S WIRELESS TELEGRAPH Co., Ltd., Chelmsford, require research and development engineers for work on special applications of high power transmitters operating in the U.H.F. spectrum. There are vacancies for Senior and Junior Graduate Engineers with experience of the generation and transmission of microwave powers. The posts are permanent and pensionable and carry salaries in the range £600-£1,400 according to qualifications and experience. Five-day week. Canteen facilities, etc. Please write, giving full details of age, qualification, experience and present salary, and quoting reference 11178. to—Marconi's Wireless Telegraph Co., Ltd., Dept. C.P.S., 336-7, Strand, W.C.2. [2811

SITUATIONS VACANT

CAPACITOR Engineer; an experienced development engineer in this field wanted to initiate and engineer to production stage a limited range of special duty capacitors; the post is permanent and pensionable and offers excellent scope for an enthusiastic and industrious man, aged 25 to 30 years, salary in accordance with qualifications and experience; our staff are aware of this vacancy, and applications will be regarded as confidential.—Box 5150.

ELECTRONIC engineers, senior and junior required; vacancies arise from an expansion of the company's business, which covers a wide field; applications are particularly welcome from young graduate engineers who have had some industrial experience; for the junior vacancies the minimum technical qualification required is the City & Guilds Certificate in Telecommunications; applications will be treated in strictest confidence; near city centre and all amenities; Saturday interview if required.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [2766

ELECTRONIC engineer required for a senior post to build up and control an entirely new group working on advanced valve applications; this is an opportunity for a man of initiative, imagination and energy; applicant should have a sound working knowledge of modern circuit techniques in the electronic field, particularly with application to radio and television and should hold a degree or equivalent; essential qualities are an aptitude for original experimental work and an ability to guide the work of others; salary will be commensurate with responsibility.—Apply in writing to Personnel Department, M.O. Valve Co., Brook Green, Hammersmith, stating age, qualifications and details of experience, quoting Ref. A.A. [2820

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 O.N.C. to degree standard are acceptable. Salaries are dependant upon age, qualifications and experience.—Apply, stating full details, to the Chief Engineer, Messrs. Furzehill Laboratories, Ltd., Shenley Rd., Boreham Wood, Herts. [0030

ADMIRALTY—Royal Naval Scientific Service. Experimental Officers and Assistant Experimental Officers required in Experimental Establishments in London, Portsmouth, Weymouth areas, Gloucestershire and Scotland; the majority of posts are for Engineers and Physicists (particularly with electronics). Candidates must be British subjects; qualifications —minimum of H.S.C. (Pass degree, H.N.C. or near equivalent an advantage); London salary (men) E.O. £720—£890, A.E.O. (according to age), £290—£645; all appointments are unestablished, but with some opportunities to compete for established posts.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A247/52A. [2895

MESSRS. BARR & STROUD, Ltd., have the following vacancies in their expanding development laboratories and design department: (a) development engineers; with experience in one or several of the following fields of electronics, low frequency circuitry, d.c. amplifiers, servo systems, simulators, microwave circuitry, etc.; (b) microwave physicist or engineer for work on centimentric waveguide and aerial systems; (c) engineer to take charge of model and assembly shop laid out for small quantity batch production, inspection, climatic and durability test of new types, batch sampling, etc.; (d) draughtsman experienced in electro-mechanical and electronic equipment design.—Apply, giving age, experience and qualifications, to The Secretary, Messrs. Barr & Stroud, Ltd., Anniesland, Glasgow, W.3. [2758

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