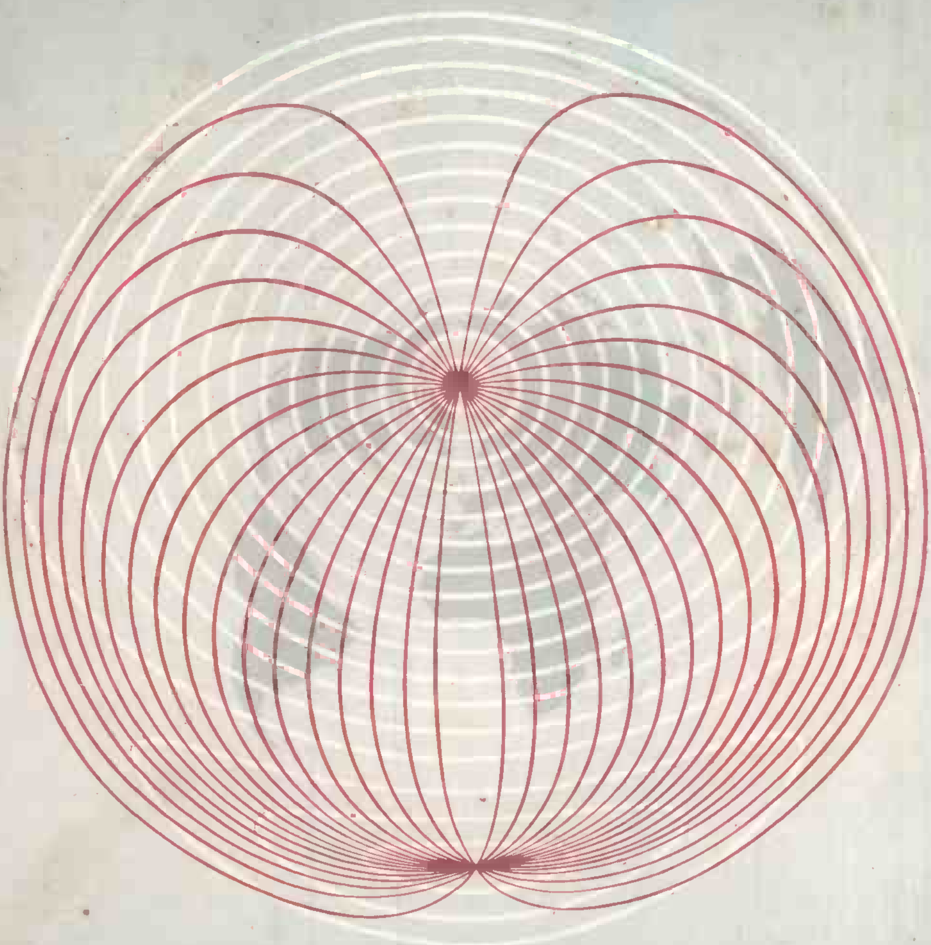
SMITH NEALE AV.

Wireless World

APRIL 1954 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

BICC

Polypole CABLE COUPLER

For- *specialised remote control—centimetre radio links—ground radar—outside broadcast television*

BICC Couplers and Cables are intended for the outdoor inter-connection of equipment, such as that mentioned above. Each application calls for composite trailing cables containing both R.F. units and other polythene insulated conductors.

BICC Polypole Mark III Couplers are available in two versions, designed for use with two standard types of BICC outdoor trailing cables. The Mark IIIA cable and coupler incorporates three coaxial circuits, and the Mark IIIB three screened twin circuits. In addition, both cables contain three triplets and 21 other conductors.

The couplers are permanently moulded to the ends of the cable in the factory. This technique provides a remarkably robust coupler which is virtually free from the hazards of conductor breakages near to, or within the coupler.

If you are interested in the uses of BICC Polypole Cable Couplers, we will be pleased to send you further information.

Note these important features

- The couplers are assembled with the conductors in tension to ensure that they each contribute their share of the total strength.
- Polythene injection moulding permits a watertight assembly.
- Screwed lock rings provide forced engagement and withdrawal. The overall metal housing can also be easily replaced should it become damaged.
- The cable itself is designed with a symmetrical cross section to provide the greatest reliability under severe handling.

BI Callender's

BRITISH INSULATED CALLENDER'S CABLES LIMITED
21, BLOOMSBURY STREET, LONDON, W.C.1.

Wireless World

RADIO, TELEVISION AND ELECTRONICS

44th YEAR OF PUBLICATION

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

APRIL 1954

In This Issue

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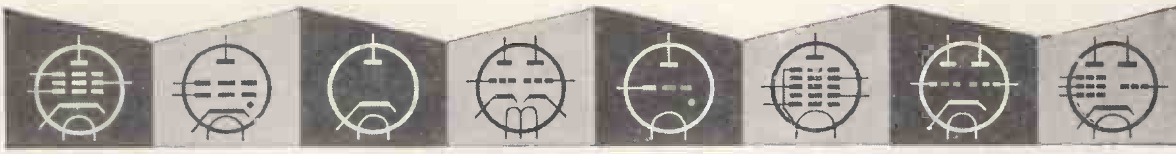


VALVES, TUBES & CIRCUITS

PCF80: A FREQUENCY CHANGER FOR BAND I AND BAND III TELEVISION

At Band III frequencies (174 to 216 Mc/s) the efficiency of a mixer stage is governed not only by the valve characteristics and the circuit components, but also by the 'invisible' components formed by VHF effects in the wiring and the chassis and by the deviations of the components from their nominal low-frequency values. Thus the following considerations of optimum valve performance must be supplemented by very careful circuit design.

The triode section of the PCF80 is designed for use primarily as an oscillator in a Colpitts circuit. The optimum drive voltage on the grid is 5 or 6 volts at the higher frequency end of the band where the circuit impedance is very low. At lower frequencies the anode impedance rises resulting in a higher oscillator voltage on the grid.

Design of the circuitry between the oscillator and the mixer must avoid the masking of poor oscillator performance by tight coupling. Inductive coupling is recommended, especially in a turret tuner. It allows adjustment to the most favourable value of mixer drive on each waveband, and it makes the whole of the oscillator coil available for the induction of an oscillator voltage into the grid circuit. With capacitive coupling it is difficult to arrange for alternative capacitors for the different wavebands. A single value, chosen for optimum drive on Band I, may give serious overdrive on Band III, thus necessitating an undesirably large compensating variation in triode oscillator drive.

The optimum conditions for the pentode mixer are determined by the conversion conductance, the input damping, and the bias and oscillator voltages on the signal grid. A cathode resistor of 820 Ω maintains a value of conversion conductance around 2 mA/V over the V_{osc} range from 2 volts to 5 volts, therefore a V_{osc} of approximately 3.5 volts is recommended. A slightly higher conversion conductance is obtainable with a cathode resistor of 330 Ω, but it requires a much more critical value of V_{osc}, and it is, therefore, oversensitive to valve-to-valve variations and to changes during life.

At the higher frequencies the valve damping largely determines the impedance of the input circuits between the mixer and the RF stage and, therefore, the gain and the bandwidth. Input resistance rises with rising drive, and input damping is improved with increasing cathode bias. In a practical bandpass circuit a cathode resistor of 820 Ω will give optimum performance at both high and low frequencies.

DATA

HEATER

I_h	0.3 A
V_h	9.0 V

CHARACTERISTICS

Pentode Section

V_a	170 V
V_{g2}	170 V
I_a	10 mA
I_{g2}	2.8 mA
V_g	−2.0 V
g_m	6.2 mA/V
r_a	400 kΩ

Triode Section

V_a	100 V
I_a	14 mA
V_g	−2.0 V
g_m	5.0 mA/V
μ (approx.)	20

TYPICAL OPERATING CONDITIONS

As a frequency changer

V_a	170	170	V
V_{g2}	170	170	V
R_{g1}	100	100	kΩ
R_k	820	0	Ω
I_a	5.2	6.3	mA
I_{g2}	1.5	2.5	mA
$V_{osc\ (r.m.s.)}$	3.5	4.0	V
I_{g1}	0	53	μA
g_c	2.1	2.05	mA/V
r_a	870	720	kΩ

BASE B9A

LIMITING VALUES

Pentode Section

V_a max.	250 V
p_a max.	1.7 W
V_{g2} max. (I_k=14 mA)	175 V
V_{g2} max. (I_k=10 mA)	200 V
p_{g2} max.	0.5 W
I_k max.	14 mA
V_{h-k} max. (heater negative)	150 V
V_{h-k} max. (heater positive)	90 V

Triode Section

V_a max.	250 V
p_a max.	1.5 W
I_k max.	14 mA
V_{h-k} max.	±90 V

Mullard

Reprints of this advertisement, together with additional data may be obtained free of charge from the address below.

MULLARD LTD., Technical Service Department, Century House, Shaftesbury Avenue, W.C.2

MVM267

Wireless World

APRIL 1954 VOL. 60 No. 4

Objectives in Sound Reproduction

COMPLAINTS are being voiced on both sides of the Atlantic about abuse of the term "high fidelity," which is applied indiscriminately to all sorts and conditions of sound reproducing equipment. There is now a demand for definition and standardization of "high fidelity," in order that those who think they have it may establish a clear advantage over the "have nots."

We have ourselves condemned the term for its inherent (adjectival) redundancy, and would now go further and question the value—even the ethics—of any definition limited to the measurable characteristics of an electro-acousic reproducing system. So many other factors are involved in the establishment of an acceptable standard of sound quality—the mind of the listener, the fact that his binaural faculties are being applied in a different environment to that of the microphone(s), and that someone else has already modified the sound to a form which they think will be acceptable by the time it reaches the hearer.

The importance of modification of the sound at its source was apparent from a lecture given recently to the Acoustics Group of the Physical Society by Dr. F. W. Alexander and T. Somerville on "Acoustic Technique in Broadcasting." The sounds which please listeners to broadcast "swing" music bear little resemblance to what would be heard by an audience in the studio. Muted brass, sub-tone clarinets and other special effects which are practically inaudible in the original blend of sound are brought into prominence by a multiple microphone mixing technique. As many as ten microphones may be used to produce the desired effect—that of "sitting in" with the players. The concert-goer, on the other hand, expects the atmosphere of the hall as a background to the music and a single microphone carefully placed gives the right blend of direct and reverberant sound. But it is not a *faithful* reproduction of the impression which a listener would receive if he took his own ears (and brain) to the same spot.

Binaural and stereophonic systems are capable of producing new and often acceptable experiences for the listener, but they are artificial and even the binaural system cannot hope to give faithful reproduction unless the shape and acoustic characteristics of the artificial head containing the microphones are a replica of those of the listener, who even then must keep as still as a dummy.

A recent demonstration of stereophony by J. Moir at a B.S.R.A. meeting gave support for the view that under favourable conditions a two-channel system with a bandwidth of 7.5 kc/s is capable of giving more acceptable results than a 15-kc/s single-channel system. But equally convincing recorded demonstrations were given by Alexander and Somerville of the realistic quality which can be simulated in a single channel by attention to studio design and the judicious admixture of reverberant sound, either by choice of microphone characteristics and placing, or by a magnetic recording technique using multiple heads to synthesize an "ideal" reverberation characteristic.

We have wandered rather far from our opening theme, far enough perhaps to see that too narrow a preoccupation with the minutiæ of equipment design may prevent us from making bold strides in other directions.

Since fidelity (of any degree) is impossible, let us set about finding the factors which introduce any incongruity into the sound—the factors which proclaim it as "canned." It is not so necessary to be able to hear that a violinist is playing on a Strad or an Amati as that he should not seem to be bowing a banjo; symphony orchestras should not sound as if they were performing either in a seaside bandstand or in Blackwall Tunnel; a lieder singer should not seem to have the physique of the Statue of Liberty.

A prescription for a good sound reproducing system should start with a specification of the listener himself. In what respects is his hearing acute and where is it open to aural illusion? What microphone and transmission technique will most economically preserve illusion, and what characteristics must be *excluded* from the reproducing equipment as being liable to introduce elements which, without reference to the original, will be self-evident incongruities.

RENÉ BARTHÉLÉMY

This appreciation is written by E. Aisberg, Editor of *Toute la Radio*, Paris.

IN René Barthélémy, who died on February 16th, France has lost a pioneer who made no small contribution to the progress of television.

Born in 1889, he qualified as an electrical engineer at the Ecole Supérieure d'Electricité. His choice of wireless as his field led to an association with General Ferrié In 1925 he foresaw the coming of the first mains-operated wireless receiver; but thenceforward his interest was centred on television, at that time in the early stages of its development. His first 30-line, scanning-disc system was completed in 1928. It was at about that time that he forecast the coming of synchronization by the application of pulses to a tuned oscillator in the receiver.

Under Barthélémy's direction, the Compagnie des Compteurs formed its Television Research Centre on the outskirts of Paris. Picture transmissions from this Centre enabled a highly successful public demonstration to be given in the theatre of the Ecole Supérieure d'Electricité on April 14th, 1931.

The Ministère des P.T.T. (which corresponds to the British G.P.O.) then began to take a real interest in television. Regular transmissions were started with equipment designed by Barthélémy, first with 30 lines, then progressively with 60, 90 and (in 1935) 180 lines, leading up to the adoption of 445-line standard in 1937.

In a remarkable demonstration at the Marigny Theatre in Paris in 1939 Barthélémy showed televised pictures on a screen with an area of 4 square metres.

The outbreak of the war put an end to the transmissions, but not to Barthélémy's activities. He went to work on the development of a new type of camera, using a slow-electron tube, and succeeded in producing a system with 1,000-line scanning and big-screen reproduction.

He was elected a Member of the Académie des Sciences in 1947 and on the very day of his death his promotion to the rank of Commander of the Legion of Honour was announced. The painful malady from which he suffered for more than 20 years never succeeded in damping his creative spirit, or in halting his persevering work.

TELEVISION OSCILLATOR RADIATION

AN investigation into the amount of radiation from the local oscillator of superheterodyne-type television receivers has recently been made under the auspices of B.R.E.M.A. As a result of this, the Executive Council of the Association has approved recommendations on limits for the radiation and on standardized methods of measurement.

When the fundamental, or a harmonic, of the frequency of the local oscillator falls in Band I the limits are 20 μV/m for direct radiation, 200 μV for aerial-terminal voltage and 500 μV for mains-borne interference. The same limits are tentatively recommended for Bands II and III. When the fundamental, or a harmonic, of the frequency of the local oscillator falls outside Bands I, II and III, the limit of 50 μV/m is recommended for frequencies up to 100 Mc/s and temporarily for higher frequencies also.

For the radiation test the receiver is connected to 10ft of aerial feeder terminated properly at its remote end. The measurement of field strength is made at a distance of 10 metres. The aerial-terminal voltage is measured across the aerial terminals when terminated by 75 Ω. Mains-borne interference is measured across a standard isolating unit connected in the supply leads.

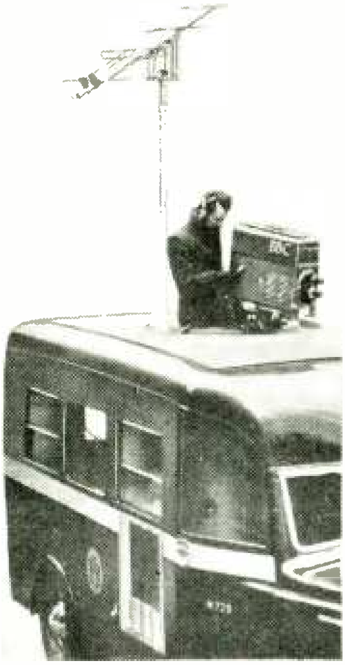
A few only of existing receivers seem to give lower interference figures than the proposed limits and some give much higher figures. Radiation figures as low as 5 μV/m and as high as 890 μV/m were found in the tests. The limit of 20 μV/m thus seems a reasonable one which should result in a considerable reduction of interference.

TECHNICAL WRITERS who, at a recent luncheon, were awarded 25-guinea premiums by the Radio Industry Council for articles published last year. Left to right, A. W. Keen (Coventry Technical College), Alan Brisbane (Enfield Technical College), A. H. Beck (Standard Telecommunication Laboratories), Joyce E. Seaborn (Ministry of Supply), H. M. Davis (Ministry of Supply), J. R. Pollard (Ericsson Telephones) and G. G. Gouriet (B.B.C. Research Deparment).

WORLD OF WIRELESS

P.O. Station Extensions • Set Makers' Problems

V.H.F. Stations • International Conferences



ROVING EYE.—The four-element Yagi array on this mobile B.B.C. television unit is controlled by a gyro-compass ensuring that the aerial is directed towards the receiving point while the van is moving. It operates in the 200-Mc/s band and in central London has a range of about two miles. The camera can be rotated through 360°.

Rugby Extensions

THE POST OFFICE STATION at Rugby was brought into service in 1925 with one long-wave telegraph transmitter, GBR, operating on 16 kc/s (18,750 metres). It now has three long-wave and 20 short-wave transmitters in addition to transmitters for the Standard Frequency Transmission Service (MSF) operated for the Department of Scientific and Industrial Research.

The need for still further services is to be partly met by a major expansion. An additional site of 700 acres (the original was 900 acres) has been acquired and a new building to house a further 28 short-wave transmitters is approaching completion. Twenty of them are expected to be in use by the end of the year. The transmitters are designed for multi-channel independent-sideband operation, which is now generally accepted for international radio-telephone services, and can alternatively be employed as multi-purpose transmitters catering for several types of telegraph service. The transmitters are rated at a peak envelope power of 30 kW and can be remotely controlled from a central control position.

Some 50 rhombic aerials between 600 and 1,000ft along the major diagonal are being erected at heights between 70 and 150ft. To cater for the variations in the optimum directions of transmission to New Zealand, which is nearly antipodal to Rugby, three steel masts 320ft high are being erected to support the aerial arrays for this service.

Set Makers' Report

IN ITS REVIEW of the past year the annual report of the British Radio Equipment Manufacturers' Association, which is of course concerned with the broadcast receiver side of the industry, covers exhaustively both the technical and organizational aspects of the year's work.

Many of the industry's problems have in the past been resolved as a result of the close liaison which has existed with the B.B.C. The proposed setting up of the Independent Television Authority to provide an alternative television programme introduces new problems. Many of the technical problems will be common to both organizations and B.R.E.M.A. has, therefore, submitted to the Government a recommendation that a central body with which the industry can deal be appointed. The Association has set up a Colour Television Sub-Committee to make a broad survey of possible systems, for "better and more practicable colour systems [than N.T.S.C.] are not impossible."

F.M. Transmitters

FIFTY frequency-modulated transmitters (26 Marconi and 24 S.T.C.) have been ordered by the B.B.C. in readiness for the Government's "go ahead" on setting up a v.h.f. chain. No details are officially available regarding the location of the transmitters but the P.M.G. has stated that the first station will be erected at Pontop Pike, Newcastle.

The transmitters, which will operate in parallel pairs, each pair handling one programme, vary in power from 1 to 10 kW. It is understood delivery will begin in about 12 months' time.

Aeronautical Communications

TECHNICAL REPRESENTATIVES of 25 countries are meeting in Montreal for the fifth session of the Communications Division of the International Civil Aviation Organization. Among the various items on the agenda are long-range navigational aids, secondary radar, methods of improving air-to-ground communications and the testing of navigational aids. There will also be a review of frequency and fixed telecommunications problems.

The United Kingdom delegation includes representatives of the Post Office, the Ministry of Transport and Civil Aviation and the radio communication industry. Among the industry's representatives, some of whom are attending as observers and not as official delegates, are K. E. Harris (Cossor), E. R. Bonner (Decca), W. H. Thompson (Ferranti), L. M. Layzell (International Aeradio), Dr. B. J. O'Kane (Marconi's), G. L. Warner (S.T.C.) and H. G. Sturgeon (Ultra). The delegation is led by J. C. Farmer, deputy director of telecommunications in the M.T.C.A.

International Television

DELEGATES from Belgium, Denmark, West Germany, Italy, Netherlands, Switzerland, United Kingdom and Yugoslavia recently met in Cologne as a working party of the European Broadcasting Union to discuss the technical problems relating to international television relays. They were particularly concerned with the series of relays planned for June and July. Decisions were arrived at regarding tolerances, shape of the sync signals and methods of testing. An *ad-hoc* group of engineers under M. J. L. Pulling (B.B.C.) is meeting programme representatives of the various participating countries at Cannes at the end of March to make final arrangements.

The working party concerned with v.h.f. and u.h.f. sound and television broadcasting also met in Cologne with delegates from seven of the countries (the U.K. was not represented).

During the meeting the German authorities demonstrated the prototype of a simple frequency changing television transmitter for use at satellite stations to provide a strong signal in Bands 4 or 5 in towns where reception of Band 3 transmissions is impracticable without a complicated aerial. By utilizing the double superheterodyne principle the received signal is converted into the desired band without demodulation and without separating the sound and vision components. An adaptor for use with standard television receivers was also demonstrated.

R.E.C.M.F. Report

TWO annual radio shows—one public and one industrial—are suggested by the Radio and Electronic Component Manufacturers' Federation in its 21st annual report. The National Radio Show would cater for all domestic equipment, and a "National Electronic Show" would serve the heavy equipment and professional field. The two shows might even be housed under one roof or at least run concurrently.

In its review of the export market the report records that India was again the principal customer for British radio components, followed by Australia and the U.S.A. A feature of the 1953 exports was the volume of sound recording and reproducing equipment sold.

In the section dealing with the technical activities of the Federation it is recorded that the British Standard defining conditions for the climatic and durability testing of components is in the hands of the printers.

Industrial Electronics

SOME 30 PAPERS will be presented at the Industrial Electronics Convention being organized by the British Institution of Radio Engineers from July 8th to 12th in Christ Church, Oxford University. The programme is divided into six sessions:—(1) Industrial Applications of Electronic Computors (chairman L. H. Bedford); (2) Industrial Applications of X-rays and Ultrasonics; (3) Nucleonic Instrumentation and Application (chairman N. C. Robertson); (4) Electronic Sensing Devices—Transducers (Professor E. E. Zepler); (5) Actuators (J. L. Thompson) and (6) discussion on How Electronics Can Increase Production.

Particulars of the programme and registration forms are obtainable from 9, Bedford Square, London, W.C.1. The fee for the convention, exclusive of accommodation, is 9 guineas.

P.A. Show

SOUND REPRODUCING and recording gear will be shown by twenty manufacturers at the two-day exhibition sponsored by the Association of Public Address Engineers which opens at the Horseshoe Hotel, Tottenham Court Road, London, W.1, at 10.0 on April 28th. Admission to the show, which closes at 8.0 on the first day and at 6.0 on the second day, is by ticket, obtainable from the Association, or on the production of this issue of *Wireless World*. The exhibitors include:—Film Industries, G.E.C., Goodmans, Grampian, Leak, Lowther, Lustraphone, M.S.S., Mullard, N.S.R. Manufacturing, Pamphonic, Reosound, Reslosound, Rola Celestion, Trix, Truvox, Vitavox and Whiteley.

Physical Society Show

THE 38TH annual exhibition of scientific instruments and apparatus organized by the Physical Society opens at the Imperial College, Imperial Institute Road, London, S.W.7, on April 8th for five days. It opens daily at 10.0 and will close at 8.0 on the 8th, 9th and 12th, and at 5.0 on the 10th and 13th. Admission is by ticket, valid for a specific session or day, obtainable free from the Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7. We hope to survey in a forthcoming issue of *Wireless World* the electronic techniques in research and measurement portrayed at the exhibition.

During the show a series of lectures will be given. The Acoustics Group of the Society has arranged a symposium on "Analysis, Synthesis and Recognition of Speech." This will be held in the Imperial College on April 12th under the chairmanship of Dr. Colin Cherry. Copies of the six papers to be delivered during the two sessions (2.0-5.45 and 6.45-8.15) are obtainable beforehand by those applying to the Society for tickets.

PERSONALITIES

J. A. Saxton, D.Sc., Ph.D., M.I.E.E., author of the article in this issue on the propagation of television, graduated in physics in 1935 at the Imperial College of Science and Technology, and in 1938, after serving on the staff of the Physics Department of the College, joined the Department of Scientific and Industrial Research. For the past 16 years he has been mainly concerned with research on various aspects of radio wave propagation, particularly at very high frequencies. Dr. Saxton is now a principal scientific officer in the Radio Research Organization of D.S.I.R. He has twice been seconded to the United Kingdom Scientific Mission, Washington, in 1945 and 1950, to act as radio-physics liaison officer for the Mission.

P. E. Pollard, O.B.E., B.Sc., has been appointed Director (Guided Weapons and Electronics) Technical Services of the British Joint Services Mission in Washington. Trained as a physicist under Professor (now Sir Edward) Appleton at King's College, London, he has been in the Scientific Civil Service throughout his working career and was for six years, from 1947, chief superintendent of the Radar Research and Development Establishment, Malvern. Mr. Pollard was among the 21 successful claimants for awards to radar pioneers made by the Royal Commission on Awards to Inventors two years ago. His claim was in respect of radar ranging systems and radar beacons.

As announced last month, the Royal Commission on Awards to Inventors recommended awards totalling £15,000 to seven claimants in respect of their work on the development of the proximity fuze. **H. Cobden Turner**, M.I.E.E., managing director of Salford Electrical Instruments and its subsidiary, British Ferrocart, Ltd., who shares £11,500 with three other claimants, joined the G.E.C. as an apprentice after gaining a diploma in engineering at the Manchester College of Technology. He subsequently went to Ferranti and later became chief designer with the Electrical Apparatus Company before joining Salford Electrical Instruments.

W. B. H. Lord, M.A., M.Sc., one of the four who share the £11,500 award, was a radio engineer with Salford's, but is now a principal scientific officer at the Atomic Weapons Research Establishment, Aldermaston. During part of the war he was with the Inter-Services Research Bureau. Mr. Lord has held an amateur transmitting licence (G5NU) since 1935.

G. M. Tomlin, M.B.E., and **L. Rollin,** who also share the above award, both received their technical education at the Manchester College of Technology. Mr. Tomlin was employed on radio and television research and development with Ferranti at Moston, from 1932 until 1938, when he joined Salford Electrical Instruments. Mr. Rollin joined the staff of Salford's in 1939 on leaving Philco's. He has recently been in charge of research and development of quartz crystal and magnetic material.

Andrew Stratton, M.Sc., A.M.I.E.E., F.Inst.P., recipient of a £2,000 award from the Royal Commission on Awards to Inventors, graduated from University College, Exeter, in 1939, and has been head of the proximity fuze section of the Armament Department of the Royal Aircraft Establishment, Farnborough, since 1945. He joined the R.A.F. Air Defence Department in 1939 and worked on proximity fuzes under N. Coles and G. A. Whitfield, who each received an award of £750. Mr. Stratton's work on the fuze resulted in the invention of a new form of oscillator detector system for radio fuzes and in 1942-43 he spent six months at the National Bureau of Standards, Washington, introducing this system into American fuzes.

M. M. Macqueen, manager of the Radio and Television Department of the General Electric Company, is on a month's visit to the U.S.A. to examine American electronic developments, including colour television. He has been elected chairman of the Council of the British Radio Equipment Manufacturers' Association for 1954.

J. de Gruchy, contributor of the article on the protection of meters in our September, 1953, issue, has left the Electrical Apparatus Company, of St. Albans, Herts, where he was head of the Instrument Department, and has started his own company. Among the equipment being produced by the new company—the Clare Instrument Company, Rickmansworth, Herts—is the protected moving-coil microammeter described in the September issue.

S. J. Preston, M.A.(Cantab.), A.M.I.E.E., representative of E.M.I. on the Council of the Radio Communication and Electronic Engineering Association, has been elected vice-chairman of the Council for 1954. Mr. Preston is one of the chief executives of the E.M.I. Patent Department.

K. G. Thorne, A.M.I.E.E., A.M.Brit.I.R.E., chief engineer of S. Smith and Sons (Radiomobile), Ltd., since the company commenced marketing operations in 1946, has resigned to take up an electronics appointment with the Canadian Government. He is succeeded by **W. A. Crossland, A.M.I.E.E., A.M.Brit.I.R.E.,** service manager for the past three and a half years. **H. M. Mellor** has been appointed service manager with the company, which is owned jointly by the Gramophone Company and Smiths Motor Accessories.

D. C. Espley, O.B.E., D.Eng., M.I.E.E., chief engineer (telecommunications), G.E.C. Research Laboratories, Wembley, was recently elected a Fellow of the American Institute of Radio Engineers "for his creative contributions to microwave and television techniques in England."

IN BRIEF

The **Three-million Mark** in television licences in the United Kingdom was passed in January; the total at the end of the month being 3,105,644. There was a record increase of 148,798 during the month. The total number of broadcast receiving licences (both for sound and television) at the end of January was 13,315,969, including 221,458 for car radio sets.

Royal Signals Institution.—Readers who have held commissions in the Royal Signals may be interested to know that a Royal Signals Institution has been formed to further the professional and technical interests of the Corps, and maintain contact with those no longer serving. Membership is open to all serving and ex-officers of Royal Signals in the British and Commonwealth forces. The subscription is 15s a year. Full particulars, and application forms for membership, can be obtained from the honorary secretary, Lt.-Col. N. G. Newell, Ministry of Supply, Room 419, Castlewood House, 77/91, New Oxford Street, London, W.C.1.

Colour Television.—Applications for attendance at G. G. Gouriet's Fleming Memorial Lecture on "Colour Television" in February were such that the Television Society has arranged for it to be repeated on April 13th and 15th at the Institute of Education, Senate House, Malet Street, London, W.C.1. Admission to the two meetings, which are complementary, is by ticket costing 5s, obtainable from the Society, 164, Shaftesbury Avenue, London, W.C.2. The lectures will begin at 7.0.

B.R.E.M.A. Council.—The following member firms of the British Radio Equipment Manufacturers' Association have been elected to the executive council for the ensuing year. The names of the companies' representatives are in parentheses:—Balcombe (E. K. Balcombe); Bush (G. Darnley Smith); Cole (G. W. Godfrey); Cossor (J. S. Clark); English Electric (D. C. Spink); Ferguson (L. Bentley-Jones); G.E.C. (M. M. Macqueen, chairman); Gramophone Co. (F. W. Perks); Kolster-Brandes (P. H. Spagnoletti); Philips (A. L. Sutherland); Pilot (H. L. Levy) and Ultra (E. E. Rosen).

R.E.C.M.F. Council.—The member firms and their representatives constituting the Council of the Radio and Electronic Component Manufacturers' Federation for 1954 are: Automatic Coil Winder (R. E. Hill); British Moulded Plastics (J. H. Bridge); Garrard (Hector V. Slade); Hunt (S. H. Brewell); Multicore (R. Arbib); N.S.F. (K. Graham Smith); Painton (C. M. Benham, vice chairman); Reliance Electrical Wire (C. H. Davis); Telegraph Construction & Maintenance (W. F. Randall, chairman).

Semiconductors.—An international conference on semiconductors is to be held in Amsterdam from June 29th to July 3rd by the Netherlands Physical Society. Admittance to the conference, which is being supported by U.N.E.S.C.O. and the International Union of Pure and Applied Physics, is free and applications for participation should be made to Dr. H. J. Vink, Floralaan 142, Eindhoven, Holland. The subjects to be considered include bulk and surface properties, intermetallic compounds, photoconductivity and the application of general physical and chemical laws for the preparation of semiconductors with specific properties.

Radio Heating and industrial electronic measuring instruments are featured in a new film on the application of electrical and electronic aids to industry. Entitled "A New Approach to Production Improvement," it runs for 50 minutes and can be borrowed free of charge by engineering societies, technical colleges, etc., from Philips Industrial Application Centre, 122, Brixton Hill, London, S.W.2.

Radio-Controlled Models.—The annual international contests for radio-controlled models, organized by the International Radio Controlled Models Society, will be held in Birmingham on July 10th and 11th. The first day will be devoted to contests for model boats and the second for model aircraft. Entrance forms and further particulars are obtainable from H. Croucher, 27, St. John's Road, Sparkhill, Birmingham, 11.

Abstracts and References.—Each month some 300 abstracts from and references to articles appearing in the world's technical press are published in our sister journal *Wireless Engineer.* The index to those published in 1953 was included as a supplement to the March issue, which is obtainable from our Publisher price 6s 6d.

"Trader Year Book."—The 1954 edition of this mine of information on radio trade and servicing matters has just been issued by the Trader Publishing Company. In addition to directories of manufacturers, wholesalers and proprietary names, it includes tables of i.f. values of sound receivers marketed since 1947, condensed specifications of some 550 current sound and vision receivers and valve and c.r.t. data. It costs 11s by post.

INDUSTRIAL NEWS

Baird Television, Ltd., has amalgamated with the Hartley group of companies and will now be known as Hartley Baird, Ltd. It will continue to produce Baird television receivers. The Hartley group includes Hartley

Electromotives, Ltd., designers and manufacturers of electronic equipment and instruments, with a factory at Shrewsbury, Shropshire, and Duratube & Wire, Ltd. A. W. M. Hartley, managing director of the Hartley group, will be managing director of Baird's and Sir Charles King will continue as chairman.

Hunt Capacitors (Canada), Ltd., has been formed, with K. A. Jackson, formerly of the Canadian Marconi Company, as general manager and R. A. Grouse, of A. H. Hunt, Ltd., as technical director, to manufacture capacitors for the Canadian market. The products of the new company, which has its works at Ajax, Ontario, will be marketed by the Electronic Tube and Components Division of the Canadian Marconi Company, Toronto.

Transradio, Ltd., claims to be the first British component manufacturer to exhibit at the Radio Engineering Show in New York, which was held this year from March 22nd to 25th. The managing director, B. Zucker, and the sales manager, N. Stephenson, attended the show, where their sub-miniature connectors and high-impedance precision connectors were featured.

Marconi Instruments, Ltd., have added a new wing to their factory at Longacres, St. Albans, Herts. It has more than trebled its size since the company's works were centralized there some seven years ago.

Dollar Order.—B.T-H., Ferranti and G.E.C. share an order for $6.5M worth of electronic equipment and associated test gear from the U.S. Navy Department. The equipment will be installed in ships and ground stations as part of the defence programme of the North Atlantic Treaty Organization.

Trinity House Pilotage Service is being equipped with Pye v.h.f. radio-telephone gear by **Rees Mace Marine** to facilitate boarding and pilotage information being passed to pilot vessels in the Dungeness, Dover and Harwich areas. Shore stations are being installed at Harwich and Dover and six vessels are being equipped.

J. & S. King, of 210, Lillie Road, Fulham, London, S.W.6, point out that they were operating a comprehensive television maintenance scheme in 1948, which was two years earlier than implied in our note on "C.R.T. Insurance" in the December issue.

The Sales Department of **Invicta Radio, Ltd.**, has moved from the head office to 100, Great Portland Street, London, W.1. (Tel.: Langham 5742.)

MEETINGS.—Details of the April meetings will be found on page 201.

BAND III TEST TRANSMITTER

THE B.B.C.'s plans for an alternative television service in the v.h.f.-u.h.f. region have recently taken a more practical turn. The Corporation has ordered from Mullard six low-power transmitters for experimental work (notably field-strength measurements) in Bands III, IV and V, and the first of these, for Band III, has now been completed.

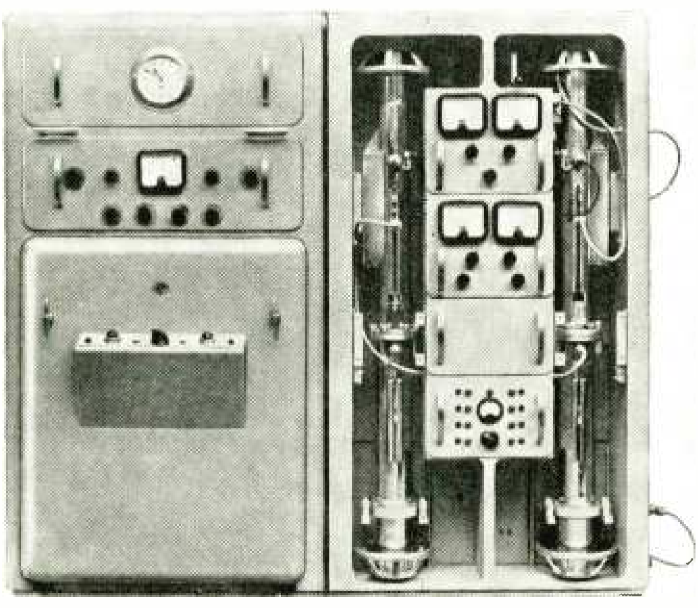
This transmitter, like all the others, is designed to be continuously tunable over the whole of its band—in this case from 174 Mc/s to 216 Mc/s Coaxial resonant lines are used in the last two stages, with the valves inside them, and the tuning is done by winding plungers up and down to vary their effective lengths.

Provision is made for two types of modulation. The first is a square wave of 1,000-c/s repetition frequency, and this gives 100 per cent modulation with a peak power output of 600 watts. (On plain c.w. the r.m.s. power output is 150 watts.) The second type of modulation is a 0.5-μsec pulse, also of 1,000-c/s repetition frequency, which gives a peak power output of 15-18 kW. With these very short pulses it will be possible to investigate the effects of echoes and multi-path transmission. Both sources of modulation are crystal controlled and a quick change-over can be made from one to the other.

On narrow-pulse modulation the output stage (which uses an earthed-grid triode) is operated in a self-oscillating condition. This is obtained by inserting a feedback connection between anode and cathode in the form of a short cylinder round the valve.

The equipment is constructed on the unit principle and is intended to be carried about in a van. It will cope with large variations in mains supply voltage and is designed so that routine measurements at different frequencies can be made by non-technical operators.

The transmitters for Bands IV and V will be similar, but will include additional drive units and the output powers will be lower. On c.w. the outputs will be 100 W and 50 W respectively and when modulated will be proportionately lower than in the Band III model.



Complete v.h.f. transmitter with front cover of the right-hand unit removed. The coaxial lines for the r.f. drive and the amplifier can be seen on the left and right of the panels. The upper parts of the lines can be raised by a hydraulic lift for valve removal.

The Transistor in Hearing Aids

2.—*Design for Use with RC Couplings Throughout*

By S. KELLY*

IN a previous article[1] the writer described experiments with junction transistors. At that time the only transistors available in this country were imported from the United States of America. It was therefore principally a matter of economics to design an amplifier with a maximum possible overall gain using the minimum number of transistors. Recently, British-produced junction transistors have been made available in experimental quantities, and the present dissertation gives the results of some experiments with the Mullard transistors Type OC10, OC11 and OC12. The OC10 transistor is a low-noise *p-n-p* type unit for use in the initial stage, the OC11 is an intermediate amplifying unit, and the OC12 is for use in the output stage. In common with other types of germanium transistors they are temperature sensitive and the parameters are subject to the normal amount of spread. The temperature limitation is 45 deg C and in the writer's experience no germanium transistors, either American or British, currently available for civilian use will withstand temperatures much in excess of 45 deg C at 95-97 per cent humidity for any period of time. The fact that home-produced transistors were available at something less than a king's ransom encouraged the writer to construct a second amplifier which would, as far as possible, eliminate the defects of the original unit.

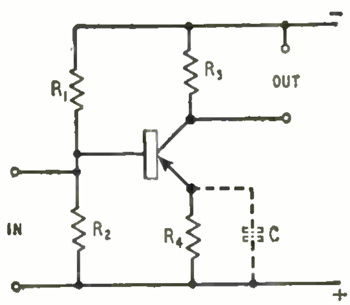


Fig. 1. Basic earthed-emitter circuit.

Cascading Transistors.—Transistors can be used in either earthed base, earthed emitter or earthed collector configurations, and when several stages are connected together the overall power gain will be a function of the individual circuit arrangements. There are nine combinations for two transistors. In practice the most efficient arrangement is earthed-emitter to earthed-emitter, which results in high voltage, current, and power gains. The earthed-base to earthed-emitter is a second best for power gain, but the input impedance is usually fairly low. The third best arrangement is earthed-collector to earthed-emitter; it has good voltage and power gain, and the very high input impedance is advantageous for use with crystal microphones, pickups or other high-impedance devices. The other combinations are seldom used in practice, but when both *n-p-n* and *p-n-p* junction transistors are available, unique circuit arrangements will be possible; by cascading *n-p-n* and *p-n-p* units together complementary symmetry can be obtained. This may be defined as (1) under normal working conditions the current of the *n-p-n* transistor will be negative of the corresponding electrode current of the *p-n-p*, and (2) the polarity of an input signal will be opposite in each transistor with the same increase of output current. Under small signal conditions the equivalent circuits of the two types of transistors are identical; the major advantages to be gained by using these symmetrical circuits is in the biasing arrangements, in that if the first transistor (say *n-p-n*) is stabilized the succeeding stage (*p-n-p*), which is d.c. coupled to it, is also stabilized. This results in a considerable economy of components and at the same time makes for very stable operation.

Circuit Requirements. — The amplifier previously described suffered from two disadvantages:

(1) The miniature transformers used had, of necessity, a poor low-frequency response due to the small amounts of iron and copper. This in itself is not a disadvantage for hearing-aid amplifiers in which bass cut is deliberately introduced, but for other applications it could prove a serious obstacle. The solution is to use (a) larger transformers with their attendant disadvantages of increased weight, volume and cost, or (b) RC coupling which requires more transistors. The final solution will be determined by the ratio of transistor to transformer cost, availability and space considerations, and strictly comes under the heading of Production Engineering.

(2) Variation of individual transistor parameters. This is a serious problem, especially in the output stage. If the base resistor (we are now assuming earthed-emitter circuits) is adjusted to give a collector current of, say, 2 mA with a particular transistor, it will be found that the collector current will vary from about 1.4 to 4 mA with different transistors, due principally to the variation in base current of individual transistors. If steps are not taken to reduce this variation, provision must be made for varying the base resistor for each individual transistor, with all its complications of maintenance and servicing. The same is true of the early stages, although to a lesser extent.

In order to use transistors successfully the maximum effective variation of gain and collector current at a given supply voltage should not exceed 10 per cent for a change of any individual transistor. In other words, taking the top and bottom limits for a particular type of transistor, they should be success-

* Cosmocord, Ltd.
[1] *Wireless World*, Feb., 1954, p. 56.

fully interchanged with a variation of collector current and gain not exceeding ±10 per cent.

Earthed Emitter.—The collector current is almost independent of collector voltage and is determined by the emitter current; the emitter current in turn is determined by the bias applied to the base. The problem then resolves itself in rendering the circuit constants independent of transistor variations, and the simplest way of doing this is the application of negative feedback. This is most easily obtained by fitting a resistance between the emitter and earth[2].

The base voltage in the circuit of Fig. 1 is controlled by the potential divider R_1 and R_2, the emitter current by R_1, output being taken across R_3. The collector current and load impedance will be specified on the transistor data sheet, and the value of R_1 will be determined by the ratio of stabilization required. This has been provisionally set at ±10 per cent.

To meet the above stability specification in the output stage, R_1 should be of such a value that approximately 30 per cent of the available supply voltage is dropped across it, and the value of 680 Ω is about right. R_3 is the d.c. resistance of the load impedance and it is usual for insert telephone receivers to be fed directly from the output transistor rather than from a transformer. These telephone receivers have a polarized connecting plug in order that the magnetizing current will always be in the correct direction, a d.c. resistance of about 300 Ω and a nominal impedance at 1,000 c/s of between 1,000 and 1,250 Ω.

The type OC12 transistor requires a collector current of 2 mA for a collector to emitter voltage

[2] See "Transistors," Part 6, by Thomas Roddam, *Wireless World*, July, 1953.

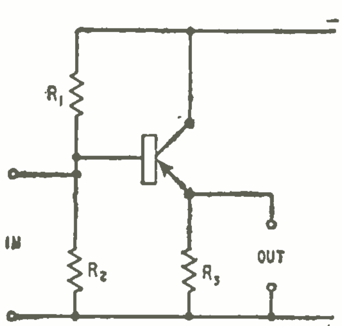
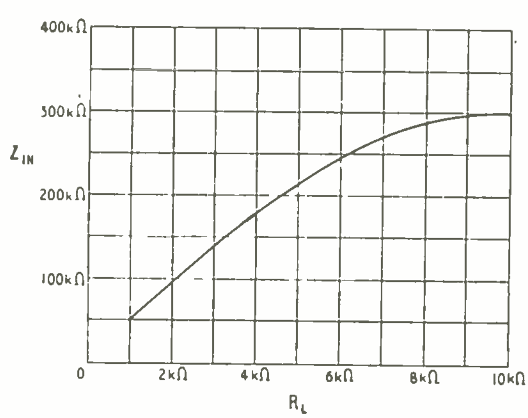


Fig. 2. (Left) Earthed-collector circuit with output taken from emitter, used as an impedance transforming device.

Fig. 3. (Below) Variation of input impedance with output load in the circuit of Fig. 2.



of 2.4. Under these circumstances the power output will be 2 mW. It will be seen that the total battery voltage to provide this will be 4.5, of which 1.5 will be dissipated across R_1. The base potential is obtained by R_1 and R_2 (33 kΩ and 47 kΩ) and they should be so proportioned that the base potential is substantially the same as the emitter potential (this being obtained from R_1 and the emitter current). Ideally, changing current should not affect the base potential, but this would require impossibly low values of resistance, and the increase in current drain is not justified by the slight increase in stability against the values quoted. Additionally, R_1 and R_2 (in parallel) are also in parallel with the a.c. input impedance of the stage and in the interest of maximum gain should be made as high as possible. Because the voltage across R_1 is in phase with the input voltage, severe degeneration will take place and the gain of the stage will be reduced from approximately 26 db to 10 db. R_1 is therefore bypassed to a.c. by means of a condenser C, its value being made so large that the total impedance is negligible over the operating range of frequencies.

In a practical case six OC12 transistors had a nominal collector variation of 1.4 to 4 mA at 3 V emitter-to-collector potential when the base was fed through a 0.5 mΩ resistance; with stabilization the variation in base current was 36-42 μA, and the variation in collector current 1.85 to 2.1 mA. The 1,000 c/s gain was within the limits of 23-26 db with C equal to 6 μF. The input impedance of the stage was 12,000 Ω without the bypass condenser and 4,000 Ω with it.

The treatment for the preceding stages is the same, except that the emitter load resistance is adjusted to a value equal to that of the collector load resistance. If more gain is required for a given battery potential the emitter load resistance can be reduced (this will of course require an alteration in the value of the potential divider R_1 and R_2) but the increased gain will be obtained at the expense of stability. OC11 transistors were used in these stages and their optimum load impedance is 20,000 Ω. It will be seen that the transistors T2 and T3 of Fig. 4 will not be working into their optimum load. Thus the power gain will be reduced below optimum by about 7 db, but, as stated before, this reduction in gain must be balanced against the increased cost of coupling transformers.

Earthed Collector.—The input impedance of a transistor in the earthed-emitter configuration is quite low, usually between 800 and 4,000 Ω. If the amplifier is to be used with a high-impedance input a matching network must be used. A transformer will give optimum power transfer, but a resistance network is more simple and less costly, and also very wasteful in gain. Crystal microphones specifically designed for use with transistor hearing aids have a source capacity of approximately 2,000 pF, and if the a.f. cut-off −3 db point at 750 c/s is accepted the input impedance of the amplifier should be of the order of 100,000 Ω. This value can easily be obtained by feeding the earthed-collector transistor into an earthed-emitter stage. The earthed-collector transistor behaves in a manner somewhat analogous to a cathode follower valve and can be used successfully as an impedance transforming device. Fig. 2 shows the basic circuit, in which degeneration is obtained by means of R_3. R_1 and R_2 are in parallel with the input impedance. Fig. 3 shows the variation of input

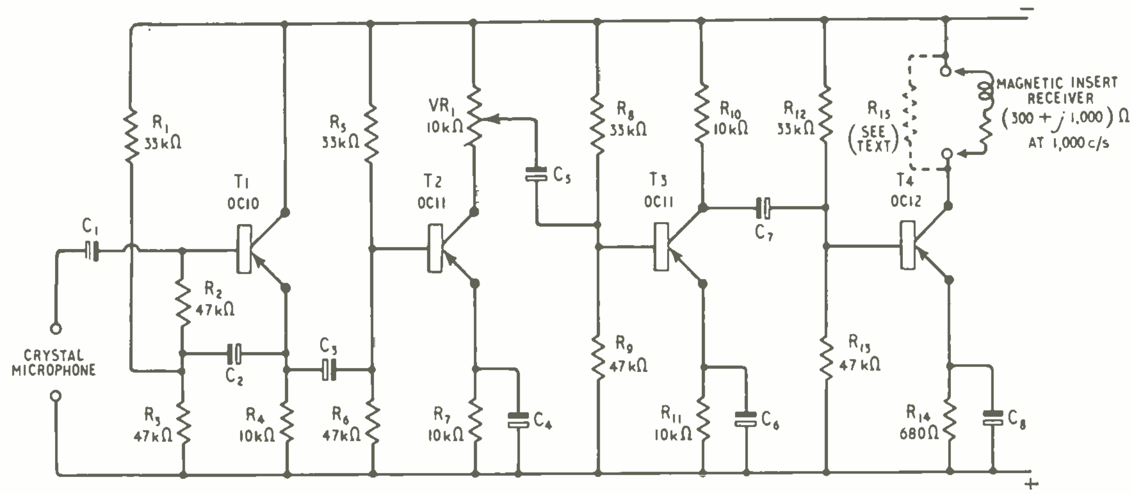


Fig. 4. Experimental four-stage transistor hearing aid with RC coupling throughout. C_1–C_8 inclusive are miniature 8 μF, 6–V d.c. working capacitors.

impedance against load impedance of this network, the effects of R$_1$ and R$_2$ being neglected.

In the practical circuit (T1 of Fig. 4) direct-current stabilization is employed as in earthed-emitter circuits. The voltage gain is very near unity, particularly when the supply voltage is made fairly high (8-10 V). Feedback is applied from the emitter to the base voltage divider to decrease the shunting effect of the divider. With selected transistors, an input impedance of 0.75 mΩ has been obtained in the audio range, although this input impedance is a function of frequency, decreasing with increasing frequency. Decreasing the load resistance will decrease the voltage gain, the internal transistor feedback, and also the external feedback of the voltage divider via C$_2$ of Fig. 4, and with the output short-circuited the input resistance is of the order of 200 Ω.

Practical Considerations.—Fig. 4 shows an experimental amplifier made in accordance with the above philosophy. It consists of one earthed-collector and three earthed-emitter stages. D.C. stabilization is obtained by means of resistances in the emitter circuits R$_4$, R$_7$, R$_{11}$ and R$_{14}$. The overall gain was measured on the set-up shown in Fig. 5. With a supply of 4.5 V, the gain figures obtained are plotted in Fig. 6, curve A being the power gain when the amplifier was fed from a source resistance of 100,000 Ω (R of Fig. 5) and fed into a 1,000-Ω insert telephone receiver. Curve C used the same input conditions as A, but with a 10-henry choke (d.c.R=300 Ω) shunted with a 1,000 Ω resistance. Curve B was with the amplifier fed from a condenser of 2,000 pF (C of Fig. 5). When used as a hearing aid with a crystal microphone the overall air-to-air gain of D, Fig. 6, was obtained. This compares quite favourably with equivalent valve units.

If further treble cut is required it is best to apply it by means of a condenser across VR$_1$ and extra bass cut can be obtained by reducing the values of C$_3$, C$_5$ and C$_7$. The overall noise of the amplifier was not measured, but when listened to against a standard valve hearing-aid unit of comparable gain, the noise was of the order of 8-10 db worse, and was equivalent to an ambient noise at the microphone face of about 40 phons.

Desirable additions to the amplifier for hearing-aid use would be automatic gain control. The overall gain is a function of the supply voltage and reducing this to 3 V reduces the gain by approximately 8 db, and increasing it to 8 V increases the gain by approximately 12 db.

The circuit is completely stable and no undue precautions were necessary in the layout, the system being laid on a small tag board almost identical in form to the circuit shown in Fig. 4. The transistors are provided with long leads to enable them to be

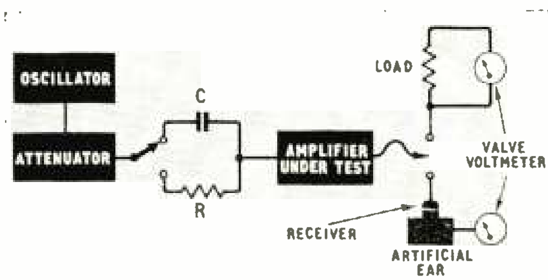


Fig. 5. Schematic diagram of apparatus for measuring circuit gain.

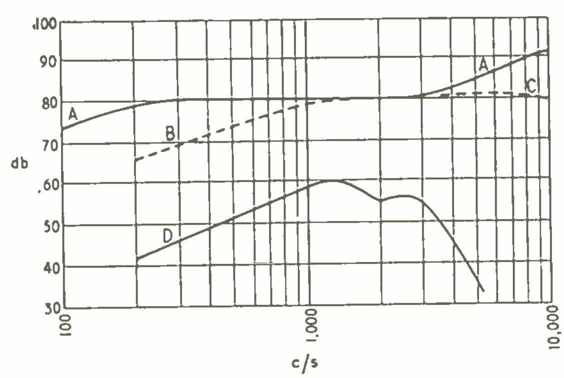
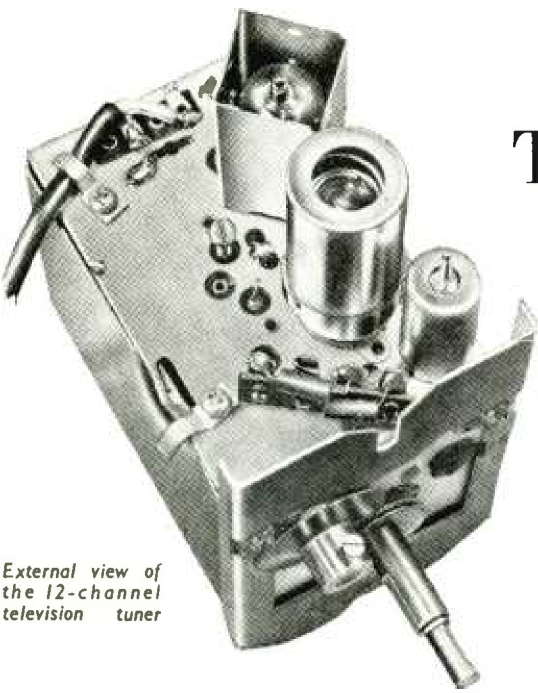


Fig. 6. Results of gain measurements made under conditions described in the text.

soldered directly into the circuit and manufacturers state that a thermal shunt must be used if this is done.

After the writer had wrecked two transistors, due presumably to an imperfect shunt, it was decided to use miniature valve sockets instead, the length of the transistor leads being cut to approximately ½in. This is a much more satisfactory proposition, because the transistors can be quickly plugged in and out for test purposes, and there is no danger of the transistor being damaged when circuit modifications are made. Occasionally a transistor was plugged in the wrong way round. This was immediately apparent by loss of gain, but no irreparable damage seems to have been done to them, both noise figures and overall gain being normal when the transistor was reconnected correctly.

Since these experiments were completed we have been informed that the transistors OC10, OC11 and OC12 will be superseded in the near future by glass-encased, hermetically sealed transistors, types OC70 and OC71. These are germanium-type *p-n-p* transistors, and whilst the temperature limitation of 45 deg C will still apply, they should be proof against humidity, and give satisfactory service under tropical conditions. Additionally, the signal-to-noise factor has been considerably improved. The design parameters are somewhat different from those of the previous types and may call for modifications in the values of components shown in Fig. 4.



External view of the 12-channel television tuner

12-Channel Television Tuner

Covering Bands I and III

THIS tuner, which is being fitted to the current production Pye sets, gives 12 channels with switch selection. It comprises a signal-frequency amplifier and a frequency changer and provides an output at intermediate frequency. Five of the 12 switch positions are for Band I and seven for Band III. There is actually room in Band III for eight channels and provision is made for the missing channel to be at either end; that is, by an adjustment, the tuner can be made to cover channels 1-12 inclusive or 1-5 and 7-13. A trimmer, with its control knob mounted concentrically

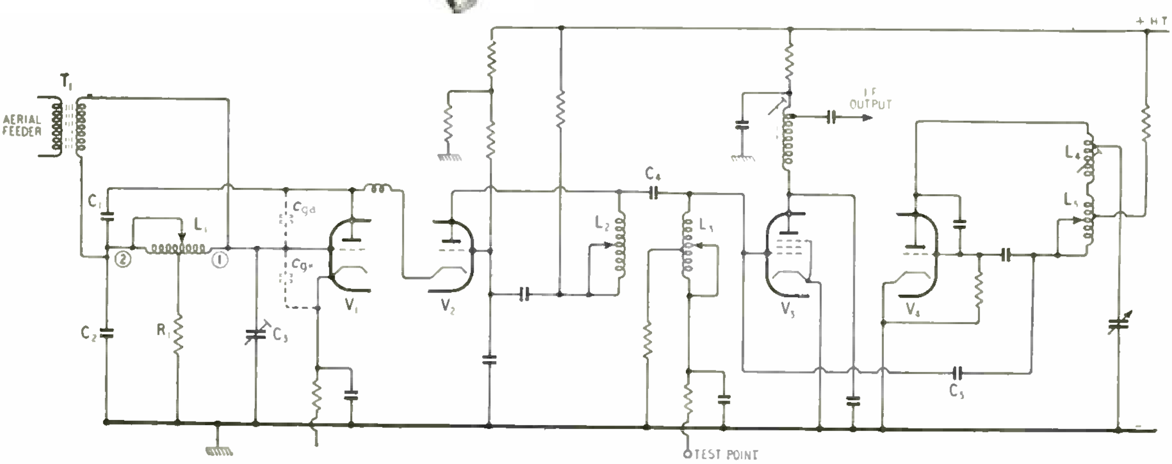


Fig. 1. Simplified circuit diagram of the Pye two-band television tuner.

with the switch knob, is provided in the oscillator circuit.

A simplified circuit diagram of the tuner is shown in Fig. 1. A double-triode cascode r.f. stage is used with a PCC84 valve. This is well known to be advantageous from the point of view of signal/noise ratio, because valve noise is inherently less with a triode than with a pentode, other things being equal.

The first section V_1 is used as a neutralized earthed-cathode stage. The valve capacitances c_{ga} and c_{gk} (supplemented by the adjustable C_3) form two bridge arms and C_1 and C_2 form the other two. The switched coil L_1 is across one diagonal of the bridge, and the anode-cathode path of the valve is across the other, so that the two are quite effectively isolated.

The input signal from the aerial is brought in by a coaxial feeder to the transformer T_1 which functions on all bands. Its secondary is connected across the tuning coil which is switched for channel selection. Actually, all coils are connected in series and the selector-switch arm short-circuits the unwanted coils. The arrangement for the input tuned circuit is shown in detail in Fig. 2; the numbers against the switch contacts are the channel numbers.

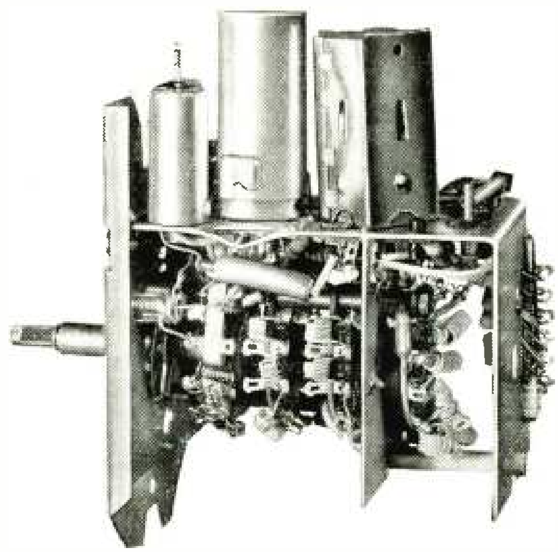
On channel 12, the coil L′ is the only one in circuit. It actually is a coil, for it has some five turns of wire and is nearly three-quarters of an inch long and a bit over one-eighth of an inch diameter. It tunes to around 200 Mc/s with the circuit stray capacitance.

For channel 11, 5 Mc/s lower in frequency, the switch is in position 11 and the inductance L″ is added. This is only an incremental inductance to shift the frequency a matter of 5 parts in 200; the required change of inductance is of the order of 1 part in 80 and is exceedingly small. The inductance of a piece of wire joining adjacent switch contacts is too great! L″ is provided by such a short-circuit between contacts with an additional parallel loop of wire, movement of which acts as a pre-set inductance control. The other incremental "coils" for channels 6-10 are similar, since each has to shift the resonance frequency by 5 Mc/s.

Loading coils are used for the lower frequencies of Band I and are relatively very large, especially the one between contacts 5 and 6 which has to lower the frequency from some 180 Mc/s to 66 Mc/s. The remaining Band I coils are smaller than this for, again, they must shift frequency in 5-Mc/s steps, but they are a good deal bigger than on Band III and increase as the frequency gets lower. They are, in fact, actually coils. The resistor R_1 is the d.c. grid-return path of the valve and R_2 provides damping for channel 1 only.

Returning to Fig. 1, the anode of V_1 is connected to the cathode of V_2 which functions as a triode earthed grid stage. This is the valve which provides the r.f. gain. It has a very low input impedance, being fed at the cathode, and so the first valve gives about unity gain only. The first valve is more an impedance converter for feeding the second valve than an amplifier. V_1 and V_2 must be considered together as forming a single amplifier stage.

The coupling to the frequency changer comprises a top-end capacitance-coupled pair of tuned circuits L_2 and L_3. The physical arrangement of this circuit is basically the same as in the case of L_1. There are basic inductances for channel 12 and the switches add incremental inductance for the lower-frequency channels. There are differences of detail, however; the damping resistors are not the same, additional



Tuner with cover removed showing Band I coils.

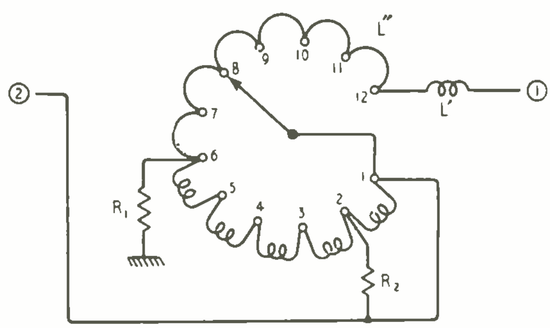


Fig. 2. Coil switching details of the aerial coil L_1 of Fig. 1.

coupling capacitance is brought in for Band I and certain individual sections of inductance are short-circuited to prevent unwanted absorption.

The mixer V_3 is the pentode section of a triode-pentode PCF80, the oscillator voltage being fed to the grid through C_5. Its anode coil is tuned to the intermediate frequency; it acts as step-down auto-transformer to match a coaxial cable which carries the i.f. signal to the i.f. amplifier on another chassis.

The oscillator is a triode V_4 operating above the signal frequency. The same basic switching arrangement is used for L_3, but the basic inductance L_4 for channel 12 is slightly different. It is tapped for the connection of a trimmer, which is a user control, and it has an adjustable slug by which the inductance can be readily adjusted by a screwdriver from outside the tuner.

This is done in order to permit a change to be made in the precise channels selected on Band III. By the adjustment of L_1, the oscillator can be shifted in frequency by 5 Mc/s—one channel—so that the top channel can be made 12 or 13 as required. On Band III all channels are similarly affected and so, according to how L_1 is set, the Band III channels are 6-12 or 7-13. The change is not enough to affect Band I appreciably. No change is made to the signal-frequency circuits, for they are flat enough to cover two channels.

The signal circuits are heavily damped by the valves and must, in any case, be wideband. The attainment of low losses is not a matter of great importance, therefore, and ordinary switch wafers are used. In the oscillator, however, losses are much more important and here a ceramic switch wafer is employed, and the coils are of a more robust design.

The unit is extraordinarily compact and the basic box measures only 4 1/16 in. deep × 3 in. high × 2 11/16 in. wide. Overall, the behind panel space need not exceed 5 in. deep × 6 in. high × 2 5/16 in. wide.

It is being fitted to the current Pye sets, as a unit separate from the main chassis. It is fixed to the side of the cabinet with the concentric controls coming out through the side. The rest of the receiver is conventional save that it starts with the r.f. amplifier and includes no r.f. or oscillator circuits.

The tuner can be fitted to certain existing Pye receivers—in the main, models for some two years back. This entails certain alterations, because the r.f. and frequency-changer circuits must be rendered inoperative.

The form of aerial necessary for two-band operation cannot, of course, be settled until a good deal more information is available about the siting of the stations, their power, and whether their radiation will be polarized vertically or horizontally. Probably several different forms will be needed to suit different receiving conditions. In the design of this tuner, it has been envisaged that whatever the form of the aerials and their feeder systems, they will be junctioned to a common feeder before the input so that the input will come in on a single cable. In some cases, quite separate aerials may be used for the two bands with separate feeders joining in a junction box near the set. In others, a combined aerial with a single feeder may be enough. This lies in the future and the most suitable form of aerial can hardly be settled until considerable experience has been gained under operating conditions. It is not, however, a matter which affects the tuner. The design which has been adopted enables any form of aerial system to be employed.

British Valve Bases

ON looking through the latest edition of the British Standard on valve bases (B.S. 448 : 1953) it comes as something of a shock to discover that there are at least 25 different types of bases in existence in this country, all with standard B.V.A. numbers like B5A and B7G.

From a purely superficial point of view, the Standard is worth studying, if only to discover what exactly are the rare birds that go under such unfamiliar names as B4F, B5D and B11A. It has a more serious purpose, however, which is given by the B.S.I. as "to schedule the agreed physical requirements for valve bases, caps and holders necessary to ensure both a good mechanical fit and a satisfactory electrical contact between mating parts." Drawings and tables of dimensions are given for each base type.

B.S. 448 : 1953 ("Electronic-Valve Bases, Caps and Holders") brings up to date the 1947 version of the Standard. It is issued in loose-leaf form in a binder so that new additions and amendments can be put in as they are published. It can be obtained from the British Standards Institution, British Standards House, 2, Park Street, London, W 1, price £1 2s 6d.

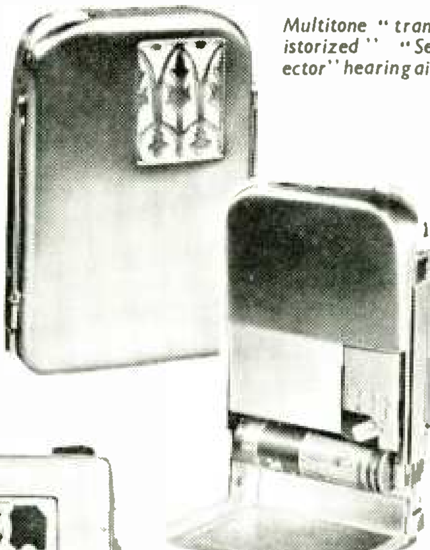
ALL-TRANSISTOR HEARING AIDS

FOUR stages with resistance coupling are used in the transistor version of the Multitone "Selector" hearing aid. The transistors are of the glass-sealed junction type, and a sensitivity comparable with a valve hearing aid is provided with a crystal microphone and a magnetic earpiece wound to match the output impedance.

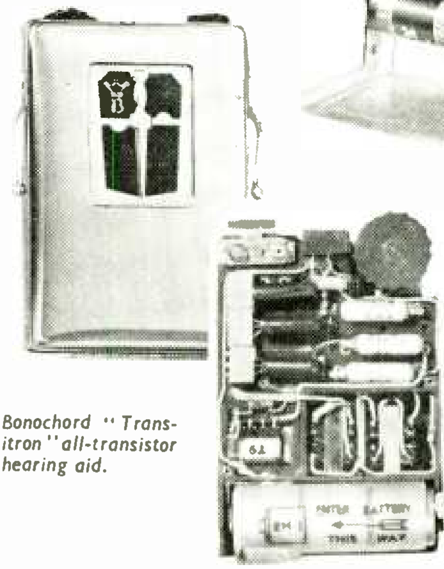
The total current consumption is 2.5mA from a single 1.5-V dry cell. Maximum power output is ample for the majority of cases, though less than with some valve hearing aids. Consequently, overload distortion must be guarded against, and to this end automatic volume control is incorporated, with three degrees of control and an "off" position. This arrangement gives complete freedom from irritating percussive effects, together with quality of reproduction which is better than that which one expects from a valve hearing aid.

Deliveries in the home market will increase as more of the glass-sealed junction transistors become available.

In the "Transitron" hearing aid, made by Bonochord, 48, Welbeck Street, London, W.1, there are three transformer-coupled transistor stages. The power output is variable, according to the number of battery cells used. Total current consumption is 2mA for 1.5V and 7.6mA for 4.5V, and according to the maker's figures the maximum air-to-air gain is 70db. Separate on-off and volume controls are provided and the polished stainless steel case measures 3¼in × 2¼in × ⅞in. The weight including battery is 4¾oz.



Multitone "transistorized" "Selector" hearing aid.



Bonochord "Transitron" all-transistor hearing aid.

Midget Sensitive T.R.F. Receiver

By J. L. OSBOURNE

Three-Valve Circuit with Amplified A.G.C.

THIS article describes a small t.r.f. receiver with a number of unusual features. It has high sensitivity, giving the standard output of 50 mW for an input of 70 μV modulated at 400 c/s to a depth of 30 per cent. This and the selectivity are adequate for the interference-free reception of a number of Continental stations in the London area in daylight. The set has an effective amplified a.g.c. circuit, and for a given gain-control setting the output volume from Hilversum on 402 metres is almost equal to that from the London Home Service transmitter. The volume control adjusts the input to the audio amplifier stages in the conventional manner, but in addition controls the degree of negative feedback, removing it entirely at the maximum setting.

Three B7G-based valves are used, a 6F33 as r.f. amplifier, a 6F12 as audio voltage amplifier and a second 6F12 as output valve. The detector is a crystal diode, the d.c. output of which is amplified by the first audio amplifier, and is then applied to the suppressor-grid of the r.f. amplifier to give a.g.c. The circuit was described by S. W. Amos and G. G. Johnstone on p. 417 of *Wireless World* for October, 1951.

One disadvantage of conventional r.f. amplifiers with grid and anode circuits resonating at approximately the same frequency is that the maximum gain available without instability is limited by the anode-grid capacitance of the valve and, in fact, it is often impossible to take full advantage of the high mutual conductances of valves and high dynamic impedances of tuned circuits for this reason. A numerical calculation will make this clear. The 6F33 has a mutual conductance of 4·3 mA/V and the dynamic impedance of the tuned circuits used in this receiver is approximately 300 kΩ at 1 Mc/s. The gain of a 6F33 with such a value of anode load is given approximately by $A = g_m R_d = 4{\cdot}3 \times 10^{-3} \times 300 \times 10^3 = 1300$ approximately. The maximum gain available from the valve without instability is given by

$$\frac{2}{\omega C_{ag} R_d}$$

in which C_{ag} is the anode-grid capacitance of the valve. This expression applies when the valve has identical tuned circuits in anode and grid circuits. For the 6F33 the anode-grid capacitance is 0·01 pF. Substituting for C_{ag} and R_d, the maximum gain available without instability at 1 Mc/s is given by

$$\frac{2}{6{\cdot}284 \times 10^6 \times 0{\cdot}01 \times 10^{-12} \times 300 \times 10^3}$$

$= 100$ times approximately.

Thus the valve is capable of more than 10 times the maximum gain which the anode-grid capacitance will allow. The full gain cannot be realized in practice, and since C_{ag} may possibly exceed 0·01 pF in a practical layout, it may be impossible even to achieve the calculated gain of 100 times without encountering sideband cutting due to regeneration if not actual oscillation.

This difficulty can be avoided and the maximum gain of 1,000 times realized with complete stability by the use of an aperiodic input circuit such as that shown in Fig. 1. The omission of the tuned circuit normally used in the grid circuit does not, in this instance, result in loss of selectivity because it was intended to use only two tuned circuits (a 3-gang

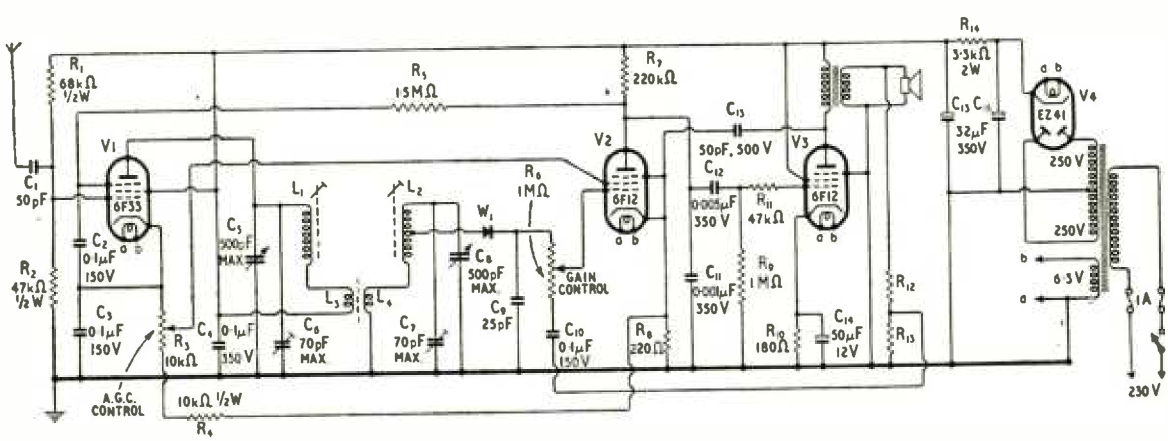


Fig. 1. Complete circuit diagram of t.r.f. receiver with bandpass r.f. coupling and amplified a.g.c. Unless otherwise stated, resistors are rated at ¼ W. Alternative valves to the 6F12 are 6AM6, Z77, EF91 and 8D3.

tuning capacitor being considered too large for a midget receiver) and they are employed as a bandpass filter coupling the r.f. stage to the detector. The voltage gain normally obtained between aerial and r.f. grid is, of course, lost, but this is made good by the high gain now available from the r.f. stage. The only disadvantage of the untuned input circuit is the possibility of cross-modulation at the grid of the r.f. stage. Because of the absence of any voltage step up between aerial and r.f. grid this danger is not so serious as might be imagined. Most r.f. pentodes will accept inputs of an appreciable fraction of a volt without serious non-linearity, and it is unlikely that inputs larger than this will be obtained unless the receiver is situated very near a high-power transmitter. In such localities it is advisable to include a resistor (of say 470 ohms) between the cathode of V1 and the junction of C_3 and R_3 to improve linearity by current feedback. Normally, however, this resistor is unnecessary and it is omitted from Fig. 1.

A 6F33 was chosen as r.f. amplifier because it has a very short suppressor-grid base (approximately 7 volts for a screen-cathode potential of 150 volts) and a reasonably high mutual conductance (4·35 mA/V) permitting high stage gain. The operating conditions for the valve must be chosen with care to avoid exceeding the maximum safe screen dissipation (0·8 watt) when the receiver is tuned to a strong signal and the cathode current goes wholly to the screen grid. It was decided to operate the valve with 150 volts between screen and cathode and at 5 mA cathode current. These conditions are obtained by choosing the values of R_1 and R_2 to give 100 volts positive on V1 grid. The cathode potential automatically takes up a potential slightly in excess of this value and, since the total external cathode resistance is 20 kΩ, the cathode current is approximately 5 mA. The cathode potential of approximately 100 volts is a suitable maximum value for application to V2 screen. The r.f. input is applied to V1 grid via C_1, the value of which is chosen to give good r.f. transfer but to give great attenuation to 50 c/s signals from the aerial; such signals would be transferred to V2 screen by cathode follower action to give hum in the receiver output.

L_1 and L_2 are the two tuning inductors; to obtain high gain these must have a high dynamic resistance. Dust-iron cores of the fully-shrouded type (Fig. 2) are used (Neosid Type 10D) and are wound with 57 turns of 9/45 Litz wire to give an inductance of 160 μH. This gives a dynamic resistance of nearly 300 kΩ at 1 Mc/s, corresponding to a Q value of approximately 300. There is, of course, no reason why commercial coils of suitable inductance and Q value should not be used instead.

Bandpass Coupling

A number of experiments were carried out to determine a suitable method of coupling the two tuning inductors. "Top-end" and "bottom-end" capacitance coupling were both tried and rejected because of considerable variation in gain over the waveband. Mutual-inductance coupling was found to give substantially constant gain and was adopted in spite of some variation in passband over the waveband. Attempts were made to obtain the necessary coupling by placing the coils in close proximity, and although it was found possible to obtain greater than optimum coupling in this way, the method had to be abandoned because the coupling was found to be

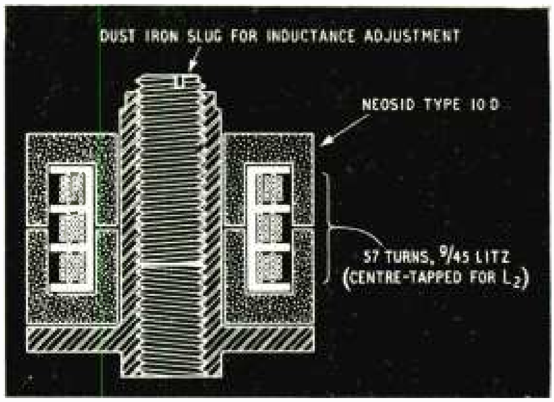


Fig. 2. Winding details of tuning inductors (L_1, L_2).

largely capacitive (the dust-iron shrouds, being non-conductive, do not screen the coils against this form of coupling). Thus it was necessary to use additional inductors connected in series with each tuned winding to provide the required inductive coupling. It is necessary to place the tuning inductors some distance apart or to employ some form of electrostatic screening between them to minimize capacitive coupling.

The coupling transformer consists of two windings each of 11 turns of 26 s.w.g. enamelled copper wire, one wound on top of the other and separated from it by two thicknesses of paper. The former is an Aladdin Type 5892 with a dust-iron slug suitable for medium-wave working. The slug is not intended for adjusting the degree of coupling in the bandpass filter but is left in the centre of the two windings L_3 and L_4 to give maximum coupling between them, as shown in Fig. 3.

The detector is a crystal diode and to keep the damping of the second tuned circuit at a minimum it is series connected to the load circuit. Even so it was found necessary to tap the crystal at the mid-point of inductor L_2 to maintain adequate selectivity. At first a 1-MΩ load resistance was used in parallel with C_9, but this was later omitted because it was found that the reverse resistance of the crystal provides an adequate discharge path for C_9 during negative half-cycles of the r.f. input. Needless to say the type of crystal should be chosen with care and preference should be given to those with a back resistance greater than 100 kΩ. The author used a B.T.H. Type CG1C. The output of the detector is applied to the grid of V2 via the coupling capacitor C_{10} and the gain control R_6 but C_{10} is connected in the low-potential end of R_6. This arrangement does not affect control of gain and is adopted to ensure that the d.c. output of the detector is always applied in full to V2 grid, irrespective of the gain control setting.

The crystal must be connected in circuit in the correct sense, i.e., so that the d.c. output biases V2 positively. Unfortunately, there does not appear to be any agreement amongst the manufacturers about coding the connections of crystals; it is usual practice to mark one end + or to colour it red, but for some crystals this indicates the end which goes positive when the crystal conducts and for others it indicates the polarity of the e.m.f. which must be applied to the crystal to make it conduct. It is best to determine the correct connections by experiment ; the crystal should be so connected that the anode potential of V2 falls when a carrier is tuned in.

V2 functions as first a.f. and a.g.c. amplifier ; to obtain high d.c. gain it is essential to keep the d.c. resistances in the cathode and screen-grid circuit low. The cathode resistor R_8 has a value of only 220 ohms, which causes very little degeneration, but a suitable value of cathode bias is obtained, as in the sensitive t.r.f. receiver described by S. W. Amos and G. G. Johnstone in the November 1951 issue of *Wireless World*, by passing the cathode current of V1 through R_8. The screen circuit resistance is low because it is fed from the cathode circuit of V1, the grid of which is connected to a resistive potential divider R_1, R_2 across the h.t. supply. Thus V1 behaves as a d.c. cathode follower in addition to an r.f. amplifier. The cathode of V1 behaves as a d.c. source with an internal resistance of $1/g_m$ (approximately 250 ohms), but V2 screen is fed from a 10-k Ω potentiometer R_3, connected in the cathode circuit and thus the screen resistance for V2 screen varies somewhat with the setting of R_3, rising to a maximum of approximately 2.5 kΩ when R_3 is at its mid-point. This value of resistance is unlikely to reduce the d.c. gain of V2 to any marked extent. The potentiometer R_3 is included to provide a means of adjusting the anode potential of V2 to the value giving correct a.g.c. performance. The adjustment should be such that the anode potential of V2 equals the cathode potential of V1 when there is no signal input to the receiver. The range of screen potential provided (approximately 50 volts) should be sufficient to enable the correct performance to be obtained in spite of the differences in valve parameters likely to be encountered when V2 is replaced by another valve of a similar type.

It is common practice to have a small fixed degree of voltage feedback in the a.f. section of small receivers of this type. This improves frequency response and decreases harmonic distortion at the cost of decreased gain, but to avoid a serious loss in sensitivity the feedback has usually to be limited to perhaps 6 db. This limitation is unfortunate, because there is a considerable margin of gain in hand during local-station reception when feedback is most required. The ideal solution to this problem is, of course, to have a variable degree of feedback which can be set to maximum on strong signals and a minimum (or zero if desired) on weak ones. A separate control for this is undesirable, however, and in this receiver feedback and a.f. gain are simultaneously adjusted by the gain control. As shown in the circuit diagram the gain control R_6 is returned via C_{10} not to earth but to a fixed potential divider R_{12}, R_{13} across the secondary winding of the output transformer. When the gain setting is low, the slider of R_6 is near the junction with C_{10} and nearly the whole of the voltage developed across R_{13} is applied to V2 grid to give feedback. On the other hand, when the slider of R_6 is near the junction with the crystal, a.f. gain is high and very little of the voltage across R_{13} reaches V2 grid, implying very little feedback.

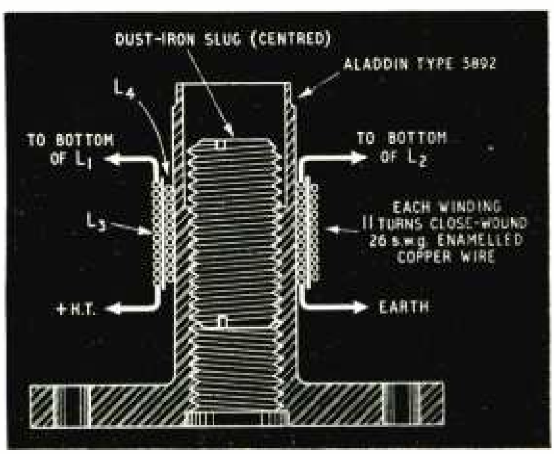


Fig 3. Winding details of coupling transformers (L_3, L_4).

Feedback Adjustment

The degree of feedback which remains when R_6 is set to maximum gain depends on the effective resistance of the crystal at audio frequencies. As the crystal is switched between conduction and non-conduction at radio frequency this resistance is somewhat difficult to assess but it is certainly small compared with R_6 (1 MΩ), and very little feedback remains when the gain control is at maximum. This can easily be demonstrated by short-circuiting R_{13} (to remove feedback entirely) when a weak signal is tuned in and R_6 is at maximum ; there is practically no change in audible output. The values of R_{12} and R_{13} must be found by experiment ; they are chosen to give the largest degree of feedback compatible with stability at low settings of the gain control. The values used by the author were 470 ohms (R_{12}) and 37 ohms (R_{13}), but these depend on the constants of the output transformer.

The transformer used by the author was a Goodmans Type 74 243. The values of R_{12} and R_{13} can easily be determined by replacing these resistors by a potentiometer and adjusting this, with the gain control at minimum, until instability occurs. Although instability usually takes the form of a supersonic oscillation, the onset is generally indicated by an audible " plonk." The potentiometer should be left a few degrees below the setting giving instability and the two " halves " measured. From the ratio of these two readings the values of R_{12} and R_{13} can be calculated ; their sum should be at least 10 times the loudspeaker resistance.

R.f. decoupling is carried out in the a.f. amplifier by capacitors C_{11} and C_{13}. C_{11} presents V2 with a very small load at r.f. frequencies (only 160Ω at 1 Mc/s) and C_{13} is connected between V3 anode and V2 cathode to give negative feedback which is negligible at audio frequencies but considerable at radio frequencies. The values of the two capacitors are so chosen that there is no obvious change in the high audio-frequency response of the receiver when the feedback is removed by operating the gain control to maximum.

The output stage and mains unit are quite conventional. The ratio of the output transformer should be chosen to present V3 with an anode load of approximately 20 kΩ. The mains transformer is a small type measuring 3 inches by 2½ inches by 2½ inches and having a single 6.3-volt winding. For rectification an EZ41 was chosen because of its small size and because it can withstand a high heater-cathode voltage. Thus all valves are operated from a common l.t.

supply. The value of the smoothing resistor is chosen to give a smoothed h.t. supply of approximately 250 volts. For compactness, the two 32-μF smoothing capacitors are in a single can.

Alignment of the receiver is extremely simple. It is necessary only to adjust C_6 and C_7 for maximum output with the tuning capacitor at minimum and an input at 1.7 Mc/s. The inductance of L_1 and L_2 should be adjusted for maximum output when the tuning capacitor is at maximum and the imput at 550 kc/s, after which the high-frequency adjustment should be repeated.

The potentiometer R_3 should be adjusted in the following way. Set R_3 to that end of its travel which gives minimum V2 screen potential and, with gain control at a maximum, tune the receiver to a very weak signal or to a " quiet " spot on the band where only receiver hiss can be heard. Now advance R_3 slowly until the signal or hiss disappears. Leave R_3 at a setting just below that which causes the signal to vanish.

The receiver is intended for use in the London area, where the Light programme is available on medium waves, and has no long-wave band. The use of a single waveband leads to a simple circuit with no complications due to waveband switching and duplication of trimmers. It is hoped, however, in a note to be published later to indicate how a long waveband could be added to the receiver. This addition is by no means a simple matter. If the long-wave coils are coupled by the method employed between the medium-wave coils, the primary and secondary windings of the long-wave coupling transformer require inductances of the order of 70 μH. It is difficult to wind two coils of this inductance value by hand on a small former of the type used for medium waves, and an alternative method of coupling is preferable.

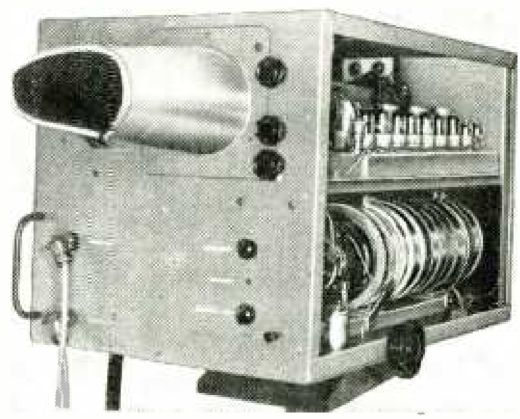
AMATEUR COLOUR TELEVISION

IN our February issue we reported that C. Grant Dixon, using home-constructed equipment, had succeeded in transmitting colour television pictures over a closed circuit. We have now received more information on the technical details of the apparatus. As already stated, it works on the frame-sequential system, with rotating colour discs in front of the camera and receiving screen, and the scanning rate is 100 colour frames per second or 33⅓ complete pictures per second. The standard adopted is 150 lines, sequentially scanned.

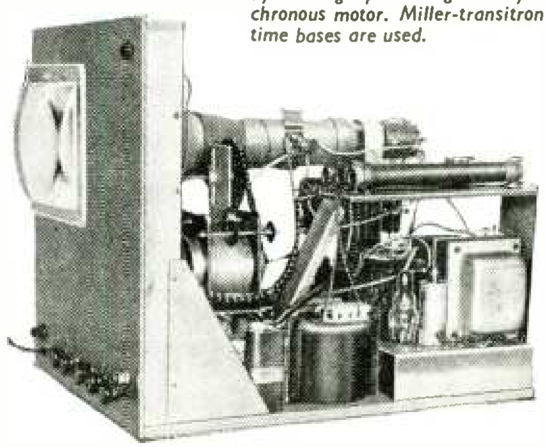
As the frame frequency is locked to the mains the two rotating colour discs are kept in synchronism with it by being driven by synchronous motors. The one at the transmitting end, which has 12 colour sectors, is run at 500 r.p.m. while the one at the receiving end, with six sectors, is run at 1,000 r.p.m. The transmitting motor can be made to slip out of synchronism temporarily for the purpose of phasing the colours correctly. There is also an arrangement for altering the phase of the frame synchronization with respect to the mains and hence to the transmitting colour disc. This enables the camera to be adjusted correctly so that each division between colour sectors on the disc always follows the scanning spot of the pick-up tube; the mosaic is then exposed to the next colour for the whole of the time between successive dischargings of the screen elements.

Apart from the camera and monitor shown in the photographs, the apparatus includes a control rack which carries a timing unit, sync and blanking pulse generators, a unit for mixing these pulses with the video signal, a c.r.t. waveform monitor and a power supply unit. The timing unit produces pulses at 15 kc/s and 100 c/s which trigger the line and frame sync and blanking pulse generators respectively. As already mentioned, it is locked to the mains in frequency, but can be varied with respect to the mains in phase.

Mr. Grant Dixon is the Chairman of the British Amateur Television Club.



In addition to a pick-up tube and rotating colour disc, the colour camera houses a time-base chassis, a video amplifier and a c.r.t. view-finder. An anastigmatic camera lens (f.4.5) is mounted in the camera casing and optical focusing is controlled by moving the pick-up tube backwards and forwards on a pair of rails by a rack and pinion arrangement. Power supplies are in a separate unit. The receiving monitor unit (below) has a 5-inch electrostatic tube working at 3.3 kV. The six-sector colour disc is driven at 1,000 r.p.m. by a Magslip running as a synchronous motor. Miller-transitron time bases are used.



Distortion in Negative Feedback Amplifiers

Points at Which Simple Theory Breaks Down

By THOMAS RODDAM

MOST amplifier designers will have encountered the unfortunate man who has applied, say 20db of feedback to an amplifier which was producing 5 per cent distortion and finds the distortion is still 2 per cent. It is tempting, when asked what we can do about it, to reply in the words of Michael Finsbury "nothing but sympathize." A rather more constructive attitude was adopted by R. O. Rowlands, in *Wireless Engineer* of June, 1953, who analysed the reduction of distortion by negative feedback in a moderately rigorous way. This analysis, however, still omits some significant factors and does not, in my view, lend itself to extension. In this article I propose to examine what the elementary theory of distortion reduction is; why it goes wrong, if it does go wrong, and how we can predict what will happen to the distortion in a particular amplifier when feedback is applied. I do not propose that you should sit down and calculate for days instead of carrying out a few measurements: on the other hand it is always useful to have calculated something similar in the past when you come to assessing the results of a particular experiment. We might follow Mahan and introduce the concept of a "calculation in being."

Before we go any further we must see just what the elementary theory of negative feedback predicts about the distortion. The amplifier, with a gain of A, has its gain reduced to $A/(1+A\beta)$ by feeding back a fraction $1/\beta$ of the output to the input. At any point inside the amplifier the signal level is the same, for a given output, whether feedback is connected or not, so that the distortion signal generated inside the amplifier is unaltered by feedback. Without feedback we find this signal, which we can call d_o in the output. With feedback connected we shall find a new value of distortion, say d'_o, in the output. We feed back $\beta d'_o$ to the amplifier input, where it is then amplified, and appears as a term $A\beta d'_o$. Then d'_o (the actual distortion) $= d_o$ (the intrinsic distortion) $+ A\beta d'_o$ (the distortion returned round the loop) and so $d'_o = d_o/(1+A\beta)$.

The factor $(1+A\beta)$ is the gain reduction factor, and so we should expect to get an improvement of 10 times for every 20db of gain that we sacrifice. Now we know that this does not happen in practice.

Let us divide up the distortion we obtain in an amplifier into gross distortion and petty distortion. Gross distortion is the distortion produced by some discontinuity in a characteristic, a sharp change of some sort which we usually, though not necessarily, associate with overloading. Driving to cut-off, driving a pentode into the "bottoming" region, driving into grid current without special circuit arrangements, at the peaks of the signal something different happens and the low level conditions no longer apply. Grid current or cut-off need not produce a discontinuity, as we know from experience with push-pull Class B circuits, but the system must be designed to work into these special regions if no ill effects are to be obtained. Gross distortion is not necessarily associated with overloading, because a failure to fit the characteristics of a push-pull Class B pair will result in "cross-over" distortion, where there is a momentary "flat" on the characteristic as we swing through the centre. This particular form of distortion is much more disturbing than overload limiting.

Gross distortion obeys the elementary theory for feedback amplifiers quite well, provided that you apply the theory correctly. The distortion is produced during short intervals of time when, shall we say, the grid of the output valve is positive with respect to cathode, grid current is flowing and the input impedance of the valve is, perhaps, 1,000 ohms. The preceding stage gives only a very small gain into such a load, so that the value of A which we must put into our equation is not the 1,000 (60db) we so blithely assume, but shall we say, about 10. For these quite arbitrary figures, and an assumed β of 1/100, the quantity $(1+A\beta)$ is not 11, but 1.1. While the distortion is being produced there is virtually no feedback effect, because the amplifier is blocked off and the distortion sent back through the feedback network cannot get round to produce the expected cancellation.

If we examine an amplifier working under these conditions by using an oscilloscope we can see fairly easily just what is happening. I have sketched it out in Fig. 1, which shows the simple sine wave limited

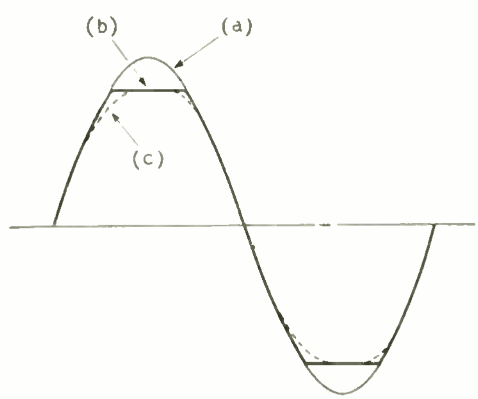


Fig. 1. Gross distortion. The sine wave (a) is distorted by the amplifier into the form (c) if there is no feedback, and into the form (b), which has a sharply defined flat top, if feedback is used.

equally at both peaks by an overloaded amplifier. When feedback is applied, the effect is to produce the rather clean flat-topped characteristic shown in Fig. 1, curve (b). It is not very difficult to calculate the way in which the total distortion increases with amplitude : all you need to do is to work out the area under the cap of the sine wave, because that is the actual " distortion signal " generated in the amplifier. If the amplifier clips one side only you can use the expression given on p. 303 of *Reference Data for Radio Engineers* (3rd edition) to calculate the individual harmonics. The diagram in Fig. 1 does illustrate, I hope, the way in which so long as the signal is below the knee of the characteristic the feedback keeps it sinusoidal, and then, well it just can't go any further.

Those readers who have some experience of speech clipping circuits may wonder why we should concern ourselves overmuch about this effect, because on speech a characteristic of this kind has little influence, at any rate if we think mainly of intelligibility. I have discussed this in these columns previously, but I must just remind you that if a second much higher frequency is present at a lower level it will be suppressed during the " flat." The double bass will modulate the ocarina, and instead of the pure, and very dull, tone of the latter we shall have a muddy product tone.

The effect of feedback on gross distortion is seen to be small, and if distortion is plotted as a function of output level, which it always should be, the distortion rises so quickly, because the output can hardly rise at all, that measurement errors play a very great part in fixing the shape of the curve. Moreover, the distortion should be divided by the predicted sine wave output, which you cannot measure anyway.

Calculating Distortion

The reader is no doubt exclaiming, to himself I hope, that he never overloads amplifiers, but that even in his safely underloaded amplifier the theory is not exact. We must, therefore, turn our attention to the petty distortion. I shall assume first of all that all the distortion originates in the last valve of the amplifier and that this valve is a 6AG7. The choice of this valve is dictated by the fact that it is the only large valve for which I can find curves of mutual conductance as a function of bias. From the curve shown in Fig. 2 we can estimate that gross distortion is likely to occur beyond about — 7.5 volts, so that we might choose — 3.75 volts, the point marked on the curve, as our working point. We can calculate the distortion which this valve will produce, by a method which has already been described in *Wireless World* (June 1951). The second harmonic distortion depends on the average slope of the $g_m - e_g$ characteristic, and for the curve shown the level of second harmonic below the fundamental will be

$$20 \log \frac{9}{12} + 18 = 15.5 \text{ db.}$$

The third harmonic depends on the amount of " sag " at the working point, and is

$$20 \log \frac{9}{1.5} + 22 = 26.4\text{db.}$$

It may seem that the distortion, which is well over 10 per cent, hardly merits the name of petty distortion, but this distortion is due solely to the smooth curvature of the valve characteristic, and I have taken the extreme values just in order to make the errors in reading the curve less.

Let us now apply some feedback to the amplifier containing this valve. Since the rest of the amplifier was assumed to be linear, the grid voltage axis, with a suitable change of scale, could be the signal axis at any point in the amplifier. So we need not worry too much about scales. The easiest way in which the feedback can be applied, for calculation purposes anyway, is as current feedback. This will reduce the effective mutual conductance by an amount depending on the feedback applied. If the feedback is simulated by, or even produced by, a resistance in the cathode, the effective mutual conductance g'_m is

$$1/(R_k + 1/g_m)$$

At the selected working point we have $g_m = 9$ mA/V: let us assume that g'_m is to be 0.9 mA, giving us 20 db gain reduction. Then R_k must be 1,000 ohms. In Fig. 3 I have constructed a curve of $g'_m - e_g$, using the equation above. From this curve we can calculate the distortion, with feedback applied. The result is that we have

second harmonic

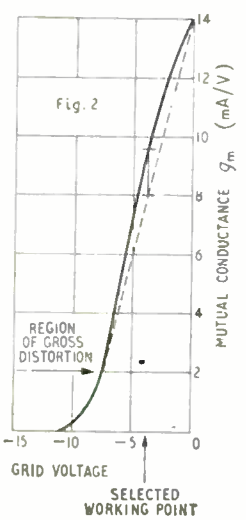
$$20 \log \frac{0.9}{0.27} + 18 = 28.4 \text{ db down,}$$

third harmonic

$$20 \log \frac{0.9}{0.1} + 22 = 41 \text{ db down.}$$

From these results we see that the gain reduction of 20db is accompanied by only 13db of second harmonic reduction and 14.6db of third harmonic reduction. Also, though I don't intend to calculate this, the characteristic shown in Fig. 3 indicates quite clearly that higher-order harmonic terms will be fairly pronounced.

We have thus proved triumphantly exactly what you have always said : negative feedback is a bit of a swindle. Well, if you look at Fig. 3 you can see where we have gone astray. The valve maker tells us to work the valve at — 3 volts bias, and most of the distortion is contributed by the drop in g'_m which



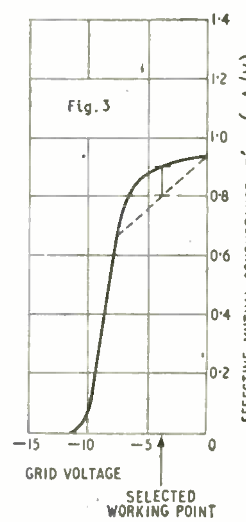


Fig. 2. Mutual conductance of 6AG7 valve as a function of grid bias. E_a = 330V. E_s = 150V.

Fig. 3. Effective mutual conductance g'_m with 20 db gain reduction due to feedback.

occurs beyond about -6 volts. Let us say that it is the behaviour around -6.75 volts which settles the distortion. Here the mutual conductance was 4.5mA/volt, and feedback has reduced it to 0.8mA/volt. We have, indeed, only 15db of feedback in this region, and the distortion has gone down 13–15db. Considering that I chose -6.75 volts because it was a thick line on the graph paper, with no faking, no trial calculations to find a " good " example, this agreement is remarkably close.

We see from this example that the reduction of petty distortion is indeed equal to the gain reduction, provided that we consider the gain reduction in the distortion region. We have, perhaps, trespassed slightly into the region of gross distortion in our example, but the limits of this are much more clearly defined in Fig. 3 than they are in Fig. 2.

This example was worked out for a single distorting valve, preceded by an unspecified number of absolutely linear stages. It is perfectly practicable to build up a composite $g_m - e_g$ curve for a number of stages by multiplying the appropriate values of g_m derived from a set of valve characteristics for the various types used. This would be especially useful in the particular case of a small triode driving something like a 50L6 and operating on 110 volts. The driving down of the triode grid, which lowers the mutual conductance, drives up the 50L6 grid and raises the mutual conductance here. With care, and luck, the two slopes can be balanced to give a reduction of the second harmonic. The effect of feedback on such a composite characteristic can be worked out by the use of a fictional cathode resistor.

Screen Distortion

Having now particularly described and ascertained the effect of feedback on distortion, I must add that this is not nearly the whole story. We have shown that the theory, if correctly applied, gives the right answer, but are we sure the circuit is designed to enable the theory to be applied? One difficulty which often arises is the result of a weakness in the cathode feedback circuit. It is very attractive to take feedback from the cathode of an output tetrode back to the cathode of the first valve of a three-stage amplifier. It is very tempting to return the screen directly to the positive supply, so that we can get the most output for the least supply voltage. When we do this, however, the screen current flows through the cathode resistance, so that what we feed back is not a voltage proportional to the current in the load, but a voltage proportional to the sum of the load current and the screen current. The screen current may be extremely distorted if the valve is being driven hard, and normally we shouldn't mind, because the screen current does not flow through the load in most normal amplifiers. In the circuit of Fig. 4 we feed back this distortion current and thus introduce the screen distortion into the control grid circuit. Then we complain that feedback is not helping all it should. The remedy is, if we want this kind of feedback, to decouple the screen back to cathode as shown in Fig. 5. Then the signal current in the screen circuit is excluded from the cathode resistance.

This decoupling is often inconvenient, so we decide to take our feedback from the valve anode, back to the preceding cathode perhaps. A new difficulty is sometimes encountered here, though it is apparent only in amplifiers of the highest quality. The swing at

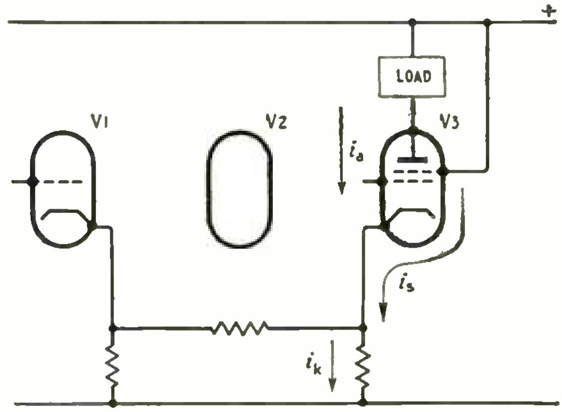


Fig. 4. With this sort of circuit the voltage fed into the cathode of V1 depends on ($i_a + i_s$), not upon i_a alone.

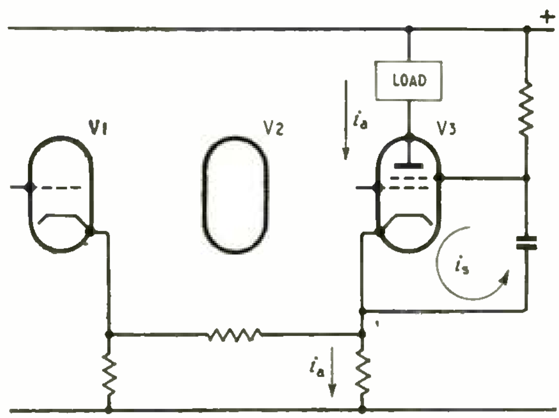


Fig. 5. By decoupling screen to cathode, i_s does not flow through the feedback resistor. The voltage fed back depends only on i_a.

the output anode is usually of the order of 100-200 volts, and almost the whole of this appears across the feedback resistor. For cheapness and convenience a carbon resistor is used here: all heedless of their fate the little victims play. Carbon resistors are not absolutely constant in value, but depend slightly on the applied voltage. This voltage effect is sufficient to produce some distortion in some particularly high-grade circuits. Obviously, in an ideal feedback amplifier, with the gain equal to $1/\beta$, any distortion in the feedback path becomes the limiting factor, and although I have never encountered this trouble myself, some American papers have recorded it.

Are there any more gaps? One, usually trivial, is the additional feedback path through the power supply impedance. Another, the only one which comes to mind at the moment, is particularly important at the edges of the working band. We write down, very happily, the equation $m = A/(1 + A\beta)$, the equation $d'_o = d_o/(1 + A\beta)$. But what do we mean by A? Pretty obviously we must mean the gain at the harmonic frequency, which will certainly not be the same as the gain at the fundamental when we are dealing, in an audio-frequency amplifier, with frequencies above a few thousand cycles per second. Furthermore, there will be a phase angle associated with A, and the value of $|1 + A\beta|$ may be quite small. The harmonics will then actually be amplified by the feedback and not reduced as we expected. The simplest way of looking at this effect is a "swings and roundabouts" way: if you use feedback up in flattening a poor frequency response, it is not available for reducing the distortion. Here it is not really the harmonic distortion which causes the trouble, but the intermodulation of high frequencies and general mud-production.

At low frequencies a somewhat similar effect is observed in some closely designed amplifiers. If the signal fed back is not in the opposing sense to the input signal, it may be enough to overload one of the early valves in the amplifier. As a result, this valve is driven into the gross distortion region and although the feedback would be available at the harmonic frequencies if the fundamental were not present, the fundamental itself prevents the amplifier having its proper amplification for harmonic reduction. Here, then, is another detail which must be watched if you want to be able to predict the performance of an amplifier with negative feedback.

This survey of the problem of distortion in feedback amplifiers is not rigorous, not exact and probably not complete. It does, however, give some explanation of why the simplest calculation of distortion reduction breaks down, and the method suggested for calculating the distortion appears to provide reasonably good quantitative results without an excess of labour. The construction of an effective mutual conductance characteristic is seen to give a rather simple way of determining a good working point and predicting the resulting distortion. Band edge effects require much more calculation and are outside the scope of this article. In this field, at any rate, if your measurements don't agree with the theory, check them and be sure you have used the right theory.

CLUB NEWS

Brighton.—A series of talks on radio mathematics is being given to members of the Brighton and District Radio Club by E. Bannister. The club meets each Tuesday at 7.30 at the Eagle Inn, Gloucester Road, Brighton, 1. Sec.: T. J. Huggett, 15, Waverley Crescent, Brighton.

Cleckheaton.—Both meetings of the Spen Valley and District Radio and Television Society in April will be devoted to transmitting topics. On the 7th H. Clegg (G3FX) will speak on the use of valves in transmitters and on the 21st A. Smith, B.Sc. (G2BOO), will deal with transmitter design. Meetings are held at 7.30 on alternate Wednesdays at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

QRP.—The council of the QRP Society (the word "Research" has been dropped from the title) has, in view of its growing overseas membership and the increasing use of v.h.f., amended its rules regarding power limitations. For v.h.f. work the maximum power has been doubled—10 watts to the final stage of transmitters and a total h.t. consumption of 3 watts in receivers. Overseas transmitters will be permitted to use a maximum of 20 watts. Sec.: J. Whitehead, 92, Ryden's Avenue, Walton-on-Thames, Surrey.

Wellingborough.—The Wellingborough and District Radio and Television Society is providing and manning a stand at the Hobbies and Careers Exhibition which is being held at the Drill Hall, Wellingborough from April 20th to 23rd. Sec.: R. J. Henty, 6B, Silver Street, Wellingborough.

Wolverhampton Amateur Radio Society has moved to new headquarters at Stockwell End, Tettenhall, where the club transmitter (G87A) is installed. The club meets on alternate Mondays. Sec.: H. Porter (G2YM), 221, Park Lane, Wolverhampton.

BOOKS RECEIVED

Art and Science in Sound Reproduction, by F. H. Brittain, D.F.H. Acoustic and psychological principles involved in sound reproduction, leading to a series of designs for high-quality amplifiers pre-amplifiers and radio feeder units. Pp. 55; Figs. 35. Price 2s 6d. General Electric Company, Magnet House, Kingsway, London, W.C.2.

Magnitude of the Radio Interference in the Television Band from Ignition Systems of Motor Vehicles, by A. H. Ball and W. Nethercot. Results of field strength measurements on a wide range of vehicles to determine the effect of suppressors in meeting the B.S.833 level of tolerable interference. Pp. 7; Figs. 4. Price 6s. The Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Information Theory, by Stanford Goldman. Survey of current knowledge written at a mathematical level suitable for first-year university students in electrical engineering. Pp. 385+xiii; Figs. 68. Price 50s. Constable and Company, 10, Orange Street, London, W.C.2.

The Electronic Musical Instrument Manual, by Alan Douglas. Revised and enlarged edition giving up-to-date information on principles, with descriptions of representative commercially produced instruments. Pp. 221; Figs. 187. Price 30s. Sir Isaac Pitman and Sons, Parker Street, London, W.C.2.

Commercial Literature

Nickel Alloy Spring Materials with resistance to corrosion and non-magnetic properties. Descriptions of various alloys and tables of characteristics in a booklet from Henry Wiggin & Company, Wiggin Street, Birmingham, 16.

Heavy-duty Relay, type C.03, for operating from a.c. or d.c. up to 500V, and fitted with two 15-A and two 5-A changeover contacts. Leaflet from Besson & Robinson, 6, Government Buildings, Kidbrooke Park Road, London, S.E.3.

Complete Transmitters (and associated equipment) of various powers for broadcasting and communications, mobile and beacon use and unattended operation. A handsome, well bound and illustrated catalogue of 240 pages giving descriptions and specifications of the major products of The Gates Radio Company, 123, Hampshire Street, Quincy, Illinois, U.S.A.

Sequence Timer for controlling a sequence of switching operations on mains circuits. It consists of a series of switches operated by cams (up to 120) geared to a synchronous motor. Leaflet from the Electrical Remote Control Company, Elremco Works, East Industrial Estate, Harlow New Town, Essex.

Solenoids for industrial use with maximum strokes from ⅜in to 1½in and pulls from 1 oz to 26 lb. Performance data and dimensions in a brochure from Oliver Pell Control, Cambridge Row, Burrage Road, Woolwich, S.E.18.

Tape Recorder in suitcase form with slide-out chassis on steel frame. Leaflet from Tape Recorders (Electronic), 3 Fitzroy Street, London. W.1.

Oscilloscopes, designed to accommodate modifications to customers' special requirements. Basic equipments described in a brochure from A. E. Cawkell, 6-7, Victory Arcade, The Broadway, Southall, Middlesex. Also a leaflet on a **Wide-Band Amplifier** for pulse amplification with a frequency response of 15 c/s to 10 Mc/s (to the −3db points) and a gain of 40.

Variable Tuning Capacitors, air dielectric; an illustrated catalogue giving specifications, law curves and mechanical drawings from The Plessey Company, Ilford, Essex.

Scintillation Phosphors for use in scintillation counters. Various materials in different forms for detecting alpha, beta and gamma rays, neutrons, protons and x-rays. Characteristics on a leaflet from Isotope Developments, Finsbury Pavement House, 120, Moorgate, London, E.C.2.

Retractable Instrument Cord in coiled spring form for use in telephones, test gear, etc. Leaflet from Aerialite, Castle Works, Stalybridge, Cheshire.

Television Coverage

Assessing the Service Areas of Transmitters at V.H.F. and U.H.F.

By J. A. SAXTON, D.Sc., Ph.D., M.I.E.E.*

Variations of field strength caused by rough terrain at v.h.f. and u.h.f. are discussed in this article; and an estimate is made of the part played by these variations in determining the coverage of broadcasting transmitters operating at such frequencies, with particular reference to television transmission in Bands I, III, IV, and V.

FREQUENCY bands at present allocated for television are 41-68 Mc/s (Band I), 174-216 Mc/s (Band III, though all the channels are in fact, as things stand not available), 470-585 Mc/s (Band IV) and 610-960 Mc/s (Band V). Band II (87.5-100 Mc/s) is to be used for v.h.f. sound broadcasting only. Of the four television bands it is only the first which is generally in use in the United Kingdom at this time. Band III is widely used in the U.S.A., as well as Band I, and there are also some Band III stations in Western Europe: so far the only exploitation of the u.h.f. bands for television has been in America. As the plans for more stations in this country develop, it is certain that use will have to be made of Bands III, IV and V (Band III stations are already projected) since, for reasons outlined below, there is a limit to the number of stations which can be operated on any one frequency in a given area without serious mutual interference—and this limit has already been reached for Band I in the United Kingdom with the stations, high and low power, now existing, and the further low power stations shortly to be put into commission.

The successful allocation of frequencies for, and the siting of, transmitters in the v.h.f. and u.h.f. bands depend upon an accurate knowledge of radio wave propagation characteristics at these frequencies. A considerable amount of information concerning v.h.f. propagation has existed for some time, but, although experimental u.h.f. field strength surveys have been made over the past few years in the U.S.A., it is only recently that any comprehensive investigations in the u.h.f. band have been carried out in this country†. This work has borne out the conclusions drawn from the American experiments for propagation over similar kinds of terrain.

At frequencies less than about 30 Mc/s radio wave propagation is influenced mainly by the electrical properties of the ground and by the ionosphere, the relative importance of these factors depending upon the frequency and upon the distance of transmission; but refraction in the troposphere and the ground profile over the transmission path are of little significance, particularly as the frequency becomes progressively lower. On the other hand, as the frequency increases above 30 Mc/s the situation is reversed; the electrical properties of the ground are no longer of any great importance, ionospheric influences disappear, and the dominant factors are refraction in the troposphere and surface irregularities of the ground, both on a small and on a large scale.

For distances up to, say, 50 or 60 miles variations in signal strength at v.h.f. and u.h.f. arising from changes in atmospheric refraction (brought about by changes in the weather) are normally not of great significance, though they undoubtedly occur at times; and thus the variation of field strength with the nature of the terrain is the most important propagation problem to be considered within what may be regarded as the normal service area of a television or other broadcasting station operating on these frequencies.

In certain kinds of weather—under settled anti-cyclonic conditions, for example—it is possible, as is now well known, for relatively strong signals to be received with Band I transmissions at distances well beyond the horizon, up to several times the normally expected service range in fact. Similar behaviour is found with Band III transmissions: thus on occasions signals on a frequency near to 200 Mc/s from France have been received quite strongly in the south of England at a distance of about 170 miles. There is no doubt that abnormal ranges will also occur at times with transmissions in Bands IV and V. It must be stressed that these increased field strengths at long range, arising from super-refraction and reflection processes in the troposphere, cannot be relied upon to provide any worthwhile extension of the service area of a v.h.f. or u.h.f. station beyond that obtaining under what are known as standard conditions of refraction—such as exist in the well-mixed atmosphere associated with unsettled weather. Long-range tropospheric transmissions are troublesome, however, since they accentuate the problem of interference between common-frequency stations; and as a consequence it is necessary to put such stations at much greater distances apart than would otherwise have been necessary. It is for this reason that the limit of common frequency working for each of the five channels of Band I has now been reached for the area of Great Britain with the existing and projected stations. It might be added that the problem is obviously aggravated by the close proximity of Western Europe. With these few comments on the influence of atmospheric refraction on frequency allocation and the siting of transmitters we may now

*D.S.I.R. Radio Research Station, Slough.

†"Ground-Wave Field Strength Surveys at 100 and 600 Mc/s" by J. A. Saxton and B. N. Harden; and "Basic Ground-Wave Propagation Characteristics in the Frequency Band 50-800 Mc/s" by J. A. Saxton. These papers are to be published in *Proc. I.E.E.* 1954, Vol. 101, Part III.

return to the main theme of this article, namely the propagation problems encountered within the normal service areas of v.h.f. and u.h.f. stations.

Ground-Wave Propagation at V.H.F. and U.H.F.:—When the transmitting and receiving aerials are at heights h_T, h_R, each at least a few wavelengths above the ground, and spaced a distance d apart over a smooth earth such that $d \gg (h_T + h_R)$, the field strength at the receiving point is given by the expression:

$$E = \frac{90\sqrt{W}\, h_T\, h_R}{\lambda\, d^2} F \text{ volts/metre} \quad \ldots \quad (1)$$

where all lengths are in metres, λ is the wavelength, and W is the effective radiated power (e.r.p.), i.e. the actual power multiplied by the gain of the transmitting aerial relative to a half-wave length dipole. The factor F, which is less than unity, takes account of the curvature of the earth: it is independent of the frequency but decreases as the distance increases. (For a flat earth F = 1). The expression (1) applies for both horizontally and vertically polarized waves at the frequencies with which we are concerned; and it results from the vector addition of the fields due to the direct wave TR and ground-reflected wave TOR as illustrated in Fig. 1.

Thus, when comparing field strengths at different frequencies at a given distance, and for the same e.r.p., h_T and h_R, we should expect on this simple model based on a smooth spherical earth to find that $E \propto 1/\lambda$, or $E \propto$ frequency (f). Experimental observations have shown, however, that this conclusion is far from borne out in practice when transmission occurs over rough terrain, as is nearly always the case for overland propagation. Consider, for example, an experiment in which the field strength is measured at various distances along a path such as that shown in Fig. 2. (The height scale is here very much exaggerated in comparison with the distance.) It is assumed for simplicity that for each of the receiving positions R_1, R_2 only one reflected ray is possible. The actual height of the receiving aerial above ground level is the same at R_1 and R_2, but for transmission between T and R_1 the effective transmitting and receiving aerial heights are h_{T1} and h_{R1}—very different from h_{T2} and h_{R2}, the corresponding values for transmission between T and R_2. It is clear, therefore, that in general field strength measurements at all points along an irregular path cannot be described in terms of equation (1) with unique values of h_T and h_R. The situation becomes more complicated when it is realized that there are ground configurations which can give rise to more than one reflected ray between T and R—quite apart from the fact that some receiving points will be in shadow regions. Furthermore, such multipath transmission is increasingly likely as the frequency is raised since relatively smaller areas of ground (or of any reflecting object) are required to give effective reflection.

Experimental Field Strength Surveys:—In view of the difficulties of interpretation outlined above it has been found essential to analyse the results of experimental field strength surveys on a statistical basis. It is then found that the measurements of field strength made over the whole of the service area of a v.h.f. or u.h.f. station conform statistically with a law of the form given by equation (1). A word of caution is needed here, for the surveys amenable to this kind of analysis, both in this country and in the U.S.A., refer mainly to terrain which is not mountainous in character, for example such as is found in the regions around London and Sutton Coldfield. It should also be added that, particularly at u.h.f., greater attenuation is observed in densely built-up areas (like London and Birmingham) than in more open country.

Experimental observations of field strength are conveniently analysed in the following manner. First, in the immediate neighbourhood of a receiving site there is nearly always some variation of field strength as the receiving aerial is displaced a few yards; the range of this variation is found to increase with the frequency, and its order of magnitude is indicated in the table for frequencies of 100 and 600 Mc/s.

These figures refer to a typical receiving aerial height of 30 feet, and as far as can be ascertained they are not very dependent upon (i) transmitting aerial height over a wide range, or (ii) distance from the transmitter.

LOCAL VARIATIONS ON A RECEIVING SITE

Frequency (Mc/s)	Minimum Range of Field Strength Variation (db)		
	10% of sites	50% of sites	90% of sites
100	8	5	2
600	17	7	3

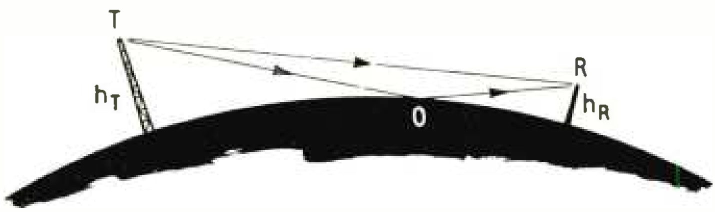


Fig. 1. Transmission over smooth earth. One reflected ray only is shown and aerial heights are exaggerated.

Secondly it is found that the general level of the signal at sites at the same distance from the transmitter, but on a representative selection of azimuths all round the transmitter, varies very considerably. The interesting fact emerges, however, that the median field strength varies with distance according to a law of the form derived for a smooth spherical earth [equation (1)], though the degree of absolute agreement with equation (1) depends upon the frequency. (The median field strength at any given distance is the value exceeded at 50% of the receiving sites at that distance.) In Band I the median field strength agrees very closely with the value $90\sqrt{W}h_T h_R F/\lambda d^2$ (i.e. within 1 or 2 db), with h_T and h_R the actual values of the respective aerials above ground level at the terminal points; but as the frequency increases the measured median field strength falls progressively below the theoretical value, though the departure seems, to a first approximation, to be the same at all distances, at least up to 40 or 50 miles. Thus in Band III the discrepancy is

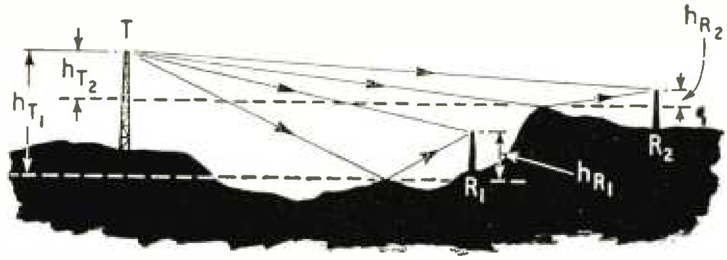


Fig. 2. Transmission over rough terrain, showing relationship between true and effective heights of aerials.

about 10 db, and it ranges from about 15 db at the bottom of Band IV to over 20 db at the top of Band V. The somewhat surprising final result is that, within close limits, the same median field strength is obtained throughout Bands I to V for a given e.r.p., and the same transmitting and receiving aerial heights; at least up to the probable limiting extent of the service area of a u.h.f. station, say out to 30 miles, or so, depending of course on the e.r.p. and the transmitting aerial height.

Before going on to examine further the significance of the constancy of field strength as a function of frequency, we may note the range of variation of the general signal level found on various azimuths around the transmitter at a given distance. In Band I 10% of the receiving locations will have a level some 7 or 8 db greater than the median value, whilst a further 10% of sites will have a level some 7 or 8 db less. In Band III the variation from the median value will be of the order of 12 db for the most favoured and least favoured 10% of receiving locations, whilst at 600 Mc/s (at the cross-over from Band IV to Band V) the corresponding variation will be 15 db. It would perhaps be as well to emphasize that the measurements from which these characteristics have been deduced were taken under a wide variety of conditions—on level ground, in front of, on top of and behind hills, amongst houses and other buildings and in open or wooded country. Further, the receiving aerial height was 30 feet, and the conditions were thus typical of what would be expected with practical television receiving installations for domestic use.

Reception at Various Frequencies:—Consider first reception by a half-wavelength dipole at various frequencies within the Bands I to V. The effective length of such an aerial is λ/π, and the input voltage to a receiver correctly matched to the aerial, neglecting any feeder loss, is $V = E\lambda/2\pi$ when the field strength at the aerial is E volts/metre. For constant E, therefore, $V \propto 1/f$. Thus, by way of example, in going from 50 to 500 Mc/s (Band I to Band IV) the input voltage decreases 10 times (20 db). At present noise figures of receivers at u.h.f. are of the order of 6 db, or more, worse than those obtainable at v.h.f., so that for the same signal to noise ratio at the two frequencies (with a given e.r.p.) a total discrepancy of about 26 db has to be made up.

The e.r.p. of the existing high-power Band I stations in the United Kingdom is about 100 kW. Within the next few years it is unlikely that actual powers exceeding some 10 kW will become available in Bands IV and V; indeed at the present time a figure of 1 kW might be nearer the mark. For the purpose of this argument, however, we shall assume the availability of 10 kW transmitters in Bands IV and V. It would be relatively easy to provide a suitable transmitting aerial with a gain of 10 db, thus achieving the same e.r.p. as obtains in Band I; in fact it would not be unreasonable to envisage transmitting aerials with gains approaching 20 db, or e.r.ps of 1,000 kW, even after allowing for the somewhat greater feeder losses which may exist in the u.h.f. bands. Taking this optimistic view we should be left with a factor of only 16 db to recover at the receiving end to give the same performance at 500 Mc/s as at 50 Mc/s—when using a simple half-wavelength aerial at the Band I frequency. In practice, beyond the immediate vicinity of the transmitter it is common in Band I to use receiving arrays of one form or another having gains of perhaps 2 to 3 db. It may well be, however, that progress in the design of u.h.f. receivers in the near future will lead to a betterment of noise figures by 3 or 4 db, leaving finally a factor of 15 db to be found from receiving aerial gain at 500 Mc/s, though this ignores the fact that cable losses will almost certainly be significantly greater in the u.h.f. than in the v.h.f. bands.

A simple 10-element Yagi array of overall length about 4 feet (and therefore not inconveniently large) can be made to give a gain of 12 db relative to a half-wavelength dipole at 500 Mc/s, so that it might appear not to be impracticable to achieve the 15 db gain required to give comparable performance at 500 and 50 Mc/s.

There are, however, still several important points to be considered. In the first place an aerial of the Yagi type having a gain as much as 15 db will be a relatively narrow band device, and this degree of gain is likely only to be realized in the one u.h.f. channel for which it has been designed. To obtain an aerial of broader band characteristics it would be necessary to go to a type involving a reflector of the parabolic type; and for a gain of 15 db a reflector 8 ft in diameter would be required (at 500 Mc/s), which would hardly be practicable. Thus, if it is essential that a high receiving-aerial gain should be achieved, the problem of designing a practical aerial to cover more than one u.h.f. channel would seem difficult to solve, to say the least. A further hindrance to obtaining high gain with a receiving aerial is brought out by the figures in the table. If there are large fluctuations of field strength over a small area, then it is obvious that the field structure is very complicated, and under such circumstances a highly directive aerial may well have an effective gain appreciably less than it would have in a uniform field, for which it will normally have been designed. This may be a serious problem in towns, for not only is the field strength in the u.h.f. bands some 15 db below the median value obtained in more open country for any given distance from the transmitter (i.e. with $h = 30$ ft), but large fluctuations generally occur in the vicinity of the receiving site. Some improvement in performance may be obtained by putting the receiving aerial really high—well above nearby surrounding objects—but this might often be neither practicable nor desirable, quite apart from the additional losses introduced by the necessarily longer cable.

The comparison of efficiency of reception at 50 and 500 Mc/s has so far been in terms of median field strengths; i.e., those exceeded for only 50% of the receiving locations at a given distance. If for example it were desired to ensure that 90% of the receiving locations should have a similar service at 500 Mc/s to that at 50 Mc/s an additional discrepancy of 7 or 8 db would have to be made up either at the transmitter or at the receiver. It seems unlikely that the e.r.p. could be increased to approach 10,000 kW at 500 Mc/s: an aerial of 30 db gain with a uniform horizontal radiation pattern is hardly feasible, and 100 kW of radio-frequency power seems out of the question for a considerable time. Also, in view of the arguments advanced above, it would be extremely difficult to find an extra 7 or 8 db at the receiving end.

We have considered in some detail the relative broadcast coverage to be obtained at 50 and 500 Mc/s. It will be clear that most of the difficulties encountered at 500 Mc/s will be accentuated at, say, 900 Mc/s towards the top end of Band V. Smaller transmitter powers will be available, there will be greater feeder losses (both at the transmitter and the receiver), it will not be advisable to use much greater aerial gains (transmitting or receiving) than those already envisaged above for 500 Mc/s, and the disadvantageous effects of rough terrain are greater at 900 Mc/s than at 500 Mc/s. On the other hand, in Band III, at frequencies near to 200 Mc/s, the situation is considerably easier than in Band IV; and it should be possible to provide a coverage more nearly comparable with that of Band I without undue difficulty. Here (in Band III), for the same e.r.p. as in Band I, it would be necessary to make up no more than about 12 db at the receiving end, assuming receivers of similar noise figure. It should in fact be possible to obtain greater e.r.ps (by several db) in Band III than in Band I without the use of unnecessarily complicated transmitting aerials, thus leaving a degree of gain to be achieved by the receiving aerial which is within the bounds of a reasonable design. It might be added that the spread of field strengths occurring at a given distance from the transmitter in Band III will be intermediate between that for Bands I and IV.

Conclusions:—Even taking the most optimistic view of the e.r.ps likely to be available in the television Bands IV and V, and of the noise figures likely to be achieved for receivers in these bands, it is clearly going to be difficult to provide an efficiency of reception at any given distance similar to that obtainable in Bands I and III over terrain of the kind found in the midlands and south-east of England; the problem will be even greater in very hilly country where more intense shadows are cast.

It may be, of course, that the policy to be adopted envisages the use of a large number of u.h.f. stations—since more channels will be available in Bands IV and V than in Bands I and III—each serving a relatively restricted area. (It is beyond the scope of this article to discuss the economics of such a scheme, but it would obviously be a very important matter.) With this in mind it is instructive to compare the v.h.f. and u.h.f. bands taking a rather less optimistic, and perhaps more realistic, view of what may be possible in the near future. If in the early stages of development it is found that the overall signal to noise ratio achievable in Band IV, say, is 15 db worse at a given distance than is at present obtained in Band I—which is not unlikely—the kind of service provided, for example, at 30 miles in Band I could only be provided at about 15 miles in Band IV. No account has been taken of the effects of man-made or extra-terrestrial noise in these arguments. Evidence is to some extent conflicting, but the amount by which it seems possible that these effects will decrease in the u.h.f. as compared with the v.h.f. bands will not seriously change the arguments advanced in this article.

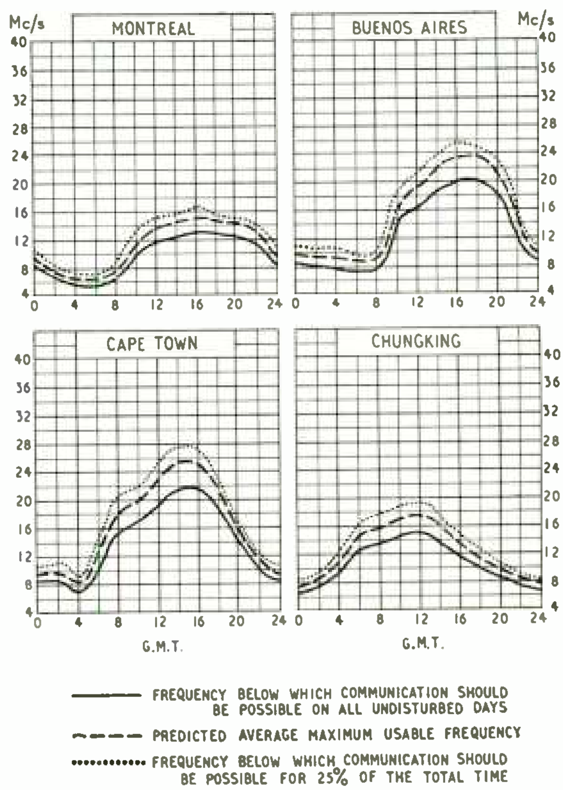
It is in the nature of things that rough terrain should produce wider variations of field strength at u.h.f. than at v.h.f., and whilst some of the effects of variations occurring locally at a receiving site may be eliminated by the use of a suitable directive aerial, little can be done in this way to change significantly the median field strengths. This statistical aspect of broadcast coverage cannot be avoided, and must form the basis upon which plans are made for serving any given area.

Short-wave Conditions

Predictions for April

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 April.

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



LETTERS TO THE EDITOR

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

Aircraft Flutter

THERE was an unfortunate error in the report of the Television Society's Exhibition (February issue) in connection with my method of simulating aeroplane flutter. I agree that a flutter produced by "an input attenuator" would be "somewhat artificial," and it was for this reason that I did not use it. The simulator in fact operated by preparing a delayed signal of controllable amplitude, passing it through a continuously variable 360 deg phase shifter (at 45 Mc/s) and adding it back on to the main signal. One revolution of the phase shifter therefore produced one cycle of flutter.

The time delay was obtained by about 100 yards of coaxial cable. The phase shifter consisted of four stator sets of quadrantal condenser plates with a quadrantal rotor set revolving inside, and was constructed from two standard 50-pF air dielectric trimmers. The four stators were fed with voltages having successive 90 deg phase shifts (obtained by three lengths of cable cut to one-quarter-wavelength each at 45 Mc/s), and the output was taken from the rotor with a capacitive load adjusted to minimize the incidental small-amplitude fluctuations of the phase-shifted signal. The rotor was driven at a controllable speed via a 30:1 reduction gear box, a small shunt motor, and a Variac transformer from the mains.

In the interests of accuracy, it would perhaps be better to say that frequencies up to some 10 c/s are passed, rather than "in the region of 10 c/s," as the frequency of minimum voltage loss through the coupling circuit is about 0.5 c/s.

A further small point is that in your diagram (page 73 of *W.W.*, Feb., 1954) the third valve shown, the video output valve, should of course be labelled "V.F." and not "A.F." H. B. S. BRABHAM.

G.E.C. Research Laboratories,
Wembley, Middlesex.

Technical Qualifications

IF your correspondent "Engineer Abroad" (January issue) would enter upon the British scene he would find a revelation awaiting him. There he would find technologists, technicians, boffins, applied scientists, etc., all working together as a team to form a radio industry second to none in the world.

Your correspondent pours scorn on radio engineering education in Britain and predicts its effect upon the efficiency of the radio industry. By what yardstick does he measure efficiency? Quality, output or the "professional status" of the members of the industry? If it is quality and output, the present radio engineering education system is certainly justified. The men who enjoy the titles of technicians, boffins, technocrats, designers, research workers and others so revolting to "Engineer Abroad" are radio engineers in their own right; men who have learned theory and practice and how to combine the two to produce results of a high order.

"Engineer Abroad" would eliminate all those titles and would like to do away with all or most of the engineering qualifications and associations as well. This is a strange contradiction in his plea for increasing "professional status." It is all the more so since there is no suggestion as to what the qualifications would be for his "radio engineer." He is indulging in over-simplication if he considers that an academic training such as bestows professional status for example, in the older branches of engineering would be adequate in the vast and increasingly complicated field of electronics. It might satisfy the student and the public but hardly the industry which depends on output for its existence. As the field of electronics widens more associations and qualifications will be required to keep members in touch with the intricate details of their particular branch and as a proof of status in a particular branch.

In conclusion, one wonders what qualifications your correspondent would demand for a "radio engineer." Would the boffins and applied scientists who conceived and developed radar be eligible, or would a university degree in any engineering subject be the hall-mark?

RADIO ENGINEER.

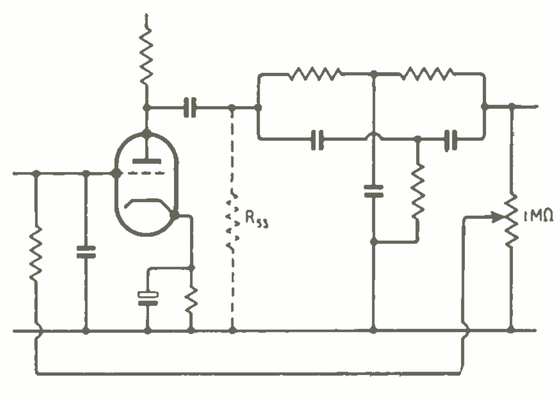
Legal Posers

HERE is a thought, prompted by a letter from one of your correspondents on the subject of television set oscillator radiation. My neighbour's television set (within 100ft) re-radiates the TV programmes at excellent strength from its intermediate frequency amplifier (16 and 19.5 Mc/s for vision and sound respectively). If, by broadbanding my short-wave receiver, I now use these spurious radiations to operate my own television set, do I require a vision licence? And does a "sound" licence cover the "sound" half of the television signal also?

Liverpool, 20. W. BLANCHARD, G3JKV.

Williamson Tone Compensating Unit

IN the switched low-pass filter shown in Fig. 19 of the article High Quality Amplifier (*W.W.*, Vol. LV, No. 11, pp. 426-7, Nov., 1949), it would appear at first sight that by moving R53 to the output end of the parallel-T network, and by using a 1 MΩ potentiometer instead of the fixed resistor specified, control of the loop gain would be possible, thus providing a variable slope feature.



Having no equipment to check results, I would welcome any comments that readers who may have tried this arrangement have to make. JOHN J. CLARK.

Chippenham.

"Plug and Socketry"

C. LISTER'S excellent article (February issue) throws welcome light on this vexed problem of "when is a plug not a plug." But, in my opinion, his suggested table of definitions does not quite meet our requirements as it shows a device having "holes" to be at one instant a socket and, later in the table, a plug.

I suggest that a plug or socket should be defined by function. As everyone knows, the function of a plug and socket is to convey electric current from one point to another. The *contacts* perform this function *regardless* of the type of moulding in which they are mounted, therefore I submit that the type of contact should be the identifying factor. Furthermore, much confusion can be avoided by using the word "pole" instead of "pin" as in the following table:—

N pole plug.—One portion of a plug and socket having N male metallic contacts. Intended for use as a cable attachment or as a rigidly mounted unit.

N pole socket.—One portion of a plug and socket having N female metallic contacts. Intended for use as a cable attachment or as a rigidly mounted unit.

The use of the word "free" for a cable-attached device and "fixed" for a rigidly mounted unit is also to be recommended.

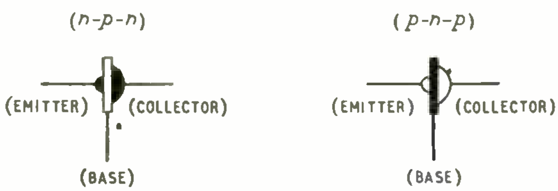
Therefore, my description of the plugs and sockets in Fig. 1 (Mr. Lister's article) would be:—

A: 3-pole plug. 5 amp. Free.
B: 3-pole socket. 5 amp. Fixed.
C: 3-pole socket. ? amp. Free. (Male moulding.)
D: 3-pole plug. ? amp. Fixed (Female moulding.)

London, N.4. P. BROWN.

Transistor Symbols

I DIFFER from F. Oakes (p. 127 March issue) in thinking that the original transistor symbol, introduced at the time of the point transistor, is no longer adequate. By all means retain it in its original context, but let us have a new symbol for junction transistors, and one which will give the maximum information with the least work for the printer and drawing office. Here is my suggestion:—



The lettering would appear only in a glossary of symbols. Useful mnemonics might be "black—dense with electrons—negative—n-type" and "white—full of holes—positive—p-type"; "collector—more power—larger electrode."

HENRY MORGAN.
Hindhead.

Ignition Interference

RECENTLY, in your excellent publication, you published letters (M. S. Morse in October, R. Oster in February) that would lead your readers to believe that television viewing in the U.S.A. is completely free from automobile ignition interference. This is definitely not true. Messrs. Morse and Oster are very fortunate if they have never experienced it. We not only enjoy this distraction at times in some fairly high-signal-level areas, but we can be and are occasionally bothered by interference from household appliances. Contrary to Mr. Oster's statement, all appliances are not filtered by the manufacturer. A partial list of interference sources would include electric shavers, oil-burner ignition systems, defective neon signs, thermostatic devices and fluorescent-light starters.

Although older cars seem to be the major source of interference, brand-new cars have no ignition-noise suppression built in unless they are sold with radio. A few non-radio cars may have suppressor-type spark plugs, however. Motor trucks seem to be a greater source of interference than passenger cars, possibly because the spark is "hotter" and the leads are longer.

The American Radio Relay League, the national organization of radio amateurs, has organized a demonstration of most TV reception complaints (which includes the sources mentioned above plus others like FM and TV receiver oscillator radiation, diathermy, and short-wave transmitters associated with other services, etc.) and has presented it to TV servicemen in most of the leading cities throughout the country. (An article describing the demonstration can be found on page 16 of the October, 1953, issue of *QST*.) The demonstration is conducted by Lewis G. McCoy, who has also appeared on a number of TV programmes to tell local audiences the "whys" and "wherefores" of some of their troubles.

I do not wish to leave you with the impression that we do not enjoy good TV viewing in this country—we do—but I would like to correct any notions that we have *no* intereference problems (including automobile ignition). Some of our interference can be traced to poor receiver design—we have some excellent receivers and some poor ones, but we trust that, in time, the poor ones will disappear from the market. But even the best designs do not have a built-in brain that will respond to radio energy that is part of a TV signal and yet not respond to r.f. energy of the same frequency and comparable magnitude that comes from a source other than a TV transmitter.

West Hartford, Conn., U.S.A. BYRON GOODMAN, W1DX.
Assistant Technical Editor, *QST*.

Tribute

IN view of the number of times that the opposite side of the picture has been presented, I think that your readers would appreciate the following tribute which appears in the March, 1954, issue of the U.S. publication *Radio Electronics*.

"Recently Britain, which has sent us so many excellent high-fidelity products and circuits, has produced a tone-compensating circuit (introduced by Baxendall*) which for a combination of virtue and simplicity is little short of fabulous."

Incidentally the writer of this article, Mr. Joseph Marshall, has some very excellent ideas himself on high-fidelity amplifiers which I hope you will acknowledge as graciously should you decide to pass them on to your readers.

Montreal, Canada. C. M. WELLS.

* *Wireless World*, October, 1952.

World Television

TELEVISION development and/or future plans in some 50 countries are reviewed in "Television: A World Survey," one of a series of reports on the facilities of mass communication issued by U.N.E.S.C.O. Although based on information available a year ago it will be found of inestimable value to manufacturers interested in the export of television gear.

While it reviews closely the financial and administrative organization of television in each country and gives a brief history of its development, there is a considerable amount of information of interest to the radio engineer. Details are given of the standards adopted, frequencies employed, transmitter power, type of aerial and approximate service area, and on the method of linking stations.

The book surveys the plans made by 52 countries to provide or extend their television networks. Brazil, for instance, which at present operates three stations on the 525-line standard, plans to establish 290 transmitters.

"Television: A World Survey" is obtainable from H.M.S.O. price 9s 6d.

Transistors for High Frequencies

Importance of Reducing Base Layer Thickness

A NOTE on p. 119 of the previous issue described the new Philco junction transistor, which has an alpha cut-off in the region of 40 Mc/s and which depends for its success upon the production by electrolytic etching of a working region only 0.0002in thick. A new junction transistor has also been announced by the Radio Corporation of America (*RCA Review*, Vol. XIV, No. 4, p.586, Dec. 1953), with an alpha cut-off frequency of about 10 Mc/s.

The RCA transistor appears to have been designed with the broadcast receiver in mind, so that gain at 455 kc/s is of paramount importance, and no advantage is to be gained by spending money on extending the response above about 2 Mc s. In their approach to the problem, Mueller and Pankove have considered two effects. The first of these is associated with the fact that in the base region the minority carriers diffuse through from the emitter to the collector without very much encouragement from any electric field. As the input to the emitter is varied the number of carriers must vary too, and so the actual number in transit will vary. There is a sort of space charge in the base, and the need to drive this space charge provides a rather large emitter-base capacitance term in the equivalent network. For the RCA TA-153 *p-n-p* audio transistor the capacitance is about 0.01 μF.

Diffusion Technique

Since the number of carriers in transit increases as the base is made thicker, this capacitance increases with base thickness, and in fact is proportional to the square of base thickness. It does not depend on the junction area, but it is proportional to the direct current. RCA have aimed at a spacing between the collector and emitter junctions of 0.0005in, which is 2½ times the Philco spacing. They stress the advantage of having the electrodes as nearly flat as possible, but they make their junctions by the indium alloying process. Each junction is internal, and is produced by diffusing indium into a germanium wafer. Small discs of a germanium-indium alloy are applied to the wafer and the assembly is heated: the indium soaks in until the two doped regions are separated by the required distance.

Having decided to use a thin wafer so that the junctions will be flat rather than hemispherical, a new difficulty arises. The emitter diameter will be about 0.01 in, and even if a base contact could be arranged round the emitter with a radius of 0.010 in, the series base resistance would be 70 ohms. Moving out to 0.040 in would increase this to 200 ohms. In the equivalent circuit shown in Fig. 1, this resistance is $r_{bb'}$ and in combination with $C_{b'e}$ is obviously of vital importance in determining high frequency response. To make $C_{b'e}$ small, the wafer thickness must be small: to make the wafer thickness small is to increase $r_{bb'}$.

Surface Recombination

There is yet another difficulty. It is not possible to apply the base connection too near to the emitter junction, as such an ohmic connection to the germanium surface provides a region in which the surface recombination of holes and electrons can take place very easily. The solution adopted by RCA is to drill a small pit in a thick germanium wafer, to give a structure of the form shown in Fig. 2. Round the junctions there is only germanium, so that no recombination troubles are encountered: away from the actual junction region the germanium is thick, and the value of $r_{bb'}$ is kept down to about 50-100 ohms. The actual junctions are 0.015 in and 0.010 in diameter, compared with the 0.004 in and 0.002 in of the Philco transistor.

The larger size of the junctions in the RCA transistor is reflected in the choice of working point. Where Philco operate at $I_c = -0.06$mA, $V_c = -0.5$V, the figures for the RCA transistor are quoted at $I_c = -1$mA, $V_c = -6$V, so that we should expect to see a factor of 16 to the advantage of Philco so far as $C_{b'e}$ is concerned. On the other hand, the RCA unit will have a lower value of $r_{bb'}$, which will offset this to some extent.

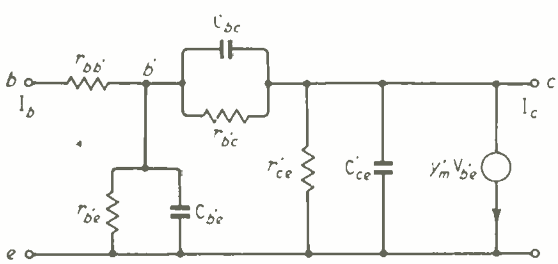


Fig. 1. Base-input single-generator π-equivalent circuit of transistor.

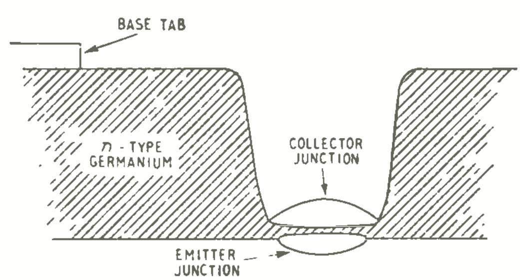


Fig. 2. Cross-section of junction in the RCA high-frequency transistors.

The performance obtained with the well-type *p-n-p* junction transistor is not easily compared with the performance of the surface barrier transistor. At 455 kc/s, however, matching both input and output, and neutralizing the feedback due to the base resistance, a gain of about 35 db is obtained. Using rather simpler circuits, without feedback neutralization, gains of 22.25 db at 1 Mc/s, and of 8-13 db at 10Mc/s have been obtained. At 1 Mc/s the noise factor is only about 4-8 db, which is not likely to cause any embarrassment in the design of a broadcast receiver.

No details are given of the method adopted for producing the pit. It is therefore impossible to form any estimate of the relative ease of manufacture of these two new ways of manufacturing high frequency transistors.

Just after this note was written further information about the Philco system became available. In a letter in the February 1954 issue of *Proc. I.R.E.* the production by the electrolytic jet etching process of a surface-barrier transistor using silicon instead of germanium is announced. Silicon presents the advantage that it is not so temperature dependent, and the appearance of a junction transistor with $\alpha > 0.95$ and $f_c\alpha > 10$ Mc/s opens up new possibilities.

Acknowledgments. Fig. 1 is based on Fig. 4, and Fig. 2 on Fig. 3 of "A *p-n-p* Triode Alloy Junction Transistor for R.F. Amplification" by C. W. Mueller and J. I. Pankove, *RCA Review*, Dec. 1953, p.586.

Calculation of Coupling

By FRANCIS OAKES* M.Inst.E.

Mutual Inductance and Coupling Coefficient on the Slide Rule

EVALUATION of the well-known formula $M = k\sqrt{L_1L_2}$ which applies to the primary and secondary inductances, the mutual inductance, and the coefficient of coupling of a transformer, is frequently required for circuit design and in everyday laboratory practice. A rapid numerical solution can be found on the slide rule, provided that in addition to the ordinary and square scales the slide carries also a reciprocal scale.

As shown in the accompanying diagram, the inductances L_1 and L_2 are set on the square scales, the mutual inductance M on the normal scale, and the coefficient of coupling *k* on the reciprocal scale. For example, the self and mutual inductances of a short-wave aerial coil were measured, and found to be 0.62, 3.7 and 0.41 μH respectively. As shown in the illustration, the coefficient of coupling *k* is 0.27.

It is important that the inductances L_1 and L_2 should be set in the left section of the square scale if the position of the decimal point involves an even power of ten, in the right if an odd power. Thus, 3.7 is set in the left section, because 3 corresponds to 10^0 (in this context 0 is regarded as an even number); 0.62 is set in the right section, because the position of 6 corresponds to 10^{-1}, an odd power of ten.

It can be seen from the diagram that not only can *k* be evaluated from M, L_1 and L_2, but that any one of the four parameters can be found by this method when the other three are given. Thus, for instance, the primary inductance L_1 can be found for given values of L_2, *k*, M, by bringing *k* on the reciprocal scale to coincide with L_2 on the square scale of the stock, and finding the required value L_1 on the square scale of the slide, without further movement of the slide, by setting the cursor to M on the normal scale of the stock, as shown in the illustration.

Proof : The linear distance between L_1 and L_2 is equal to the linear distance between *k* and M, but since L_1 and L_2 are set on logarithmic scales of half the length unit and *k* of the same unit but opposite direction than the normal scale on which the setting of M is effected, the following equation holds good :

$$\tfrac{1}{2}\log L_1 - \log\frac{1}{k} = \log M - \tfrac{1}{2}\log L_2$$

The left side of this equation relates to the slide, and the right to the stock.

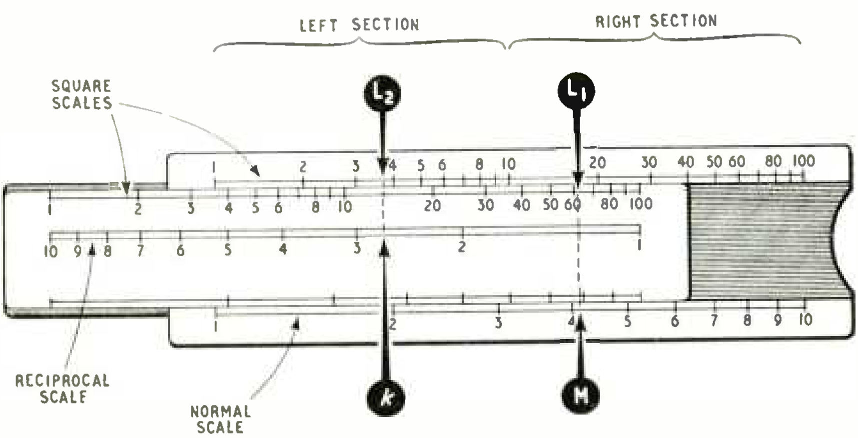
$$\tfrac{1}{2}\log L_1 + \tfrac{1}{2}\log L_2 - \log\frac{1}{k} = \log M$$

$$\tfrac{1}{2}\log L_1L_2 + \log k = \log M$$

$$\log\sqrt{L_1L_2} + \log k = \log M$$

$$\log k\sqrt{L_1L_2} = \log M$$

$$\therefore k\sqrt{L_1L_2} = M.$$



Inductances are registered on the fixed and sliding square scales, mutual inductance on the fixed normal scale, and coefficient of coupling on the reciprocal scale.

* Ferguson Radio Corporation.

Band III Television Aerials

Evaluation of Requirements from Available Data

By F. R. W. STRAFFORD,* M.I.E.E.

THE Postmaster-General has already announced the frequencies for the alternative transmissions in Band III. Provisionally two channels will be available within the Band III spectrum of 174–216 Mc/s. These will be designated as follows: channel 8 186–191 Mc/s. (Midlands), channel 9, 191–196 Mc/s. (London and South Lancs).

There is no information as yet regarding the siting, power, or mode of polarization for the transmitters, and without this fundamental data it is impossible to relate Band III aerial requirements to Band I unless certain assumptions can be made.

A realistic approach may be based on the assumption that both transmitters are radiating the same amount of power from the same site. It is then a reasonably simple matter to decide how much more efficient a Band III aerial must be relative to a Band I aerial in order that the develped e.m.fs be equal.

The theory of propagation of u.h.f. waves over a smooth but curved earth is very complicated.† The field intensity at a receiving site is related to the respective heights of the transmitting and receiving aerials, their distance apart, and the dielectric constant and conductivity of the earth. No matter how these parameters are disposed the field intensity is always proportional to the square root of the power, W, radiated from the transmitting aerial.

If one considers a separation between transmitting and receiving sites which is considerably greater than the respective heights of their aerials (Fig. 1), so that the grazing angle, θ, of the reflected wave is a few degrees only, a useful approximate expression for the field intensity, up to, but not beyond, the horizon is :—

$$E = \frac{0.01\sqrt{W}\,h_T\,h_R\,f}{d^2} \text{ microvolts/metre} \quad (1)$$

where h_T and h_R are the respective height of the transmitting and receiving aerials in feet, d is distance in miles, and W is watts in a *half-wave* transmitting dipole. f is in Mc/s. One often sees the expression e.r.p. (effective radiated power) for a transmitting aerial which takes into account the increased radiated power, in useful directions, obtained by stacking a number of radiators into an array.

For a given output power from the final stage of the transmitter, and a given volume into which an array can be packed, it is clear that more half-wave dipoles can be "phased up" on Band III than on Band I because individual dipoles are only one quarter the size (the frequencies are approximately in the ratio 4/1). Thus, a greater e.r.p. is possible from Band III from the aerial viewpoint, but it must be remembered that serious limitations may restrict the amount of power available for feeding the aerial since a considerable increase in frequency is involved and all sorts of limitations in transmitter output valve performance will creep in.

Equation (1) is useful for computing average field strengths up to the horizon but is quite useless beyond it. It is here that one encounters diffraction phenomena which have the net effect of reducing, very rapidly, the field intensity, and of having a *far greater adverse effect on Band III than on Band I.* Useful empirical formulæ[1] for field intensity beyond the horizon for Bands I and III respectively are :—

$$E_1 \text{ (Band I)} = \frac{0.01\sqrt{W}\,h_T\,h_R\,f_1\,D_h^{2}}{d^4} \ \mu\text{V/m} \quad (2)$$

and

$$E_3 \text{ (Band III)} = \frac{0.01\sqrt{W}\,h_T\,h_R\,f_3\,D_h^{4.8}}{d^{6.8}} \ \mu\text{V m} \quad (3)$$

A new term D_h appears in these two equations and is the distance from the elevated transmitting aerial to the horizon, and is equal to $1.25\sqrt{h_T}$ at the latitude of London (not critical for U.K.).

It is important to recognize that these equations are largely empirical and cannot take into account the normal departure from a smooth curved earth. Buildings, trees, and the general undulation of the countryside must produce irregularities so that at a given distance the field strength may be considerably above or below the calculated values. Nevertheless the smooth curves of field intensity, as a function of distance, are likely to represent average values.

The field strengths calculated for Band I and Band III from these formulæ are not very helpful unless they can be related to the amount of signal they will induce in a receiving aerial. Now, the e.m.f. generated across the centre connections of a half-wave dipole whose radiation resistance is matched to the receiver input impedance is well known to be[2] :—

$$e = \frac{E\lambda}{2\pi} \quad (4)$$

where E is the incident field strength and λ is the desired wavelength.

Let λ_1 = Band I wavelength (metres)
f_1 = Band I frequency (M/cs)
λ_3 = Band III wavelength
f_3 = Band III frequency.

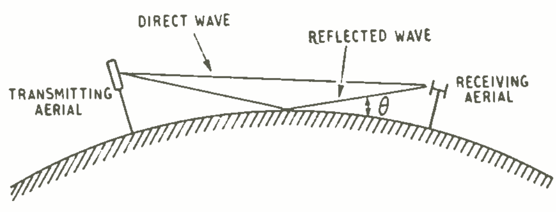


Fig. 1. Propagation conditions known as "grazing incidence," where θ is a very small angle.

* Belling and Lee Ltd.
† Propagation over radio line-of-sight paths is discussed elsewhere in this issue.—ED.

By substituting equation 4 into equations 1, 2 and 3 we obtain the following for the signal e.m.f. developed in a simple half-wave dipole, which is an excellent standard of reference.

Up to the horizon :—

$$e_1 = \frac{0.0016\sqrt{W}\, h_T\, h_R\, f_1\, \lambda_1}{d^2} \quad \text{Band I } \mu\text{V} \quad \ldots (5)$$

$$e_3 = \frac{0.0016\sqrt{W}\, h_T\, h_R\, f_3\, \lambda_3}{d^2} \quad \text{Band III } \mu\text{V} \quad \ldots (6)$$

Beyond the horizon :—

$$e'_1 = \frac{0.0016\sqrt{W}\, h_T\, h_R\, f_1\, \lambda_1\, D_h^{2}}{d^4} \quad \text{Band I } \mu\text{V} \quad (7)$$

$$e'_3 = \frac{0.0016\sqrt{W}\, h_T\, h_R\, f_3\, \lambda_3\, D_h^{1.8}}{d^{6.8}} \quad \text{Band III } \mu\text{V} \quad (8)$$

Now the product $f\lambda$ is a constant since one is inversely proportional to the other, so that up to the horizon the signal e.m.f. induced in a half-wave receiving dipole is identical for Bands I and III, providing all the other parameters are unvaried. Beyond the horizon the diffraction effects take control *and attenuate the Band III signal very much more rapidly than Band I.*

Curves are plotted in Fig. 2 on the following basis:

Height (h_T) of transmitting aerial	625 ft.
Height (h_R) of receiving aerial	30 ft.
Band I frequency (f_1)	55 Mc/s.
Band III frequency (f_3)	190 Mc/s.

As expected, the Band I and III curves are coincident up to the horizon but split thereafter with rapid falling off on Band III. From this one immediately realizes why increasingly high frequencies seriously restrict the useful range. The curve for Band IV propagation, although not under general discussion, shows why transmissions at these frequencies are almost confined to line-of-sight conditions. Field reports from the United States of America are already confirming this.

According to a report by R.C.A.[3] their Band IV

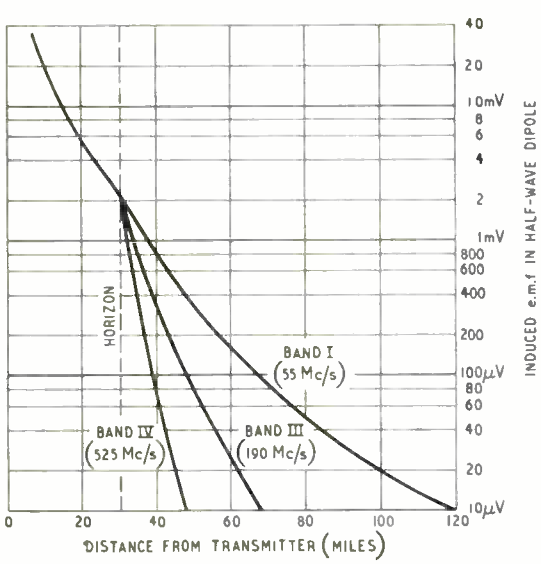


Fig. 2. Induced voltage in a simple half-wave dipole.

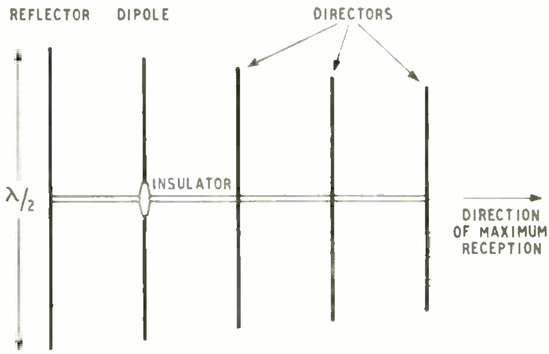


Fig. 3. Details of the Yagi aerial.

station KPTV at Portland, Oregon, with an aerial located at about 1,000 ft above average terrain and operating on channel 27 (548–554 Mc/s), strongly suggests that first-class reception is confined to those receiving installations where the aerial is in optical view of the transmitting aerial! This naturally excludes sites which are close but obscured from view by neighbouring buildings because "swamp" field intensities obviously exist. Another interesting point to be gleaned from Fig. 2 and equation 8 is that, since the horizon distance is proportional to the square-root of the height of the transmitting aerial, doubling the latter will *double* the normal service area within the horizon.

On the other hand, doubling the transmitter power will only extend the service area by a few per cent because of the rapid attenuation beyond the radio horizon.

The recipe for good transmitter coverage on Band III is "large helpings of mast height with power added to taste."

Aerial Requirements

Returning to the essential problem of Band I and III transmissions, it would appear that a simple half-wave dipole at a range of 30 miles from the transmitter would provide excellent reception if the conditions specified for W, h_T and h_R were met. Bearing in mind the increased attenuation, with frequency, of obstacles such as buildings, it might be fair to estimate that, within 20 miles of a station as described, a well exposed Band III dipole would be as effective as a similarly erected Band I dipole at about 30 miles. Indeed, U.S.A. surveys seem to suggest this.

Making allowance for this probable 30% reduction in distance due to practical receiving conditions it would appear that recovery of the lost signal at a given range within the horizon will require a receiving aerial gain of 7 db, and this can only be achieved by an economical combination of increased height and multi-element aerials.

Thus, at limit distance for Band I (B.B.C. high power) with simple outdoor dipoles a multi-element array may be essential for equally satisfactory reception on Band III.

Since this condition exists at about horizon distance it is very obvious from the curves of Fig. 2 that, beyond the horizon, at distances where multi-element aerials are required for Band I, little or nothing will be received on Band III unless very elaborate aerials are used and are erected at abnormal heights.

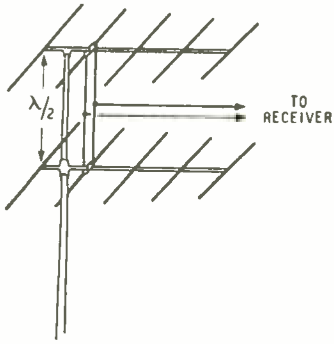


Fig. 4. Stacked Yagis have a gain of 3db over a single unit.

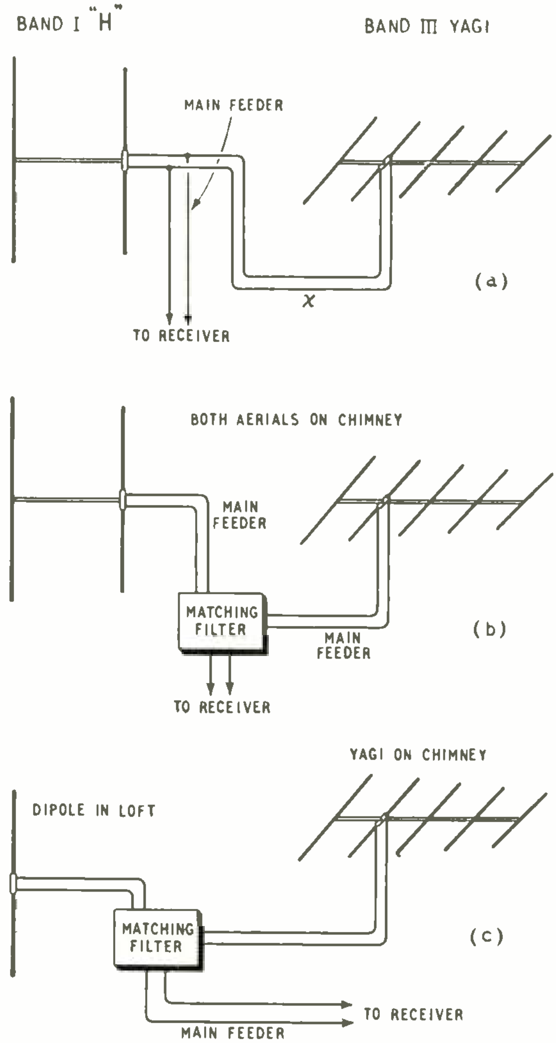


Fig. 5. (a) Two dissimilar aerials connected to common feeder via matching section x, (b) by means of a matching filter located near receiver, (c) by a filter adjacent to one of the aerials.

The simplest multi-element arrays for TV reception are based upon the Yagi system named after its discoverer[1] in 1928 (note the very early date). Essentially it is a simple half-wave dipole backed by a reflector element placed at from 0.15–0.25 wavelength behind it, and with one or more director elements placed in front at spacings of about 0.1 wavelength (Fig. 3).

This arrangement provides the basis for at least 90% of the multi-element TV aerials used throughout the world to-day. Notice that the reflector is slightly longer than the dipole, whereas the directors become progressively shorter. It is essential to follow this technique if a good directional characteristic with optimum gain is to be achieved along the direction of the arrow.

It is erroneously thought that the number of elements determine, uniquely, the gain of such a system. The total length is a major contributory factor, and it can be shown that, for a given length, l, of the array there is an optimum number of directors beyond which no improvement will result. Thus a Band III array with an overall length of, say, five feet comprising a reflector, dipole, and twelve directors, may be inefficient compared with an array having a length of ten feet with a reduced number of directors. Additional reflectors, incidentally, contribute inappreciably to the performance.

According to R. A. Smith[5] it is suggested that the forward gain of a Yagi aerial of total length l is approximately $3l/\lambda$ greater than a half-wave dipole. This only holds for arrays longer than one wavelength which, at 190 Mc/s, is approximately five feet and an array of four feet in length comprising one reflector, a dipole, and three directors should provide a matched gain of about 7 db over a dipole, which brings the reader back to the earlier suggestion that if a dipole gives good reception at the horizon on Band I a five-element Yagi should provide the same result on Band III, assuming the transmission and reception conditions are as originally outlined.

Band III Aerials

This may be a slight exaggeration of what will happen in practice because the sharp directivity of the Band-III Yagi compared with the omnidirectional Band I dipole will improve the signal-to-noise ratio of the former in the presence of ambient man-made and terrestrial interference fields such that a more efficient performance will result. It is more likely that a Band III Yagi array about three feet in length and with one director will be a satisfactory substitute for the Band-I dipole under these receiving conditions.

It has been stated that a gain of 7 db is possible with a four-foot Yagi. If higher gains are required it may not be wise to increase the length (l) of the array and add additional elements, because the bandwidth decreases and may impair picture definition. Experience is needed under field conditions to determine how far one may extend the Yagi array without impairing picture quality.

By stacking two identical arrays (Fig. 4) at a spacing of not less than half a wavelength (2 ft 6 in) and connecting their outputs in phase, an improvement of 3 db in gain may be effected. This 3 db does not seem to be a very useful increase—it is only $\times\sqrt{2}$—but it must be clearly remembered that when receiver threshold noise is present 3 db represents the difference between an acceptable and useless picture.) This has been proved because long experience on Band I has taught the installer that the advantage to be gained by using an " H " aerial over a dipole is definite and economically worth while when signal strength is low, and our better knowledge of aerial measurement techniques, coupled with more accurate apparatus, indicates that the optimized "H" averages about 3 to 4 db better than a dipole.

A problem which faces the designer is that of accommodating these additional aerials, or stacks of aerials, on the typical dwellings of this country, bearing in mind particularly the semi-detached suburban dwellings with one small chimney stack per two or more families. It may be necessary to erect masts on a ridge-tile fitting and support them by sets of guy wires.

The siting of Band III aerials will call also for closer attention than hitherto. U.S.A. installers have found it necessary to "probe" the space above a building for a position of maximum field strength. The greater reflectivity of surrounding buildings gives rise to stronger standing-wave patterns than on Band I so that the accidental location of the aerial in a deep minima may have a serious effect.

The possibility of increased "ghosting" may exist, but greater use of multi-element arrays, with their sharper directivity, may offset this.

Combined Aerials

The author may be getting into deep water by descending from the technical to the psychological, but when an alternative TV service is established, it seems obvious that if it is properly planned it will be as necessary to the viewer as the Light and Home programme is to the listener. This seems to be reasonable because no one would think of purchasing a broadcast receiver capable of receiving the Home programme but not the Light, or vice versa.

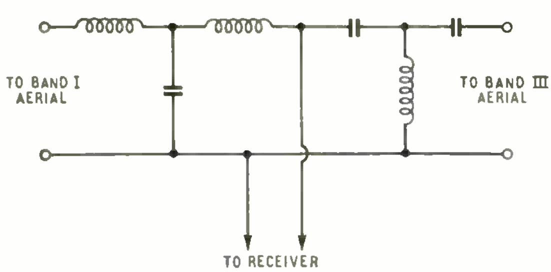


Fig. 6. Generic circuit for a matching filter.

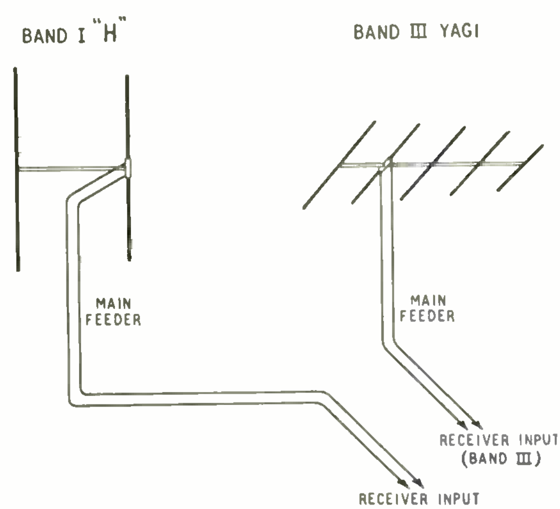


Fig. 7. Band I and III aerials with entirely separate feeders.

If this reasoning is sound the potential viewers for alternative TV must be about equal to the number of existing viewers with only the £ *s d* problem to solve.

Based on Band I experience there will always be a large number of fringe viewers, and because of range limitations on Band III they will now be located on the outskirts of the densely populated areas, thereby increasing the fringe viewer density. The problem of connecting Band III aerials to existing Band I installations calls for considerable thought on technical and economic grounds. Aerials connected to transmission lines cannot be paralleled in the manner of extension loudspeakers or doorbells, and the average installer would not possess the skill nor the apparatus for determining the correct points of attachment.

If the aerials are in close proximity the Band III feeder may be cut to a length x (Fig. 5a) such that its impedance-transforming properties will provide substantially independent matching of either aerial on its particular frequency. This length x can only be deduced from a knowledge of the impedance at the dipole terminals of the Band III aerial, and is best determined experimentally.

But the main feeder to the receiver may be unduly lossy for efficient Band III signal transfer because it will be doubled in any event due to the 4/1 increase in frequency. In this case a separate feeder of low inherent loss must be run to the receiver, and if the latter is equipped with but a single input socket some form of matching filter (Fig. 5b) must be used to maintain mutually exclusive performance of the two aerials. The two receiving aerials may be widely separated; for example Band I in the loft and Band III on the chimney—again the matching filter (Fig. 5c) is needed. A generic circuit for such a filter is shown in Fig. 6 and is clearly a combined high-pass and low-pass network.

The more flexible arrangement, whereby complete independence of operation on either band is assured, makes use of separate feeders for the aerials (Fig. 7) but requires separate input sockets on the receiver. While it is technically sound there is the difficulty of adding extension aerial sockets in other rooms and the cost of installing the extra feeder, where, in many cases, a matching filter might be branched-in much closer to the aerial.

The technical and economic problems involved cannot be solved without statistical assistance based on an established service, but they will assuredly be tackled and solved with minimum delay when the time arrives, and because this is the age of miracles some of them may be solved earlier.

The author wishes to acknowledge with thanks the assistance of a colleague, I. A. Davidson, in carrying out the computational work involved in preparing the graph of Fig. 2.

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[3] "*Broadcast News*" published by R.C.A. October 1953.
[4] H. Yagi, Beam transmission of ultra-short waves. *Proc. I R.E.* (N.Y.) Vol. 16, p. 715 (1928).
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"AUTOMATION" By LEON G. DAVIS

Mass Production of Electronic Sub-assemblies by Automatic Plant

IT is perhaps logical that the development of a new system of electronic construction should find its first important application in an automatic production line for the manufacture of electronic equipment. The system that makes this possible is described by its developers at the U.S. National Bureau of Standards as "modular design of electronics for mechanized production of electronics." It utilizes mechanically standardized sub-assemblies or "modules" (see Fig. 1), which can be produced with a wide range of different circuit configurations.

Starting from raw or semi-processed materials, machines automatically manufacture ceramic components and adhesive carbon resistors, print circuits and mount resistors, capacitors, and other miniaturized components on standard ceramic wafers ⅞in square by 1/16in thick. Special components not suitable for printing techniques can also be incorporated. The wafers are then stacked up to form the "modules." Automatic inspection machines, controlled by information on punched cards, check the physical and electrical characteristics of the wafer circuits at numerous points along the production line.

The completed "module" combines all the requirements of an electronic circuit with ruggedness, reliability and extreme compactness. In general, it comprises about four to six wafers. A number of individual "modules" can be combined to form a major sub-assembly, and this operation can also be done by machines. The pilot plant, now being operated under contract by the Kaiser Electronics Division of Willys Motor Company, is designed for a production goal of 1,000 "modules" per hour.

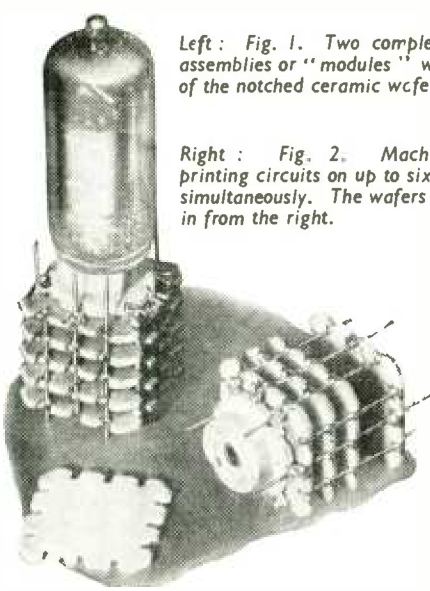
The system dispenses with the conventional circuit diagram of the tested electronic prototype and places all necessary production programming information on a work sheet. Each work sheet contains the front and back outlines of six wafers with appropriate numbering to identify each notch in the wafer, each vertical connecting wire, and the component that is to be placed on the wafer. The engineer translates his conventional wiring diagram to this type of diagram. He indicates the position of the component and its proper value and tolerances, and lines are drawn to indicate how the circuits between wafers are to be connected.

In addition, the work sheet is used to establish the inspection procedure. The current paths on each wafer are recorded on punched cards and these accompany the wafers through all the manufacturing processes. The work sheet is also used in the construction of standard "modules" or counterparts which are employed in the final testing and inspection.

Producing the Ceramic Parts

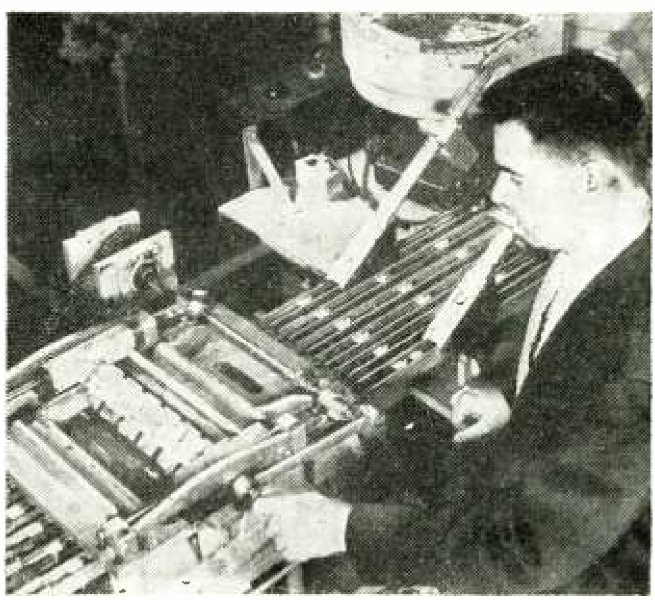
The wafers and valve sockets are produced from raw materials and are stamped out at a rate of about 2,800 pieces per hour. They are then cured at 2,300°F in a tunnel kiln. The wafers are mechanically gauged, and all pieces which do not fit within close tolerances are rejected. They are pressed with twelve peripheral notches (three on a side) and a keying notch on one side. In the final assembly, wires are mechanically soldered into these notches to serve as physical supports and electrical connectors.

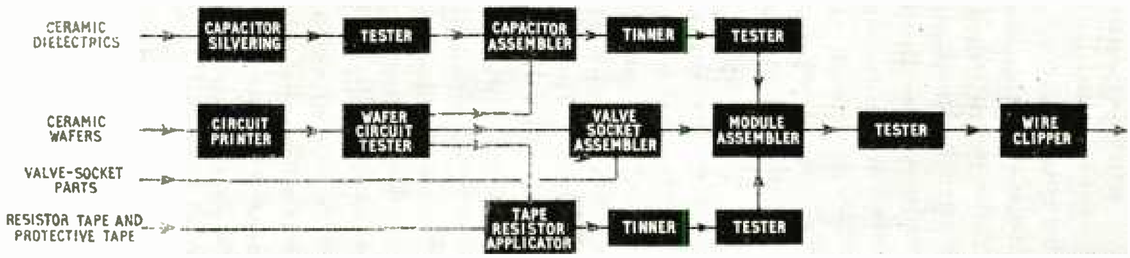
Capacitor dielectrics are manufactured in very much



Left: Fig. 1. Two complete sub-assemblies or "modules" with one of the notched ceramic wafers.

Right: Fig. 2. Machine for printing circuits on up to six wafers simultaneously. The wafers are fed in from the right.





Flow diagram showing the main processes in the automatic production line.

the same manner as the ceramic wafers. The dielectric is non-porous ceramic composed usually of magnesium, barium, calcium and strontium titanates of high purity, organic binders and water. After firing it is about ½in square and 1/50in thick. Capacitances may be varied from 7 pF to 0.01μF by changing the relative proportions of the constituent minerals.

The materials required for the manufacture of the tape resistors are a heat-resistant asbestos paper in tape form, polyethylene tape, carbon black or graphite, resin, and a solvent. The resistor material, a mixture of the carbon, resin and solvent, is ground to a fine adhesive powder. The compound is then sprayed on a loop of the asbestos paper tape and a protective coating of polyethylene tape is applied. A 75ft roll of tape will produce over 10,000 resistors. The tape resistors produced range from 10 ohms to 10 megohms. They will hold their rated resistance within ±10 per cent up to temperatures of about 200°F, and are capable of dissipating ¼ watt.

In another series of operations, appropriate sections of the wafers or capacitor dielectrics are silvered. Circuits are printed on the wafers (Fig. 2), notches are coated, plates and leads are applied to capacitors, furnace-curing takes place and the circuits are inspected. Finally, all silvered surfaces receive a thin coating of solder.

Automatic Orientation

During these metallizing operations the keying notch pressed into each wafer first comes into use. The wafers are loaded into vibratory bowl feeders provided with spiral escape channels, which have a series of four exit ports followed by steps set into them. A small screw is inserted into each exit port, and this permits only those wafers to pass which have their keying notch aligned with it. If a wafer is incorrectly oriented it is turned through 90 degrees as it falls down the channel step following the exit port. A grooved channel inverts it if it has failed to pass through the other four ports and the keying procedure is repeated. As a consequence, all wafers passing from the feeders are oriented in the same direction and have the same surface turned upwards.

Tape resistors, titanate capacitors, valve sockets, and other components are mounted on the wafers between the appropriate silvered conducting patterns. Rolls of resistor tape are placed on a machine that automatically cuts the tape into half-inch lengths, presses the resistors between the printed contacts on the wafer, applies pressure, and ejects the completed resistor-mounted wafer. A single machine is used to mount up to two capacitors on each surface of a wafer. Each capacitor is automatically oriented and the silvered circuit on both surfaces is electrically tested before mounting. In the valve-socket assembler, silvered valve pins are mechanically placed into their proper holes in the socket, a wafer is placed on top, and a rivet binds the two pieces together.

Assembling Operation

After the various parts have been mounted on the wafers the notches in the ceramic are tinned with solder. The machine that performs this operation automatically grips each wafer and dips one side after another into flux and solder.

The wafers with their components mounted on them are now ready for assembly and this operation is accomplished by a single machine. Six vibratory feeders issue the wafers to a loading device that holds the wafers in an upright position between jaws. A chain drive carries this jig to a soldering position, where six more wires are bonded to it. Sections of wire between the wafers are cut out as required by the circuit connections.

During each stage in the production, provision is made for complete automatic inspection. This com-

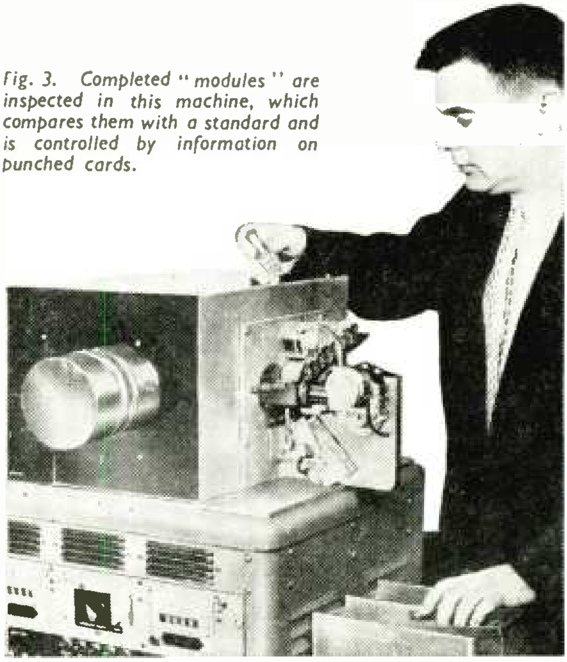


Fig. 3. Completed "modules" are inspected in this machine, which compares them with a standard and is controlled by information on punched cards.

prises both physical gauging and electrical comparison. Printed circuits, resistors, and capacitors are compared with their ordinary prototype equivalents both before and after assembly. This is accomplished by the use of electronic computers, bridge circuits, and other comparison devices. The inspection "code" is carried on the punched cards which were prepared by the design engineer and have accompanied the wafers all through the production process. After the final assembly of each "module" its whole circuit is again tested to see that it meets specifications within set tolerances (Fig. 3).

The new automatic production system should prove of great strategic importance in the event of a national emergency, since the costs for conventional production and maintenance would be formidable in view of the quantities and varieties of equipment needed. The development of the system makes possible a rapid change over from civilian to military products (and back again) at short notice and at the same time allows a greatly expanded production capacity. Most of the operating "know-how" is stored in mechanical fingers and electro-mechanical control mechanisms, and even electronic equipment designs may be stored, ready for production, in the form of punched cards and circuit stencil screens.

COMPONENTS SHOW

WITHIN a few days of the publication of this issue the eleventh Components Show opens at Grosvenor House, Park Lane, London, W.1. This annual private exhibition organized by the Radio and Electronic Component Manufacturers' Federation opens at 10.0 on April 6th for three days. Admission is by invitation ticket obtainable from the R.E.C.M.F., 22, Surrey Street, Strand, London, W.C.2, by bona-fide users of components in design, manufacture or research. A list of the 130 exhibitors, including a number who have not previously participated in the show, is given below. It is hoped to include in our next issue a review of the trends in component design and manufacture as portrayed at the show.

	Stand No.
A.B. Metal Products	33
Advance Components	11
Aerialite	118
Allan Radio	114
Antiference	52
Associated Electronic Engineers	1
Associated Technical Mftrs.	29
Automatic Coil Winder Co.	111
B.I. Callender's Cables	68
Bakelite	122
Belling & Lee	55
Bird, Sydney S., & Sons	53
Bray, Geo., & Co.	93
British Electric Resistance Co.	28
British Mechanical Productions	62
British Moulded Plastics	113
Bulgin & Co.	46
Bullers	4
Carr Fastener Co.	21
Clarke, H., & Co.	92
Collaro	82
Colvern	38
Connollys	60
Cosmocord	76
Creators	100
Daly	105
Dawe Instruments	73
De La Rue & Co. (Plastics)	80
Diamond "H" Switches	3
Dubilier Condenser Co.	69
Duratube and Wire	24
Edison Swan Electric Co.	63
Egen Electric	20
Electro Acoustic Industries	40
Electronic Components	98
Electronic Engineering	128
Electrothermal Engineering	88
English Electric Co.	101
Enthoven Solders	43
Erg Industrial Corporation	119
Erie Resistor	15
Ever Ready Co.	124
Ferranti	16
Fine Wires	91
Garrard Engineering Co.	37
General Electric Co.	129
Goldring Manufacturing Co.	74
Goodmans Industries	12
Gresham Transformers	30
Guest, Keen & Nettlefold	107
Hallam, Sleigh & Cheston	90
Hassett & Harper	117
Hellermann	81
Henley's Telegraph Works Co.	2
Hunt, A. H.	44
Igranic Electric Co.	7
Imhof	57
Jackson Bros.	51
Langley London	126
London Electric Wire Co.	14
London Electrical Manufacturing	42
Long & Hambly	31
Magnetic & Electrical Alloys	39
Marconi Instruments	103
Marrison & Catherall	110
McMurdo Instrument Co.	64
Micanite & Insulators Co.	59
Morganite Resistors	23
Mullard	65, 108, 109
Multicore Solders	66
Murex	5
Mycalex Co.	86
Neill, James, & Co.	123
N.S.F.	61
Painton & Co.	27
Parmeko	48
Partridge Transformers	22
Plessey	49, 67
Pye	130
Radio Instruments	106
Reliance Electrical Wire Co.	47
Reproducers & Amplifiers	75
Reslosound	45
Rola Celestion	35
Ross Courtney & Co.	102
Salford Electrical Instruments	36
Scott, Geo. L., & Co.	89
Simmonds Aerocessories	116
Simon Equipment	83
Spear Engineering	127
Stability Radio Components	72
Standard Telephones & Cables	32, 79
Static Condenser Co.	94
Steatite & Porcelain Products	54
Stocko (Metal Works)	99
Stratton & Co.	10
Suflex	77
Supply, Ministry of	112
Swift, Levick & Sons	125
Symons, H. D., & Co.	97
Taylor Electrical Instruments	18
Telcon-Magnetic Cores	95
Telegraph Condenser Co.	17
Telegraph Construction & Maintenance Co.	78
Telephone Manufacturing Co.	26
Thermo-Plastics	9
Transradio	120
Truvox	71
Tucker Eyelet Co.	6
Tufnol	87
United Insulator Co.	8
Vactite Wire Co.	13
Vitavox	41
Walter Instruments	85
Wego Condenser Co.	25
Welwyn Electrical Laboratories	58
Westinghouse Brake & Signal Co.	34
Weymouth Radio Manufacturing	115
Whiteley Electrical Radio Co.	19
Wimbledon Engineering Co.	84
Wingrove & Rogers	56
Wireless Telephone Co.	70
Wireless World and *Wireless Engineer*	104
Woden Transformer Co.	50
Wolsey Television	96
Wright & Weaire	121

Radio Receiver Characteristics

Attempt to Standardize Measurement and Description of Performance

As its title indicates, the new British Standard Glossary* is confined to *electrical* characteristics, and even some electrical characteristics (such as those concerned with hum, and stability with respect to temperature and supply voltages) are excluded. But within these limits the description "glossary" hardly does justice to it. Not only are more than one hundred terms defined, but there are copious explanatory notes, especially on the theory of noise. The scope of the work, its general terminology, and the conditions assumed, are explained at some length in an introduction. There, with the help of a diagram representing a whole receiver or any section thereof as a four-terminal network connected to a source and load, definite meanings are given to such terms as "output circuit" and "response."

It is much to be hoped that universal adoption, wherever practicable, of standard terms and characteristics will enable results obtained in different laboratories to be fairly compared, and will lead to more definite assessment of receiver performance. Looking at the long lists of receiver properties with such names as "modulation-frequency intermodulation distortion characteristic," however, one cannot but feel the need for a "preferred list." Admittedly receivers of all kinds do between them have a great many characteristics in which somebody, sometime, might be interested, and this Standard tries not to leave any out; but the first impact is rather overwhelming.

New Definitions

A number of the new definitions anticipate the revision of BS.204:1943 (Glossary of Terms used in Telecommunications), which did not everywhere provide a satisfactory basis for the quantitative definitions of the newer work. It is good to see that the misguided effort in BS.204 to displace the commonly-used "frequency distortion" by "attenuation distortion" has now been reversed. "Non-linearity distortion" is now admitted as an alternative to "non-linear distortion"; perhaps in time the latter will be put where it belongs, in the "deprecated" class.

Some inconsistency and uncertainty in the use of terms is noticeable. There is nothing to show that "modulation factor" and "degree of modulation" are not the same thing; but if they are, why not stick to one or other? The same might be said of "change of frequency," "frequency change" and "frequency conversion." In the notes on distortion it is not clear whether a "linear system" does or does not include an ideal detector. In one sense such a detector can be described as linear and in another it cannot. In the definitions of various distortion characteristics it would have been helpful if the measure of the "component magnitudes" had been standardized as either voltage or power and not left ambiguous.

Confusion has for some time existed in the use of the symbol μ; officially it denotes the "amplification factor" of a valve, but some authorities very regrettably use it to mean "voltage amplification" of an amplifier. What could be more calculated to make confusion worse confounded, then, than the introduction, in this new Standard, of "voltage amplification factor"!

In four definitions, harmonic distortion is reckoned in terms of the ratio of the harmonic content to the "response" (i.e., total output) instead of to the fundamental component of the response. As a general principle it is desirable that the unwanted quantity should be compared with the wanted, not with the sum of the wanted and unwanted. On this point BS.2065 is not only in disagreement with the corresponding American standard, but is inconsistent with itself, for in its definition of amplitude distortion the measure of the response is its fundamental component.

Intermodulation Distortion

Although the declared aim of this Standard is generality, it defines intermodulation distortion factor in such a way as to take account only of the second-order (i.e., simple sum and difference) products, thereby encouraging design for small second-order products, regardless of the more objectionable higher-order products. (Incidentally, it would have been helpful if a standard method of numbering all intermodulation products had been given.) Harmonic distortion factor on the other hand, although harmonic distortion can be regarded as a particular case of intermodulation, is defined on a basis of total harmonic content. On the question of distortion, this Standard seems to fall between two stools, neither boldly tackling the problem of differing objectionableness of distortion products nor leaving the matter quite general and open.

The intermodulation definitions, by making the basis of comparison the geometric mean of the input component magnitudes, imply that for a given geometric mean the distortion is independent of the individual component amplitudes. This is dangerously far from the truth. It is quite possible for the distortion to be slight with equal components, and intolerable with widely unequal components having the same geometric mean, owing in the latter case to the larger amplitude running into grid current or "bottom bend." These factors so defined are therefore valueless unless the conditions are more closely specified, and the need for this is not mentioned.

In spite of the many years this Standard has been germinating, therefore, it does not reveal itself as a completely mature growth. Many of its definitions are so general as to be of little value, for they still leave it to individual workers to specify important conditions in their own separate ways. And where a lead is given, as in distortion measurement, it is not always in directions that provide a sound measure of electrical performance.

M. G. S.

*British Standard Glossary of Terms for the Electrical Characteristics of Radio Receivers (BS2065:1954). British Standards Institution, 2, Park Street, London, W.1. Price 6s.

Two-Band Television Receivers

Choice of Intermediate Frequency

By G. H. RUSSELL

IT has been made clear by the First Report of the Television Advisory Committee[1] and subsequent discussion that the adoption of Band III for television broadcasting is about to take place. Although only channels 8 and 9 will be available for some time, nevertheless we must look forward to the time when the whole band will be available for television. This will necessitate the construction of receivers to cover both Bands I and III. Some thought must therefore be given to the choice of a suitable intermediate frequency, and the consequences arising out of its adoption. The choice of an intermediate frequency which would be supported by the manufacturers' organizations, the B.B.C., the Post Office and other interested parties, could be a matter of some urgency if we do not wish to find ourselves in the same state with television as we are with radio at the present time.

Possibly one of the greatest single nuisances that can cause interference with a receiver is that of a transmitter operating on or near the intermediate frequency of the receiver. With a view to minimizing this trouble, the Radio Manufacturers' Association of America has recently decided on a standard vision i.f. of 45.75 Mc/s.[2] The Americans have been able to do this because their lowest transmitting channel (2), is 54–60 Mc/s. The European frequency allocations prevent us from adopting the same frequency. Nevertheless, it would be advantageous for us to secure an agreement on a European basis if only to avoid trouble occurring under unusual propagating conditions—a situation with which we are already familiar.

European Conditions

Unfortunately, the position is already somewhat bedevilled by the fact that countries are already making unilateral decisions on this matter. In Italy, for example, an i.f. band of 40–47 Mc/s has been declared protected by government decree.[3] This decision is based on their choice of 61–68 Mc/s as their lowest transmitting channel. Although a protected i.f. band is a step in the right direction, its being a purely national decision makes one wonder whether the decree will offer any protection against sporadic-E activity, and whether, under conditions of such activity, their viewers may not find themselves the recipients of alternative programmes from Alexandra Palace or the Eiffel Tower! We in this country could not adopt channel 1 as an i.f. band as it would put about 50 per cent of our receivers out of action. The foregoing only serves to illustrate how complicated the situation can become when events are allowed to take their natural course. There is only one certain way of dealing with this form of interference, and that is the suppression of all transmitting within a protected band over a wide geographical area, and this can only be made effective by international agreement. But first the band which requires protection must be decided upon.

Before proceeding further, an examination of the frequency allocations in the v.h.f. and u.h.f. bands, and in the bands which might possibly be selected for intermediate frequency, will be necessary. The present allocations for the frequencies from 29.7 Mc/s to 585 Mc/s are shown in Table 1.

I.F. Harmonics

The next most important source of interference is that of i.f. harmonics. These are much more serious in television receivers than in ordinary radio receivers because of the large bandwidth and the high level at which the detector operates. With the high intermediate frequencies involved, sufficient attenuation of the radiation of these harmonics from the detector is a difficult and costly process, if indeed any measure of success can be attained at all. It is generally agreed that it is necessary to take into consideration harmonics up to and including the fourth. This means that the i.f. cannot fall between:

20.5 and 34 Mc/s (41/2 to 68/2)
13.7 and 22.7 Mc/s (41/3 to 68/3)
10.25 and 17 Mc/s (41/4 to 68/4)

A relatively wide frequency clearance must be maintained between the lowest signal frequency and the high-frequency edge of the i.f. pass-band, if instability is to be avoided. Our choice, then, bears a close resemblance to that of Hobson's. Assuming that we are concerned only with the British standard of vestigial-sideband transmission, the i.f.

TABLE 1

Band (Mc/s)	Allocation
29.7-41	Public Services.
41-68	Television Broadcasting (Band 1).
67-87.5	Public Services.
87.5-100	Sound Broadcasting (Band 2).
100-108	Public Services.
108-144	Aeronautical Services.
144-146	Amateur Transmitting.
146-174	Public Services.
174-216	Television Broadcasting (Band 3).
216-235	Aeronautical and Navigational.
235-420	Public Services.
420-470	Aeronautical, Navigational and Amateur.
470-585	Broadcasting.

[1] First Report of the Television Advisory Committee, 1952, H.M Stationery Office, 1953.
[2] *Electronics*, Nov. 1950, Vol. 23, No. 11, p. 99.
[3] Gazzetta Ufficiale della Repubblica Italiana, (Part 1), 3rd April, 1952.

vision carrier would fall at 35.25 Mc/s, the pass-band would be 34-38.5 Mc/s, allowing 2.5 Mc/s clearance between it and the lowest signal frequency. Some authorities believe that the fifth i.f. harmonic can be troublesome,[4] and it is interesting to note that the fifth harmonic of the band given above falls in Band III, and the situation becomes impossible. Adequate precautions will have to be taken in the receiver design to reduce fifth-harmonic radiation to negligible proportions.

[4] K. R. Sturley, "Radio Receiver Design," Part 2, Chapman and Hall, 1947, pp. 391/2.

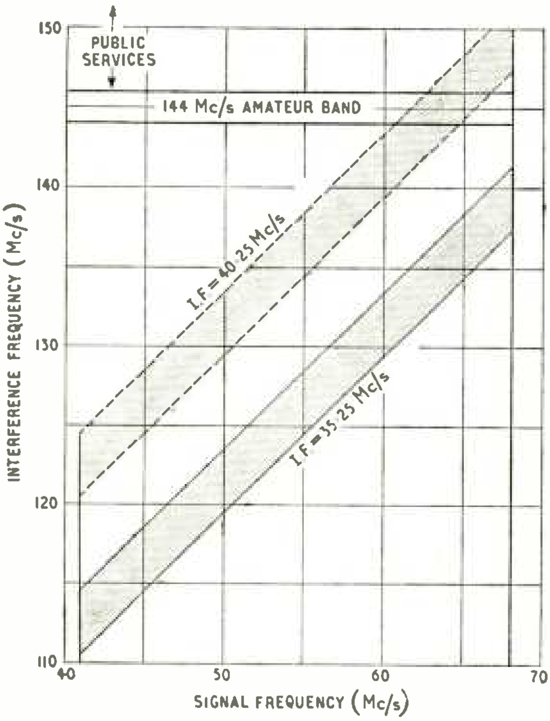


Fig. 1. Second-channel interference, Band I.

Although the intermediate frequency has already been determined, the matter, clearly, cannot be allowed to rest there. It is necessary to investigate other forms of interference which may be expected to arise out of the use of this particular frequency, although it can only be a matter of academic interest to the receiver designer, in so far as it involves factors over which he has little or no control. The remaining important forms of interference are due to, (a) second channel, (b) oscillator second harmonic, (c) the local oscillator of a neighbouring receiver. The last of these can be dealt with first. On Band I, the oscillator covers from 80.25 to 102 Mc/s, and on Band III, from 215.5 to 250 Mc/s. As can be seen, the oscillator of a receiver tuned to the lowest channel of Band III could cause interference to a neighbouring receiver tuned to the highest-frequency channel in that band. This can only be avoided with certainty by ensuring that these two channels do not serve the same area. Similarly, only by careful adjustment between the television channels on Band I, and the sound-broadcasting channels on Band II, will a lot of heart burning be avoided in the future.

Interference Charts

Graphs are used to illustrate the second-channel and oscillator-second-harmonic interference position, and these are shown in Figs. 1, 2, 3 and 4. For the purposes of this analysis, it is assumed that severe interference could be caused by broadcast, amateur and public-service transmitters. Fig. 1 shows that no interference may be expected on Band I from these sources due to the second channel. In Figs. 2 and 3 two sets of possibilities occur because there are two responses to the oscillator-second-harmonic. If the oscillator frequency is f_o, then interference can occur

Fig. 2. Oscillator second-harmonic interference (a) Band I ($2 f_o$ — i.f.); (b) Band I ($2 f_o$ + i.f.)

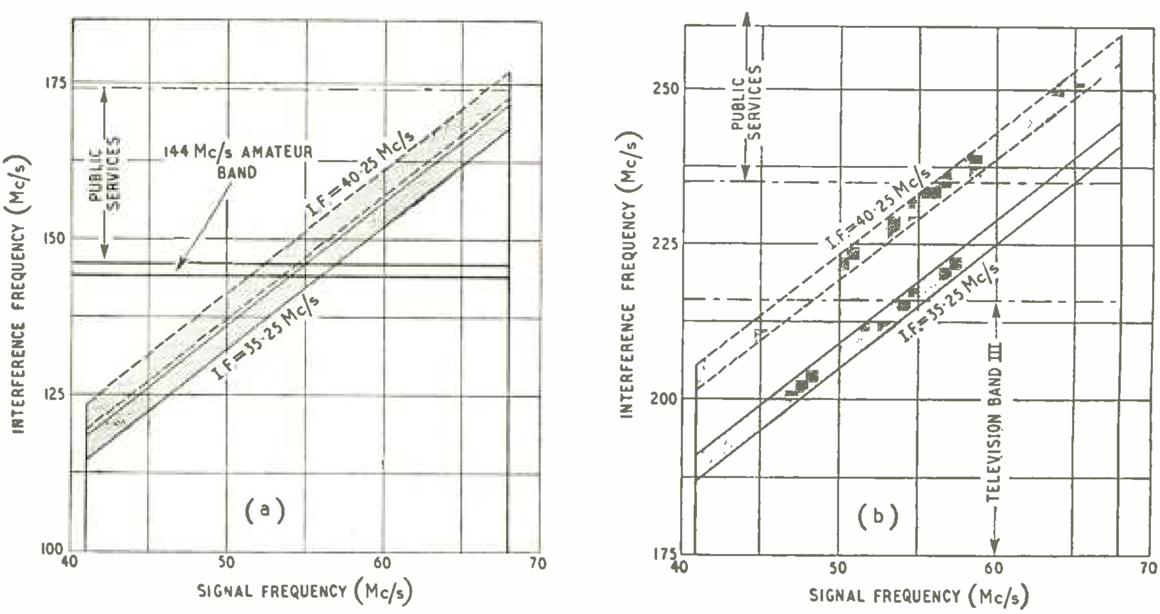
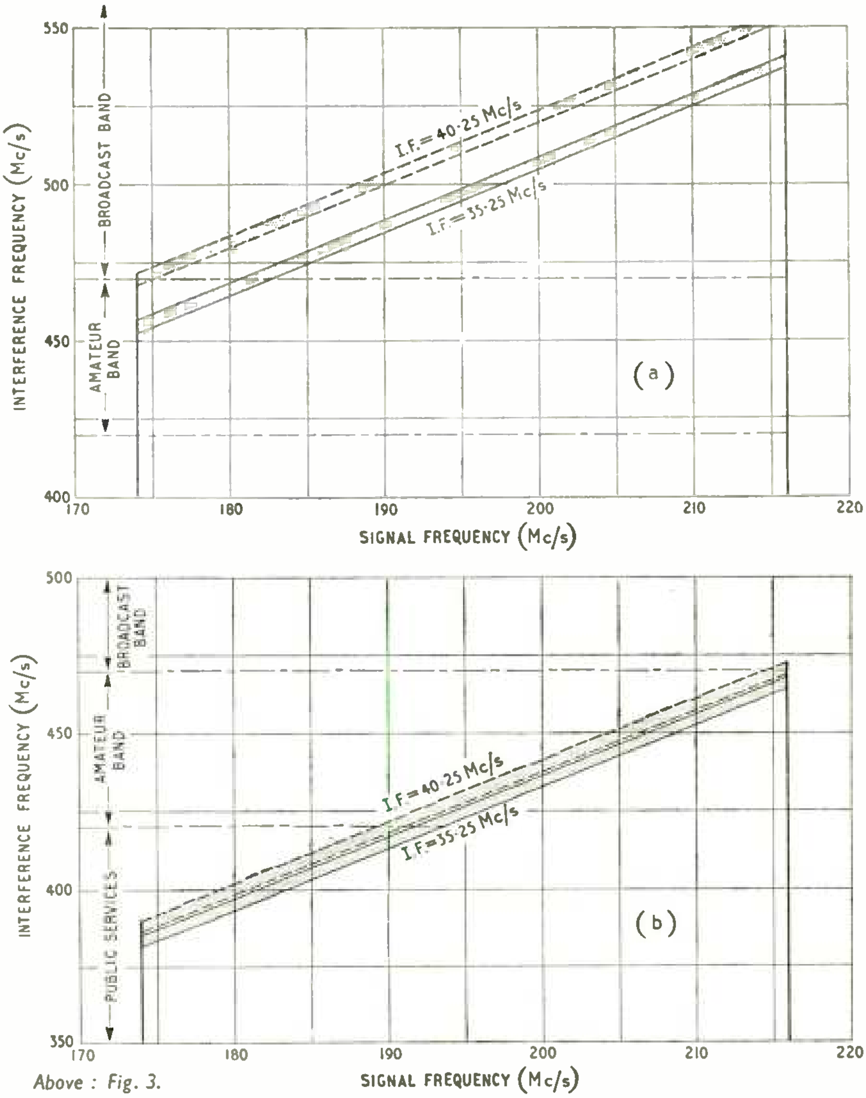


Fig. 3. Oscillator-second-harmonic interference, (a) Band III ($2f_o$ + i.f.) ; (b) Band III ($2f_o$ − i.f.)

from $2f_o \pm$ i.f., the more important of these being $2f_o -$ i.f., as this is nearer the signal frequency where the selectivity of the signal circuits may be expected to be poorer. On Band III, however, the position is less satisfactory, as, owing to the severe damping of the signal-frequency circuits caused by valve input impedance, the selectivity may prove to be inadequate for dealing with interference from strong signals on $2f_o +$ i.f. The graphs are constructed on the basis of vestigial-sideband working, and assume that, for interference purposes, the bandwidth is 4 Mc/s wide; i.e., from 34.25 to 38.25 Mc/s. A rule placed vertically against any carrier frequency on the signal-frequency scale, will give the interference band on the interference frequency scale, where the signal frequency cuts the two "curves" for the particular value of intermediate frequency. Conversely, a ruler placed horizontally against any interference frequency, will show the position and extent of that interference on the signal-frequency scale.

A summary of the results obtained from the graphs, is given in Table 2 on the following page. From this it can be seen that the prospect of interference-free television is none too bright. However, in practice, the position may not be as bad as it might be. Some of the interference possibilities listed, such as those arising from $2f_o +$ i.f. on Band I, should produce little trouble in any self-respecting receiver. As to the other forms of interference, the designer can do little to alleviate the position, and the matter becomes the responsibility



Above : Fig. 3.

Below : Fig. 4.

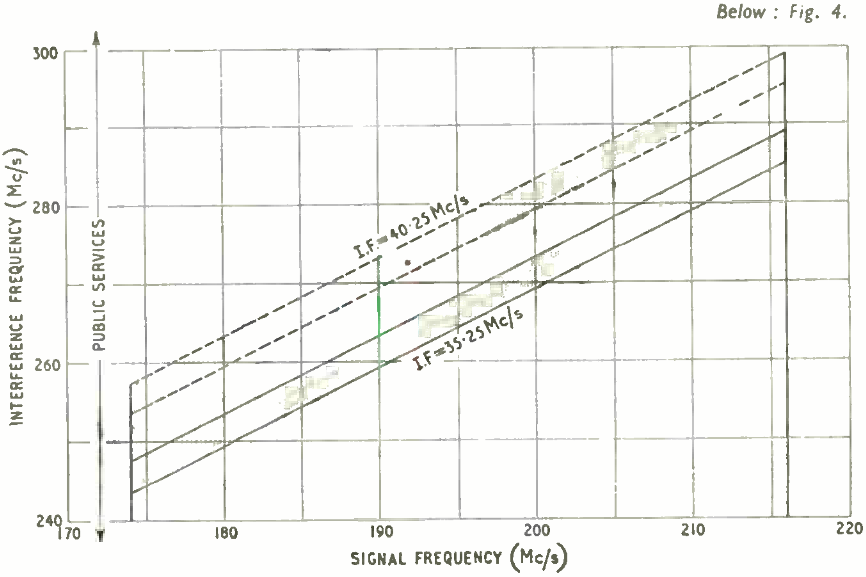


Fig. 4. Second-channel interference, Band III

of the authority who allocates frequencies to stations.

For the purpose of comparison, curves have been drawn for an i.f. of 40.25 Mc/s, in order to ascertain whether relief could be obtained by using a higher intermediate frequency at the expense of losing Channel 1. The results are quoted beside those for 35.25 Mc/s, and they show that nothing worthwhile would be gained by such a change. It would appear therefore, that we shall have to do the best we can with 35.25 Mc/s. If it is agreed that this is, in fact, the most favourable i.f. to select, then it is suggested that the first step that should be taken is to standardize on this frequency, and then to suppress all broadcasting in the band 34.25 to 38.25 Mc/s. The next step should be to evolve a sensible frequency plan, if such a thing is possible. Viewing the past history of frequency planning, one cannot help entertaining serious doubts about such a possibility.

TABLE 2
Table of Interference Possibilities

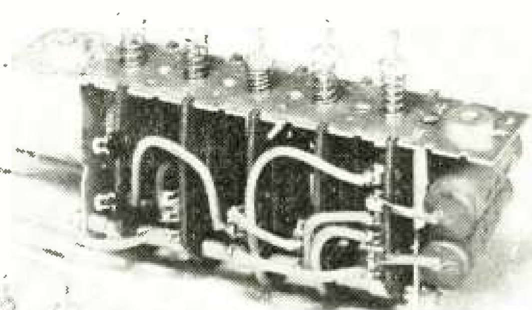
i.f. 35.25 Mc/s			i.f. 40.25 Mc/s	
Frequencies affected (Mc/s)	**Interference source** (Mc/s)	**Cause**	**Frequencies affected** (Mc/s)	**Interference source** (Mc/s)
41—55.6	186.5—216	$2f_o$ + i.f.		
54—56.9	144—146	$2f_o$ − i.f.	51.4—54.5	144—146
55—68	146—172	$2f_o$ − i.f.	52.3—68	146—174
—	—	2nd Ch.	60.5—66.5	144—146
—	—	2nd Ch.	62.5—68	146—151.5
63—68	235—245	$2f_o$ + i.f.	56—68	235—259
—	—	$2f_o$ − i.f.	66.5—68	174—177
174—182.8	452.5—470	$2f_o$ + i.f.	174—175.2	467.5—470
174—193.7	381—420	$2f_o$ − i.f.	174—191.4	386—420
174—216	243.5—289.5	2nd Ch.	174—216	253.5—299.5
180.8—216	470—540.5	$2f_o$ + i.f.	174—216	470—555.5
191.9—216	420—468	$2f_o$ − i.f.	189.5—216	420—470
—	—	$2f_o$ − i.f.	214.7—216	470—472.5

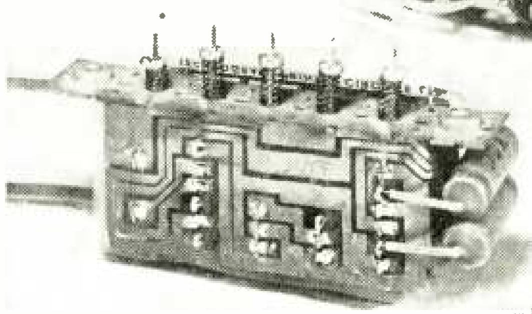
SIMPLIFIED WIRING

THE illustration shows the original wiring of a push-button switch used on a tape deck and the same unit now fitted with a printed circuit strip. The change to this more up-to-date system was adopted after an examination of the wiring had shown that three-quarters of the connections to the switch were made between points located on the actual switch unit. The strip is merely wrapped round the switch with the tags projecting where required and soldered to the adjacent metallizing.

The printed circuit is of the etched variety in which the connections required are printed on a metal-foil-covered plastic insulating base and the unwanted metal etched away in an acid bath.

Apart from other advantages, wiring mistakes are avoided, inspection time is reduced and rejects minimized. The assembly shown is embodied in the latest tape deck produced by Truvox, who say that though printed circuitry is at present a little more costly than older methods, savings in other directions about balances the increase.





The old (top) and the new (left) method of assembling the control switch in the Truvox Mark 3 tape deck.

Relaxation Oscillators

"CATHODE RAY" Explains

How They Differ from Ordinary Oscillators

NO American film is really typical unless every now and then somebody says "Take it easy!" or "Relax!" Whether this is because life in the U.S.A. tends to make everyone naturally tense, or whether it is because the script writer wants to make the audience believe the situation is tense, I am not quite sure. But I am told that the connection between what is commonly understood by relaxing and the sort of relaxing that presumably goes on in what are called relaxation oscillators is not obvious to all. What are relaxation oscillators, and how does one distinguish them from any other kind?

Most people who have heard of them at all, I believe, have an impression that they are quite recent—possibly a development of the second world war. It is true that they were greatly developed during the war, but the name actually appears at least as early as 1926.* And the things themselves appeared earlier still; perhaps the most celebrated date is April, 1918, when Abraham and Bloch described their famous multivibrator. I am confining the discussion to valve oscillators, of course; if one were to include mechanical relaxation oscillators there would hardly be any limit to their antiquity.

Electrical Transients

Not to beat about the bush any longer, relaxation oscillators are those that do not rely on inductance-capacitance tuning circuits. But it is hardly satisfactory to define something by what it is not. In any case, dictionary definitions, even when perfectly correct, often fail to make matters clear to the uninitiated; and in this case unfortunately *Roget's Dictionary of Electrical Terms* confuses relaxation oscillators with intermittent oscillators (better known as squeggers). To understand exactly what relaxation oscillators are, one should go right to the beginning and consider electrical transients. That may sound rather formidable, because the orthodox way is by differential equations; but fortunately a very good picture can be built up by considering some familiar mechanical analogies.

If we puncture a tyre there is a mechanical transient. The air, which up till then had been resting quietly inside the tyre, hisses out. Its speed of exit is greatest at the start, and gradually eases off as the pressure relaxes. This fact can be shown as in Fig. 1. The electrical analogy, of course, is connecting a resistance across the terminals of a charged capacitor. The electrical pressure or voltage of the charge drives current through the resistance, and as this loss of charge causes the voltage to decline the current gets less and less, as shown in Fig. 2. The curves in both of these diagrams can be called relaxation curves, because they show the way in which tension (mechanical or electrical) is relaxing. Their shapes are similar because the mass of air coming out of the tyre is small compared with the resistance offered by the small hole it has to come out through, and the inductance of the circuit (which corresponds to mass or inertia in a mechanical analogy) is small compared with its resistance.

Another mechanical analogy is a released spring, but here the situation is complicated by the mass of the spring generally being far from negligible in comparison with the friction or mechanical damping or resistance. The result is that the spring oscillates to and fro several times before coming to rest. The outline or "envelope," shown dotted in Fig. 3(c) is similar to the curves in Figs. 1 and 2. The same kind of damped

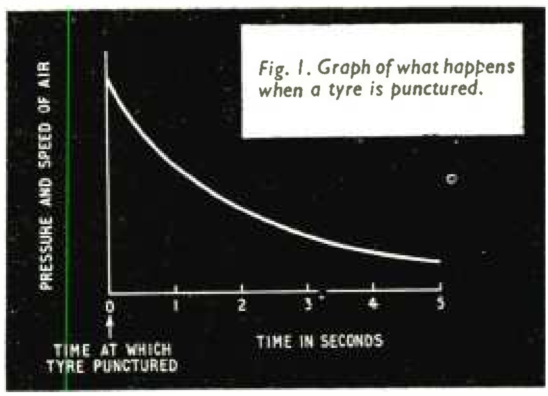


Fig. 1. Graph of what happens when a tyre is punctured.

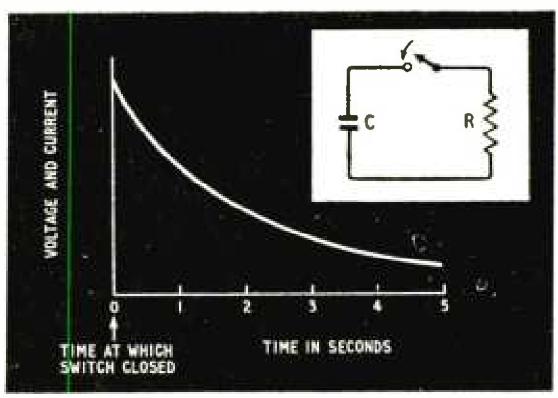


Fig. 2. Electrical analogy of the punctured tyre.

* "Relaxation Oscillators." B. van der Pol. *Philosophical Magazine*, Nov. 1926, p. 978.

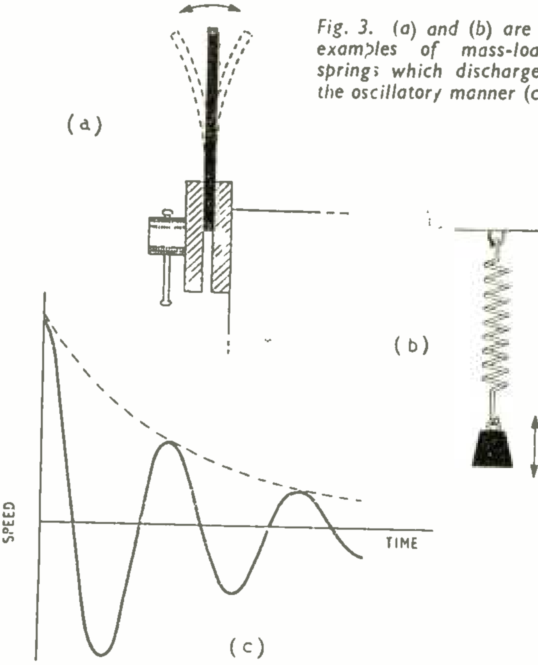


Fig. 3. (a) and (b) are two examples of mass-loaded springs which discharge in the oscillatory manner (c).

oscillation is obtained when the inductance of a discharge circuit (Fig. 4) is sufficiently large compared with the resistance. The amount of inductance needed to make a discharging circuit oscillatory (that is to say, overshoot the final level at least once) must be greater than $R^2C/4$. (If R and C are in ohms and microfarads, L will be in microhenries.) Even if the discharge circuit of a capacitor is highly inductive, the current can be prevented from oscillating by arranging that there is enough resistance to make $R^2C/4$ at least as great as L. A very familiar practical analogy is the springing of cars. If nothing were done to increase the mechanical resistance, every time a car went over a bump or pot-hole it would bob up and down like Fig. 3, which might almost be worse than having no springing at all, for if the bumps happened to occur about once per cycle of oscillation the bouncing would soon become violent. That is why dampers or so-called shock-absorbers are fitted.

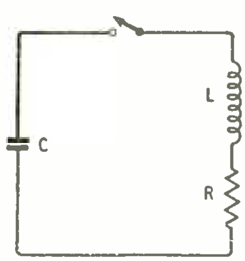
In radio, on the other hand, oscillations are the stuff of life, and one of the main objects of the game is to prevent them from dying out at all but to keep them going at constant amplitude just as long as one wants. Theoretically it can be accomplished by reducing the resistance to zero. This can't be done literally, in the circuit itself, and even if it could it would be of no practical use, for there would be no spare power to do a job of work. That is where the valve comes in, for it can be arranged to neutralize resistance by feeding in power from the h.t. supply at the right moments to keep the current in a tuned circuit oscillating, even when oscillatory power is drawn off. The best mechanical analogy, I think, is the balance-wheel of a watch. If you have let the mainspring run down, or it is broken, a push on the balance wheel will only make it oscillate to and fro several times, in the Fig. 3 manner. But when the force of the mainspring is brought to bear on it twice per cycle by means of the escapement mechanism, the wheel keeps going continuously.

Negative Resistance

The sort of oscillator in which the resistance of a tuned or naturally oscillatory circuit is neutralized by a valve is sometimes (if it has to be distinguished) called a harmonic oscillator. That is not because it is notable for generating harmonics—quite the reverse—but because it performs "simple harmonic motion." In practice it does also generate some harmonics, but that is usually an undesired incidental consequence of the fact that it is impossible to bring the net resistance of the system *exactly* to zero and keep it there. To make quite sure that the net resistance is not positive (which would make oscillation die away) one has to make it at least slightly negative. When that happens, oscillation builds up, as in Fig. 5, theoretically without limit. In practice, of course, the valve that provides the negative resistance very soon reaches its own limits; owing to grid current, cut-off, and one thing or another, its characteristics change, and in the end such changes always reduce the negative-resistance contribution of the valve. So when the amplitude of oscillation reaches the point at which the net resistance of the whole outfit is zero it stops growing. It is this limiting action that causes harmonic distortion.

Most often a stable balance is achieved quite automatically, so that when the balance point has been reached the oscillator carries on indefinitely at a more or less steady amplitude. But many experimenters will have found for themselves that some valve oscillators fail to do this; the growth of amplitude causes a change in circuit conditions that makes the net

Fig. 4. Inductance-loaded discharge circuit analogous to Fig. 3.



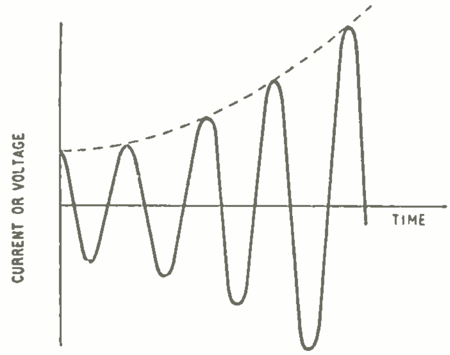


Fig. 5. If the total resistance in Fig. 4 is made negative, its oscillations grow like this.

Fig. 6. Voltage current graph of a linear resistor, in which its resistance is indicated by the slope, constant and positive in this case.

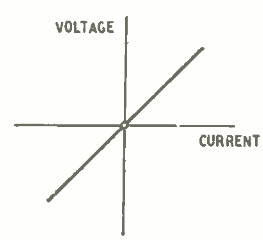
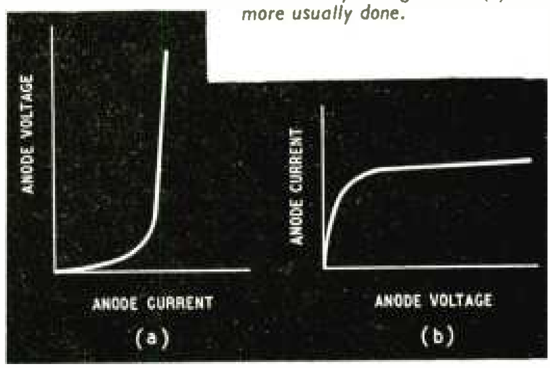


Fig. 7. Anode voltage current graph of a pentode, (a) plotted in same way as Fig. 6 and (b) as more usually done.



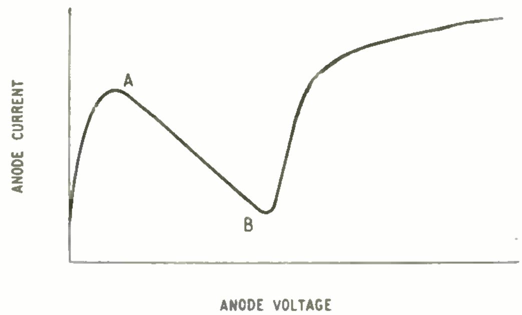


Fig. 8. (Above) Anode characteristic of early type of tetrode, showing negative-resistance portion AB.

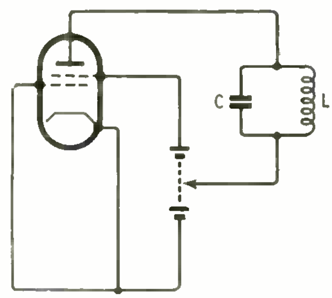


Fig. 9. (Right) Dynatron oscillator circuit.

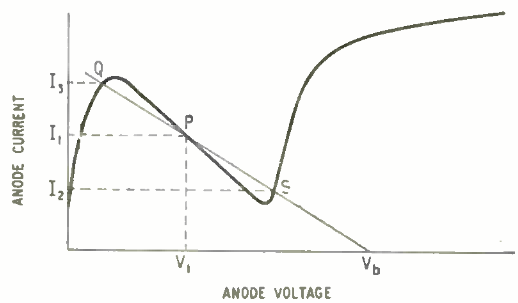


Fig. 10. QPS is the load-line of a resistor substituted for L and C in Fig. 9, and V_b is the anode supply voltage applied to it and the valve in series. (The load resistance is positive because voltage across it is reckoned to the left from V_b.) All three working points, Q, P and S look possible, but P is unstable.

resistance positive, causing the oscillations to die away, and it is only when they have ceased that the net resistance again becomes negative and oscillations start building up again. The result is that oscillation keeps on stopping and starting. A common example is a tightly coupled r.f. oscillator, having in series with its grid a capacitor shunted by a very high resistance. This arrangement—the well-known squegger—usually stops and starts at some audible frequency, as can be discovered by putting a pair of phones in the anode circuit.

The thing to concentrate on just now, however, is not the squegger but more precisely how it is that valves can reverse the natural tendency depicted in Fig. 3, converting it into Fig. 5. In other words, how comes this "negative resistance"?

But first, what is the nature of positive resistance? So far as the kind of resistance that was studied by Ohm is concerned, one of its basic features is that the current flowing through it is directly proportional to the voltage applied to it, as shown in a graph such as Fig. 6. When the voltage is reckoned upwards, as here, the resistance (being V/I) is represented by the *slope* of the graph. Since Ohm's day we have extended the idea of resistance to include circuit elements such as valves, which have voltage/current graphs that are not simple straight lines passing through the origin. Fig. 7(a) is an example in which the resistance starts off quite small, as shown by the gentleness of the slope, and then rapidly becomes very large as the voltage increases. Drawn this way, the curve may not be easy to recognize, but when plotted the other way round, Fig. 7 (b), there is no difficulty in identifying it as the anode characteristic of a pentode or tetrode. Either way, in spite of having a large range of values, the resistance is always *positive*. An increase of voltage never makes the current less, or vice versa. An exception is the old-fashioned tetrode with its kink, shown in Fig. 8. Between A and B an increase in voltage does reduce the current, so the slope resistance is negative. And if one connects a tuned circuit in parallel between anode and cathode, as in Fig. 9, it oscillates without more ado, provided that the dynamic resistance of the tuned circuit is greater than the negative resistance of the valve, so that the parallel combination is negative.†

Elusive Working Point

This type of oscillator, by the way, is called the dynatron, and has the quite exceptional feature of providing negative resistance to d.c. Most valve oscillator circuits depend on inductive or capacitive couplings so can only function with a.c. But, you may say, oscillations *are* a.c., so what possible significance can "d.c. negative resistance" have? Well, as it happens, this brings us to a crucial stage in the approach to relaxation oscillators. Suppose we replace the tuned circuit in Fig. 9 by a plain resistance, equal perhaps to the dynamic resistance of the tuned circuit. Obviously it cannot oscillate; yet the resistance of the system as a whole is negative, so what does it do? Suppose the anode voltage V_b (Fig. 10) is applied through the resistance represented by the slope of the load line SPQ, with the intention of working at the point P. On paper this seems quite sound, because the current flowing through both resistance and valve is I_1, and the voltage $V_b—V_1$ is dropped in the resistance, leaving V_1 between anode and cathode of the valve; and the current through the valve when voltage V_1 is applied to it certainly is I_1. Yet if you were to

† If you are sceptical about the sign of a parallel combination of positive and negative resistances being the same as that of the *smaller* of the two, try using the formula $\frac{R_1R_2}{R_1+R_2}$ to find the resistance when R_1 is, say, −15 kΩ and R_2 is +20 kΩ. (The answer should be −60 kΩ.)

try it you would find point P strangely elusive. Why?

Suppose the anode current and voltage did manage to be I_1 and V_1. Then the slightest fall in current would cause the voltage across the resistor to fall more than it rose across the valve, so there would be some spare voltage across the valve which would reduce the current more, causing the voltage across the resistor to fall still more, and so on. The current would keep on falling until a fundamental change in the situation occurred, and this would not occur until the net resistance of the system ceased to be negative. What happens is that the working point shifts as quick as a flash to S, where the current is less than at P but the total voltage, V_b, is again correct. But so it is at point Q, where the current is more than at P, and like S this is a point where the resistance of the valve is positive. Since Q and S are both possible positions, which one would be the actual working point? Would the current be I_2 or I_3? Well, it all depends on what was done at the start. If the voltage V_b were switched on after the cathode had warmed up, the anode current would probably be found to correspond to point Q. But if now the resistance were reduced (indicated on the diagram by raising the slope of the load line attached to V_b sufficiently to make Q and P coincide, the working point would slide instantaneously down the negative slope until it got to S. Increasing the resistance until S and P coincided would reverse the process. We have probably experienced mechanical analogies of this; such as the tin lid that caves in with a bang when we press it on top, and then springs back with another bang when we push it from underneath.

Slowing Down the Transitions

These changes from one stable shape of the tin lid to the other, quick though they may be, are not in the same speed class as the slide down the slippery slope of the negative resistance of a dynatron. But we can slow down the process by connecting a large capacitance across the valve from anode to cathode. If it is, say, 20μF, with a resistance of 0.3MΩ, the charging is slow enough to follow on a milliammeter. Instead of gradually tailing off like Fig. 2 it tends to accelerate, until stopped suddenly by the bend in the characteristic curve. If one starts off with infinite resistance, the capacitor being uncharged, the slide is started by gradually reducing the resistance until point Q is passed; once started, it carries on automatically until a point somewhere near S is reached. There it stops, and to get a repeat performance one has to push it back to the top of the hill, say by short-circuiting the capacitor.

Obviously this is nothing like continuous oscillation, the reason being the absence of anything automatic to give the push back to the starting point. In the LC oscillator it is the energy stored in the tuned circuit that gives the reverse push, just as the energy stored in a child on a swing by a push brings it back again to the pusher. It would be possible to modify the dynatron circuit by providing a relay to short-circuit the capacitor momentarily every time the anode current fell below a certain level, such as I_2 in Fig. 10. Then the thing would generate a continuous succession of saw-tooth waves, sliding steadily down the negative-resistor slope, back to the start instantaneously, sliding down again, and so on. It would be a relaxation oscillator—but a very clumsy one. There are much better ways of keeping the oscillation going. The simplest is the ordinary neon-tube oscillator, Fig. 11.

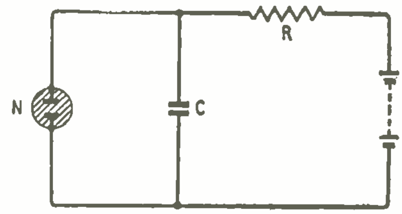


Fig. 11. Simple capacitive relaxation oscillator.

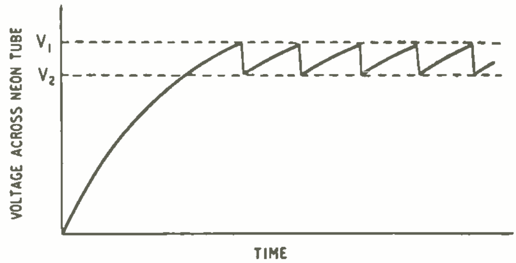


Fig. 12. Voltage waveform obtained with Fig. 11.

The peculiarity of neon tubes, such as the small lamps used to remind housewives that their electric ovens are still on, is that practically no current at all passes until the voltage reaches something like 180; then it goes up with a bump, and unless there is some resistance in series to limit the current to a reasonable amount the life of the device is likely to be only a fraction of a second. Reasonable current once having been started, however, it continues to flow until the voltage across the tube is reduced well below the "striking" voltage; probably about 20 volts lower. So what happens when the voltage is switched on in Fig. 11 is that C charges through R, the voltage across C rises, and N does nothing until its striking voltage is reached; when it strikes it is equivalent to a resistance of only a few hundred ohms, which compared with R is almost a dead short, so C very rapidly begins to discharge. It gets only as far as the extinguishing voltage of N, however, for then N cuts out, and C starts charging again, slowly compared with the discharge because it takes place through the comparatively high resistance R. At the higher voltage N strikes, and so on continually, as in Fig. 12, where V_1 is the striking voltage and V_2 the extinguishing voltage. The duration of each cycle, and hence the frequency, depends on CR (the time-constant of the circuit) and on V_1, V_2 and the applied voltage.

From a practical point of view this type of relaxation oscillator has little in its favour except its extreme simplicity and cheapness. But it is a very good illustration of the British Standard definition of a relaxation oscillator‡, which I think this is the right moment to quote:

> *A generator of oscillations characterized by cycles, each consisting of a period during which energy is stored in a reactive element followed by a period of transition, or relaxation, during which the reactance discharges. These processes usually occur at very different rates.*

Note "reactive element"; not "capacitor." The reason is that the definition is intended to include oscillators in which the energy is stored magnetically in an inductor. We shall take a look at an example of this in a moment, but just now you may be able to see

‡ B.S. 204: 1943, *Glossary of Terms Used in Telecommunication*, Definition No. 1924.

why I have gone rather fully into the principles before giving the definition. Except for the comment at the end, which, as Americans say, is not mandatory, there is nothing very obvious to exclude ordinary tuned oscillators from this definition. Their cycles of oscillation certainly each consist of two periods during which a reactive element alternately charges and discharges. The essential thing about this definition is what it *doesn't* say. It doesn't say anything about the second reactive element that is necessary to a tuned or LC oscillator, in which the energy discharged from the first reactive element is stored, and from which the first is then recharged. Since things that are not mentioned in a definition are not necessarily absent from everything covered by it, this definition fails to distinguish clearly between relaxation oscillators and others. It is only the added comment that gives one a hint that LC oscillators are not meant to be included. Personally I would alter the words "reactance discharges" to "energy is dissipated," because the essential distinction is that in an LC oscillator energy is tossed to and fro between two reactors, whereas in a relaxation oscillator a new lot is used up every cycle.

Mechanical Analogies

We seem to have been getting rather behind with our mechanical analogies, but it is not difficult to think of plenty of mechanical relaxation oscillators; some of them, operating from the galleries of the cheaper variety theatres to denote contempt or disapproval, being less polite than others. Of the others, a good example is the creaking of a rusty hinge. What happens when the door suspended on it is slowly pushed is that the tension builds up against the stiff friction, until suddenly it gives way and one surface slips over the other, relieving the tension and causing the friction to take charge once more. If "Pressure on the hinge" were substituted for "Voltage across neon tube," Fig. 12 would apply fairly well. To some extent a violin is a relaxation oscillator working on the same principle. Rosin is used to increase the friction between bow and strings, causing the string alternately to be pushed forward and to slip back; but since the string itself has both mechanical inductance and capacitance, and is attached to a wooden resonator, the tone is modified in such a respect as to be more generally acceptable than that of a creaking hinge.

At one time the most important kind of relaxation oscillator was the multivibrator, which generates waves with such steep rise and fall that hundreds of harmonics are strong enough to be detected, and this is very useful in frequency measurement. But with the popularization of oscilloscopes, and still more of television receivers, the multivibrator class has been vastly outnumbered by saw-tooth generators of many kinds. There are whole books devoted mainly to these things, so I don't propose to embark on descriptions of them all, but will finish with the promised example of an inductive relaxation oscillator.

As it turned out, it was rather a rash promise, and if I'd known the bother it was going to give me, well . . . ! The trouble was that all the inductive relaxation oscillators circuits I could find included capacitors, which would inevitably have confused the issue. So I hooked up the simple—deceptively simple—circuit shown (appropriately enough) as Fig. 13, consisting of an ordinary medium triode and a 1 : 1 output transformer. Connected in this way, it has a negative-resistance characteristic, for when voltage across the anode winding of the transformer makes the anode more positive its tendency to increase the anode current is more than neutralized by the grid being made negative.

It certainly worked. With as little as 20V "h.t." it produced peaks of over 1,000V across each of the transformer coils. Fig. 14 shows two cycles of this output as seen on the oscilloscope. This waveform was not unexpected, but to think up a convincing explanation of the cycle of operation that could be reconciled both with it and with the current waveform in the anode circuit was a different matter. Oscillograms of this class of circuit, using iron-cored coils in unconventional ways, always look very different from the tidied-up versions one sees in books. Fig. 15 shows, at the top, the anode current and transformer voltage waveforms after the period of the voltage pulse has been very much broadened out to show the details. To make sense of them, even in this modified form, it is necessary to add the grid current waveform and to fill in the zero-current levels (shown dotted) and to realize that the parts shown shaded are currents forced through stray capacitance by the fierce voltage peak. The effective flux-producing current in the transformer is $I_a - I_g$, shown at the foot of Fig. 15; and the voltage V_t across either transformer coil does now clearly look as if it were proportional to the rate of decrease of net current, which according to theory is what it ought to look like. It would have been so embarrassing if it hadn't! If one considered the anode current alone it certainly couldn't; the important thing is that the close-coupled transformer forces the flow

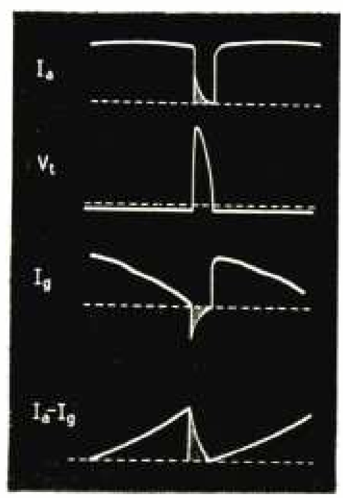


Fig. 15. (Right). Current and voltage waveforms of Fig. 14, with voltage-peak period greatly broadened out.

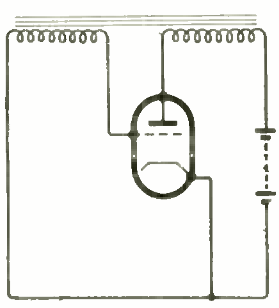


Fig. 13. Simple inductive relaxation oscillator.

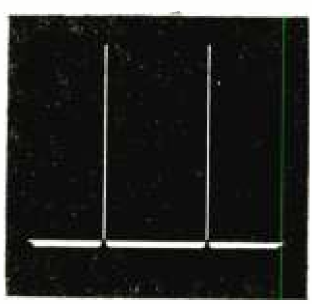


Fig. 14. Voltage waveform obtained with Fig. 13.

of grid current that makes the resultant current waveform a saw-tooth. During about 99 per cent of each cycle, magnetic energy is being slowly and steadily built up by the growth of net current; during the remaining 1 per cent it is "discharged" by the sudden convulsive cut-off of current when grid current ceases to load the secondary, and this sudden relaxation is the cause of the relatively enormous voltage peak.

Summing Up

To describe the operation of this "simple" circuit in full detail would take an awful lot of time, and would spoil your enjoyment of working it out for yourselves, so I finish with a quick summary of the whole subject. Single reactive elements—capacitors or inductors—discharge their voltage or current in the manner shown in Fig. 2. Combinations of both capacitor and inductor discharge in the manner in Fig. 3, provided there is not much resistance. When the resistance is reduced below zero these oscillations, instead of dying away, build up as in Fig. 5, but this growth comes to a "ceiling" when the valve providing the negative resistance becomes overloaded. If negative resistance is applied to a single reactor it charges up, usually like the reverse of Fig. 2, and here too the process is halted by the valve characteristics. What happens next is either that the system sticks in a stable position, from which it has to be "triggered" to repeat the operation, or the valve causes a discharge that automatically obtains continuous repetition, as in a machine-gun. It is arrangements of this last type that are called relaxation oscillators. Squeggers are combinations of harmonic and relaxation oscillators.

Although the tendency is for relaxation oscillators to produce very angular waveforms, this is not an essential feature; in the familiar RC audio oscillator the resistances and capacitances are so arranged that negative resistance sufficient to maintain continuous oscillation is confined to a band of frequency that includes the fundamental but excludes the harmonics, so a very pure waveform is obtainable from a relaxation oscillator.

CRYSTAL SET AMPLIFIER

Avoiding a Possible Pitfall

IT is often the simple things that cause most trouble; a case in point is the connection of the crystal set described some two years ago in *Wireless World** to a valve amplifier.

The simplest way perhaps is to use an intervalve transformer as one can then hardly go wrong; a 3 or 5 to 1 step-up will suffice. Two changes in the original circuit are, however, advised; one is to drop the 0.002 μF 'phone bypass capacitor to from 100 to 500 pF, the other is to connect a 47-kΩ resistor across the primary winding. The latter addition will damp out any transformer resonances.

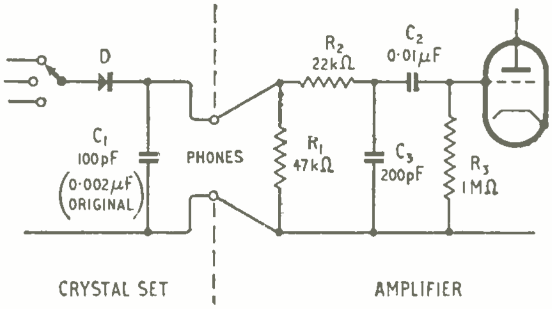
Resistance-capacitance coupling can, of course, be used in place of a transformer, but there is at least one pitfall which may or may not affect the performance of the valve amplifier; it depends on the actual working conditions. If the amplifier has a grid input capacitor and grid leak (the latter often being a volume control) then it only remains to connect a resistor of about 47 kΩ across the 'phone terminals of the crystal set. However, it would be advisable in this case also to drop the original 'phone bypass capacitor (0.002 μF) to about 100 pF.

If, however, the amplifier is not fitted with a grid coupling capacitor and leak; or perhaps a single-stage amplifier is being added to boost the output, not necessarily for loudspeaker reproduction, but to give more comfortable volume in two or more 'phones; then in addition to a diode load resistor of 47 kΩ, as already mentioned, a grid coupling capacitor and leak must be included, as shown in the accompanying circuit.

The reason for the blocking capacitor C_2, diode load R_1 and grid leak R_3 is, of course, to keep the d.c. voltage developed across R_1 by the rectifying action of the crystal diode from reaching the grid of the following valve. This voltage may have either a positive or a negative sign at the grid end of R_1—it depends on the way round the crystal diode, D, is connected—and were C_2 not there this voltage would either add to or subtract from the grid bias on the valve.

With weak signals this d.c. component might not matter, but with strong input signals—the condition when a crystal set works best—several volts could be developed across R_1. Under such conditions the grid bias on the following valve could be anything from zero to several times the optimum. The resistor R_2 and capacitor C_3 give additional r.f. filtering, should it be required. H. B. D.

* "A Modern Crystal Set," *Wireless World*, September, 1951.



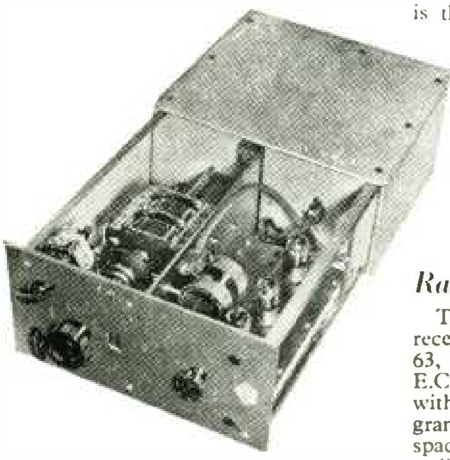
Circuit arrangement for connecting crystal set to amplifier

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Transmitter Drive Oscillator

A HIGH-STABILITY variable frequency drive oscillator has been developed by Mullard for use in commercial radio transmitters required to operate on any frequency in the band 4 to 30 Mc/s. By international agreement transmitters using these frequencies must keep within



High-stability variable frequency transmitter drive unit made by Mullard.

±0.003 % of the nominal frequency over periods of at least 24 hours.

The very high stability is achieved by the employment of the Mullard precision variable capacitor, by the choice of inductors and temperature compensating capacitors and by enclosing the frequency determining elements in a temperature-controlled oven.

The oscillator output is variable over the limited range of 1.0 to 1.7 Mc/s and is passed through a tuned buffer stage to a frequency multiplier giving an r.f. output on either the second (2 to 3.4 Mc/s) or the third (3 to 5.1 Mc/s) harmonic as required. A final wide-band amplifier delivers 0.5 W of r.f. at 70 Ω output impedance. Further stages of frequency multiplication are, of course, needed to provide the actual working frequency, but these will be either in the drive unit or in the main transmitter.

The oscillator is made by Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Television Aerials

AN unusual method of securing the sections of a television aerial is used in the "Lightweight Two" model made by J-Beam Aerials, Ltd., Cleveland Works, Weedon Road Industrial Estate, Northampton. The system takes advantage of the fact that two aluminium surfaces forced into close contact tend to adhere.

By providing wedge-shaped contact surfaces in the die-cast fittings a solid joint of good mechanical and electrical qualities is obtained merely by giving the parts concerned a few sharp taps with a hammer.

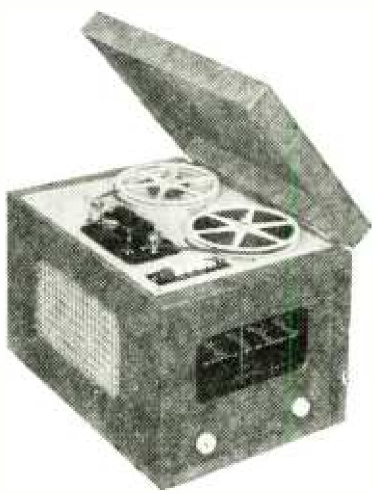
Another feature of J-Beam aerials is that the lower half of the aerial dipole is integral with the supporting mast and forms the outer section of a coaxial matching section for the feeder.

The price of the "Lightweight Two" is dependent on the channel required, but complete with mast and lashings is under £5.

Radio-Recorder

THE "Impressario" instrument recently developed by Lee Products, 63, Great Eastern Street, London, E.C.2., is a magnetic tape recorder with normal inputs for microphone, gramophone, etc, and in addition, space for a built-in high-quality radio receiver unit. Power supplies for the feeder unit are taken from the main amplifier, which can be used separately as a straight amplifier (output 4W).

Internal switching is arranged to change over to radio recording, but this is overridden by muting contacts on the microphone and gramophone input jacks. The tuner unit, which is purchased as a separate item, fits into a special compartment at the side. It is a modified version



Lee Products "Impressario" tape recorder and radio feeder unit.

of the RF/716 three-waveband superhet, with low - distortion detector.

The tape mechanism is by Truvox and gives speeds of 3¾ and 7½in/sec with interlocking push-button concontrols.

The price of the recorder is £51 19s 6d and of the radio unit, £14 14s.

Push-button Track Changing

TWIN track recording without the necessity for changing spools is a notable feature of the new TK9 tape recorder by Grundig (Great Britain), Kidbrooke Park Road, London, S.E.3. The recording is made in either direction, and the change from one track to the other is made automatically by pressing a button.

Using 850-ft tape reels, a playing time of 2 × 45 minutes is provided at the tape speed of 3¾ in/sec. An automatic stop functions at the end of a reel, and a geared indicator marks the progress of the recording or playback, enabling any item to be located quickly.

Frequency response is stated to be 50-9,000 c/s ± 3 db and a tone control is provided for playback. A "magic

Grundig Type TK9 tape recorder.

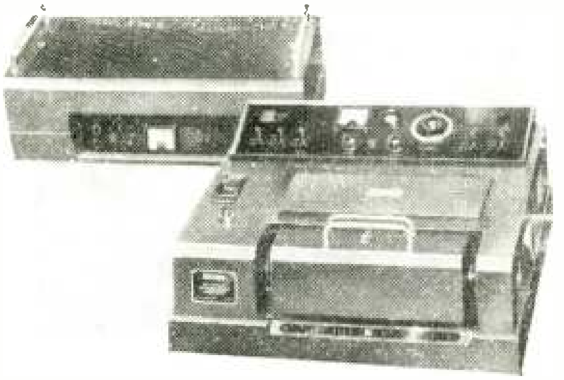
eye" level indicator functions on both recording and playback.

The overall dimensions are 13¾ × 12½ in × 8 in and the weight is approximately 28 lb. The price is £68 5s excluding microphone; alternative moving-coil or crystal microphones are available at £6 6s and £4 14s 6d respectively.

Compact Facsimile Receiver

ALTHOUGH portable picture transmitters have been available for some time, the receiving equipment installed at newspaper offices has usually been of the rack-mounted type and has occupied considerable floor space.

A compact bench-mounting photographic receiver (D-700) has now been developed by Muirhead and Company, Beckenham, Kent, which measures only 21 in × 19 in × 11 in, and weighs, together with its power



Muirhead Type D-700 photographic facsimile receiver.

supply unit of comparable size, only about 100 lb.

Positive or negative prints on paper or film up to 10½ in × 10 in can be recorded. Drum speeds of either 1 or 2 r.p.m. are provided and the scanning pitch is 100 lines/inch. The bandwidth required is 2 kc/s centred on a carrier of 1.3 kc/s. For line operation the signal is amplitude modulated, but for radio transmission f.m. can be used with a conversion unit. There is provision for a speech channel and for the use of a synchronized "Mufax" monitor which enables the picture to be seen on electrosensitive paper as it is received.

The price of the D-700 photographic receiver is £950.

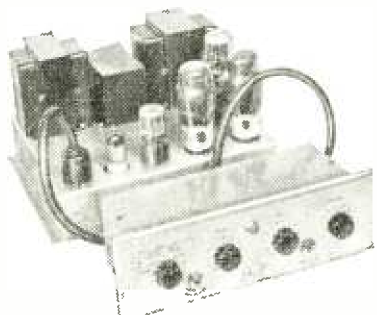
Ten-watt Amplifier

FIRST introduced for export, the Leak TL/10 amplifier and "Point One" pre-amplifier are now available for the home market.

Like the TL/12, the new amplifier uses a triple loop feedback circuit with 26db in the main loop. Harmonic distortion is claimed to be 0.1 per cent at 7.5 W and 1,000 c/s, and frequency response ± 1 db between 20 c/s and 20 kc/s. Damping factor is 25 and hum −80 db referred to 10 W.

The pre-amplifier, in addition to four fixed compensating channels providing basic correction for most British and foreign record characteristics, is fitted with continuously variable bass and treble tone controls. The main volume control is supplemented by an attenuator at the back of the set, for accommodating the variations in sensitivity of crystal, moving coil and other types of pickup.

An up-to-date feature is the provision of jacks enabling the amplifier to be used in conjunction with tape recorders for both recording and reproduction.

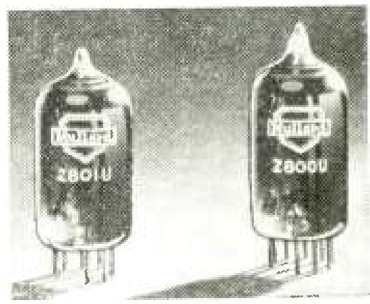


Leak TL 10 amplifier and "Point One" pre-amplifier.

The price of the two units is £28 7s and the makers are H. J. Leak and Company, Brunel Road, Westway Factory Estate, London, W.3.

Cold Cathode Tubes

TWO cold-cathode trigger tubes, the Z800U and Z801U, have been introduced by Mullard for use as



Mullard Z801U and Z800U cold-cathode trigger tubes.

low-current stabilizers and counters with Geiger-Muller tubes. Particular features of the Z800U is said to be its very stable trigger breakdown voltage and freedom from photo-electric effects, while one of the main characteristics of the Z801U is its very high charge sensitivity; an energy input of only 45 $\mu\mu$coulombs is required to initiate the main discharge. Triggering is effected by applying a negative pulse to the auxiliary cathode via a small capacitor of about 10 pF.

The makers' address is Century House, Shaftesbury Avenue, London, W.C.2.

"Hall Mark" for Die Casting Alloy

DIE castings, particularly in zinc alloy, are finding many applications in the radio and electronic industries and it is, therefore, of interest that the British Standards Institution and the Zinc Alloy Die Casters Association have together drawn up a certification mark scheme for this type of casting. It means that users of zinc alloy castings carrying the B.S.I. "Kite" mark can be assured that the quality of the material complies with the very exacting requirements of BS1,004:42.

Zinc alloy die casting probably provides the quickest transition from raw material to the finished product; the castings are strong and durable provided the alloy is free of certain impurities. The presence of lead, tin and cadmium, even in such minute quantities as a few parts in 100,000, can result in a casting that would otherwise be almost as strong as cast iron becoming as brittle as a biscuit. BS1,004 specifies that the content of these and other "poisonous" elements shall not exceed 0.012%. A little aluminium, copper and a trace of magnesium and iron are beneficial.

A.R.R.L. Handbook 1954

COMPILED by the technical staff of the American Radio Relay League, the Radio Amateur's Handbook has come to be regarded as a textbook of amateur radio. It provides the novice with much of the theoretical and practical knowledge he needs for the design, construction and efficient operation of an amateur radio station.

The "old hand" is equally well served, and the current issue has been carefully revised to include the latest developments of the past year. V.H.F. and u.h.f. chapters have accordingly been considerably expanded and there are many useful designs of equipment for mobile operation. These should be of great interest to members of the newly formed U.K. Radio Amateur Emergency Network, since amateur radio communications of this kind are well established in the U.S.A.

Copies of the Handbook are obtainable in this country from The Modern Book Co., 19-23, Praed Street, London, W.2, or they can be ordered for direct delivery from the U.S.A. through the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1; the price is 30s (31s by post).

APRIL MEETINGS

Institution of Electrical Engineers

Kelvin Lecture: "The Physics of the Ionosphere" by J. A. Ratcliffe, O.B.E., M.A., F.R.S., on April 29th.

Informal discussion on "Safety Measures for Radio and Television Equipment," opener E. P. Wethey, on April 12th.

Radio Section.—Discussion on "Technical Problems involved in Receiving Alternative Television Programmes" on April 5th.

"A Versatile Transistor Circuit" by E. H. Cooke-Yarborough, M.A., "The Measurement of the Small-Signal Characteristics of Transistors" by E. H. Cooke-Yarborough, M.A., C. D. Florida and J. H. Stephen, Ph.D., "A Bridge for Measuring the A.C. Parameters of Type 'A' Transistors" by A. R. Boothroyd, Ph.D., and L. K. Datta, M.Sc., and "The Transistor as a Regenerative Amplifier with some Application to Computing Circuits" by G. B. B. Chaplin, M.Sc., on April 7th.

"The Experimental Synthesis of Speech" by W. Lawrence on April 26th.

All the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

Mersey and North Wales Centre.—"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies" by W. S. Proctor, M. J. L. Pulling, M.A., and F. Williams, B.Sc., at 6.30 on April 5th at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North Midland Centre.—Faraday Lecture "Electro-Heat and Prosperity" by O. W. Humphreys, B.Sc., at 7.0 on April 12th at the Town Hall, Leeds.

Sheffield Sub-Centre.—Faraday Lecture "Electro-Heat and Prosperity" by O. W. Humphreys, B.Sc., at 7.30 on April 14th at the City Hall, Sheffield.

Northern Ireland Centre.—"Special Effects for Television Studio Productions" by A. M. Spooner, B.Sc.(Eng.), and T. Worswick, M.Sc., at 6.15 on April 13th at the Presbyterian Hostel, Howard Street, Belfast.

South Midland Radio Group.—"The Theory and Application of Transistors" by F. F. Roberts, B.Sc., and H. G. Bassett, B.Sc., at 6.0 on April 26th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

North Staffordshire Sub-Centre.—"Technical Colleges and Education for the Electrical Industry" by H. L. Haslegrave, M.A., Ph.D., M.Sc. (Eng.), at 7.0 on April 5th at the Technical College, Stafford.

London Students' Section.—Address by the president, H. Bishop, C.B.E., B.Sc.(Eng.), at 6.30 on April 13th at Savoy Place, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Crystal Valves in Radio and Electronics" by B. R. Bettridge (G.E.C.) at 6.30 on April 21st at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

Scottish Section.—Members' papers at 7.0 on April 1st at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

North-Western Section.—Programme of technical films at 7.0 on April 1st at the College of Technology, Sackville Street, Manchester.

North-Eastern Section.—"Electroencephalography" by Prof. Alexander Kennedy, F.R.C.P., and J. W. Osselton, B.Sc., at 6.0 on April 14th at the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

Merseyside Section.—"Logic, Algebra and Relays" by Prof. E. Williams, B.A., B.Eng., at 7.0 on April 1st at the Electricity Service Centre, Whitechapel, Liverpool, 1.

West Midlands Section.—"Radio Telephone Equipment" by T. C. Howell at 7.15 on April 27th at the Technical College, Wulfruna Street, Wolverhampton.

South Wales Section.—"The Manufacture of Radio Receiving Valves" by G. P. Thwaites, B.Sc. (Brimar), at 6.30 on April 7th at Glamorgan Technical College, Treforest.

British Sound Recording Association

London.—"The Design of Tone Correction Circuits" by E. W. Berth-Jones, B.Sc., and H. J. Houlgate at 7.0 on April 9th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Television Society

London.—Fleming Memorial Lecture "Colour Television" by G. G. Gouriet, B.Sc., at 7.0 on April 13th and 15th at the Institute of Education, Senate House, Malet Street, London, W.C.1.

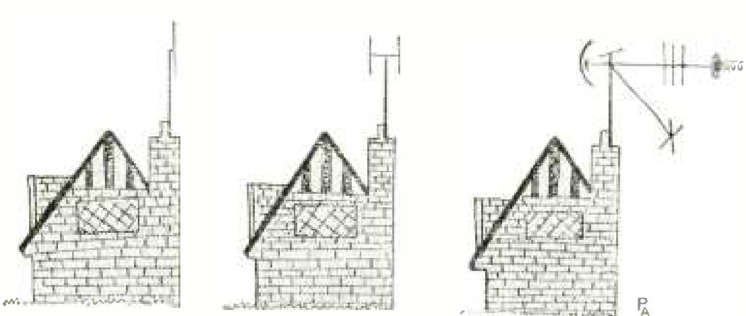
"Valves for U.H.F. and V.H.F. Television" by D. N. Corfield (S.T.C.) at 7.0 on April 22nd at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Radar Association

"Radar and the Weather" by P. A. L. Harris (Mullard) at 7.30 on April 7th in the Anatomy Theatre, University College, Gower Street, London, W.C.1.

Institution of Production Engineers

Nottingham Section.—"The Electron Microscope" by W. J. Lloyd at 7.0 on April 7th at the Victoria Station Hotel, Milton Street, Nottingham.



1936 1946 1956

RANDOM RADIATIONS

By "DIALLIST"

Any Suggestions?

THERE'S ONE fault that shows up with quite remarkable frequency in television receivers, though it is not unknown in sound-only sets. Here is a typical example: the television receiver has been working as it should for maybe an hour or more. Then the picture shrinks, or fades, or does both together and in a few moments the screen is blank. None of the outside-the-cabinet controls has the slightest effect. Then somebody happens to turn a lighting switch and, hey presto! all is well with the picture. There must, I imagine, be a hidden fault in the set, due to a dry joint, or to a break in a lead or something of that kind. When the receiver is cold a connection, though a pretty chancy one, exists. But when it is thoroughly warmed up expansion of the metal causes a movement to take place which results in a "dis." The little "kick" in the mains voltage due to the use of the lighting switch may cause an arc to occur at the "dis" and result in some kind of a weld between the very slightly separated members of the joint. Any such weld would consist of very thin filaments of metal between the two parts. It would be likely to break down rather soon—and that is just what does happen. Can any readers offer other explanations?

EVAW

LIFE IS FULL of little problems. I was confronted by one of them when I found that some rather highly technical stuff that I'd been asked to put into French contained the term "backward-wave oscillators." The French seem so to dislike inventing technical terms of their own that they're usually content to borrow them from us. "*Un wobbulateur*" and "*un oscillateur grid-dip*" are, for instance, perfectly good French. By all the rules, then, it seemed that I wouldn't be taking much of a chance if in this case I simply wrote "*un oscillateur backward-wave*." Luckily I didn't. Except that it was probably a micro-wave device concerned with travelling waves, I had, frankly, no idea of what the thing was. Nor had the first four radio addicts whom I consulted on the telephone. The fifth, however, had a hazy recollection that a paper had been read on something of the sort at an I.E.E. meeting. A search in my files of the *Proceedings of the I.E.E.* showed that such a paper had indeed been read; and what's more, read by the French inventors of the oscillator, Warnecke and Guenard! Not only that: they'd given it the name by which it is known in France, the *carcinotron*. I can't help thinking that EDNO (*onde* backwards) would have been neater and less of a mouthful. And why not an English name EVAW on the same lines?

The Hydraulic Light Bulb

AN EDGWARE READER records one of those electrical adventures which all too seldom brighten our humdrum lives. On his return home one evening he found the kitchen floor awash and soon traced the cause to a running tap and a stopped waste pipe in the bathroom above. The water had made its way down by way of the ceiling rose and the flex of the pendant lamp below. When he switched on, the lamp gave full brilliance, accompanied by "a nasty vibrational burning noise." Subsequent investigation, he tells me, disclosed a pinhole in one of the lamp's contacts, through which water had made its way into the hollow glass "foot" inside the bulb. When the bulb was connected up again the water quickly boiled away and all was (and is still reported to be) well. Actually I described some years ago my own efforts* to use this effect for the cheap production of constantly changing coloured lights to delight the little ones at Christmas. The basic idea was to introduce a succession of aniline dyes into the water fed to deliberately pinholed bulbs *via* their flex leads. I had reluctantly to abandon my experiments owing to the difficulty of obtaining sufficient supplies of the dehydrated water necessary if "shorts" were to be avoided.

Not So Funny

IT'S ALL VERY WELL to talk about our having a television service that covers eighty-something per cent of the homes in this country; but that takes no account of the homes in alleged service areas in which anything approaching even tolerable reception is impossible at most times. I'm not thinking now of houses standing on roads which carry an endless stream of (mostly unsuppressed) motor traffic. Some of those that I have in mind are near one or other of the pylons of our grid system; and their occupants learn the hard way something about brush discharges. People who live near busy aerodromes have as bad a time as any.

* "Autochromatomorphic Illumination," D. I. List, F.R.G.S.; *Tiny Tots*, Nov. 31, 1938.

Well-designed a.g.c. may take charge to some extent of aircraft flutter; but nothing much can be done about interference at short range from radar and other such things. Perhaps most of all to be pitied are those living close to radio-equipped police- and fire-stations; or those who have certain kinds of ray-treatment clinics almost next door to them.

Let's Know the Price!

A LETTER in a recent issue of *Wireless World* asked why those who advertise wireless gear, laboratory equipment and so on so often say nothing about prices. That is something which has long puzzled me. If other people's reactions to such advertisements are like mine, I don't think that they can be a very paying form of publicity. Consciously or unconsciously, I argue that as the price isn't mentioned it must be pretty stiff. Not much use, then, writing for the full particulars as suggested in the advertisement, and so I just don't do anything more about it. When, on the other hand, I see an attractive something-or-other advertised *with* its price I'm at once attracted. It may be rather a lot of money for me, but I do send for the further particulars. I'm, in fact, already what I believe salesmen call "a prospect"; and, if the state of my overdraft permits, it doesn't take much high-pressure work to make me a buyer.

"Bib"

AS YOU KNOW, I'm always on the lookout for tools which make things easier and save time and bad language in the wireless workshop, amateur or professional. One that is definitely good enough to mention in these notes is "Bib," the wire-stripper recently brought out by the Multicore people. It's the simplest thing, as ingenious tools often are: just two flat blades of very hard steel, pinned together to form what looks like a thin pair of pliers. At the business end there is a sharp-edged V-shaped notch in each blade. Close the handles and the Vs come together to form a diamond-shaped cutter. Just put the flex, V.I.R. or what-not into the cutter, squeeze the handles and pull. Off comes the insulation as clean as a whistle and not a strand is so much as nicked. The stripper is easily adjusted to deal with wires of various diameters. The tool also contains cutters which snip wire cleanly and a simple device for separating the leads of twin, plastic-covered flex without damaging the insulation.

UNBIASED | By FREE GRID

Silent Sound

MODERN MOTHERS are well acquainted with the baby alarm consisting of a microphone over the child's cot feeding into the domestic wireless receiver so that the petulant pulings of the child are superimposed on the radio programmes. *Wireless World* gave this idea to the world nearly 30 years ago in reply to an anxious parent in the then popular Readers' Problems, or Questions and Answers, section of the journal.

No doubt many of you with sensitive musical natures have often had your nerves stretched to breaking point by the mewling and puling of the animated piece of protoplasm upstairs marring a pianissimo passage from a Chopin nocturne. All this can be a thing of the past if modern mothers will be really modern and insist on a television set being adapted for fitting a baby alarm so that the child's cries appear not as an irritating over-riding sound from the loudspeaker but as an interference pattern on the screen. The programme would not be unduly marred by this visual baby bawling as it is by the present sonic system.

There is another very great advantage of this idea. Experienced mothers are supposed to be able to apply the principle of differential diagnosis to a child's cries and tell instantly whether the baby's bellowings indicate a crying need for nourishment or nappies. In practice, however, it is not at all easy to do this when there is a background of Sousa in full blast. But if the child's caterwaulings were made to appear as a visual interference pattern I feel sure this difficulty would not arise. It is, therefore, up to the manufacturers of television sets to let us have the necessary P.U. terminals and circuitry.

Great Minds Think Alike

IT IS EXTRAORDINARY how frequently I find myself in tune with the minds of the mighty or, at any rate, only a semitone or so out of resonance. Two years ago I suggested in these columns that wireless ought to have a patron saint and put forward the claims of St. Michael for that office. On the very same morning that the editor read my suggestion the Pope put forward the same idea; we differed only on the question of personnel and Gabriel was, as you know, appointed.

Now I find that once again a somewhat similar thing has happened. This time it is the Oldham Borough Council with whom I am in accord. I see that it has decided to use plastic plumbing in its houses, a thing which I decided on and told you about in the February issue.

This time the semitone difference between my thought and that of my fellow *magna meus* is not a matter of personnel but of the reason for the use of plastic pipes. In my case I suggested it as a means of curing the cross-modulation chatter caused by corroded and, therefore, high-resistance joints in pipes and guttering in an area close to two powerful B.B.C. transmitters, whereas Oldham's reason for adopting the idea was to stop burst pipes as it has been found that plastic plumbing stretches.

Carping Criticisms

THERE ARE MANY THINGS which I have vainly pleaded with wireless manufacturers to give us. One of them is a remote-control unit whereby we could not only switch the set off from our armchairs but could tune it and adjust the volume control also. Such a unit should preferably be a radio-controlled one and not have a trailing cable over which everybody would be bound to trip up. One manufacturer did make such a device once —in fact I believe there was more than one—but, like the pale hands beside the Shalimar where are they now? Another thing for which I have asked in the past is a valve which heats up quickly and makes it snappy like an electric light bulb.

It is interesting to note that both these requests have now been granted simultaneously, but not quite in the form which I had in mind. The common answer to my two requests is the mains/battery portable. Obviously, as you can have this by your armchair and can adjust it in comfort, it does after a fashion answer my request for a remote-control unit. My request for snappy cathode heating has been answered also by this type of set, for obviously it must use battery-type valves.

Now although my double request has thus been answered I am not at all happy about it. These little sets are getting more and more popular and threaten to become ubiquitous. I have no complaint against them if used within reason and in situations where a more ambitious set cannot be put into action. But nobody can deny that these receivers have a less satisfactory output than those using pukka mains valves and it is clear that the manufacturer of at least one of them realizes it as, apart from his mains/battery portable, he markets a "mains only" one using indirectly-heated valves. When I wrote to him about it he quite frankly admitted that the reason was that the "mains only" portable gave a more satisfactory output.

The other reason why I prefer not to use one of these small portables if a more ambitious set is available is that, because of their use of a small built-in aerial, they are more susceptible to interference from such things as unsilenced electric sewing machines and other disturbers of the etheric peace. A good outdoor aerial will always win the day unless somebody comes along with a drastic new invention.

1914 *Amateurs and Coherers*

I SHOULD LIKE to convey my very sincere and hearty thanks to all those kindly readers who wrote to me about coherers as a result of the photograph I published in the January issue. I should have liked to have replied to them all individually but for various reasons this was quite impossible.

I was quite wrong in supposing that coherers had disappeared by 1908. Whatever may have been the case in professional circles they were still in use in non-professional circles right up to the outbreak of the 1914-18 war. I have used the expression "non-professional circles" deliberately rather than "amateur circles" for I have no mind to have my bowler bashed in by any of those serious amateurs of 1914 vintage who swore by (and also at) the crystal. It is quite evident from information which has been so kindly sent to me that these coherer outfits were offered for sale merely as scientific toys.

Reprisals

Model 8 UNIVERSAL AVOMETER

20,000 ohms per volt *plus* AUTOMATIC Overload Protection

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Size $8\frac{1}{8}'' \times 7\frac{1}{4}'' \times 4\frac{1}{2}''$
Weight $6\frac{1}{2}$lbs. (including leads)

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It is of importance to note that this model incorporates the "AVO" automatic cut-out for protection against inadvertent overloads.

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D.C. VOLTAGE	D.C. CURRENT	A.C. VOLTAGE	A.C. CURRENT	RESISTANCE	
2.5V.	50μA.	2.5V.	mA.	*First indication 0.5Ω.*	
10V.	250μA.	10V.	1A.	*Maximum indication 20MΩ.*	
25V.	1mA.	25V.	2.5A.	0—2,000Ω	using internal batteries
100V.	10mA.	100V.	10A.	0—200,000Ω	
250V.	100mA.	250V.	—	0—20MΩ	
1,000V.	1A.	1,000V.	—		using external batteries
2,500V.	10A.	2,500V.	—	0—200MΩ	

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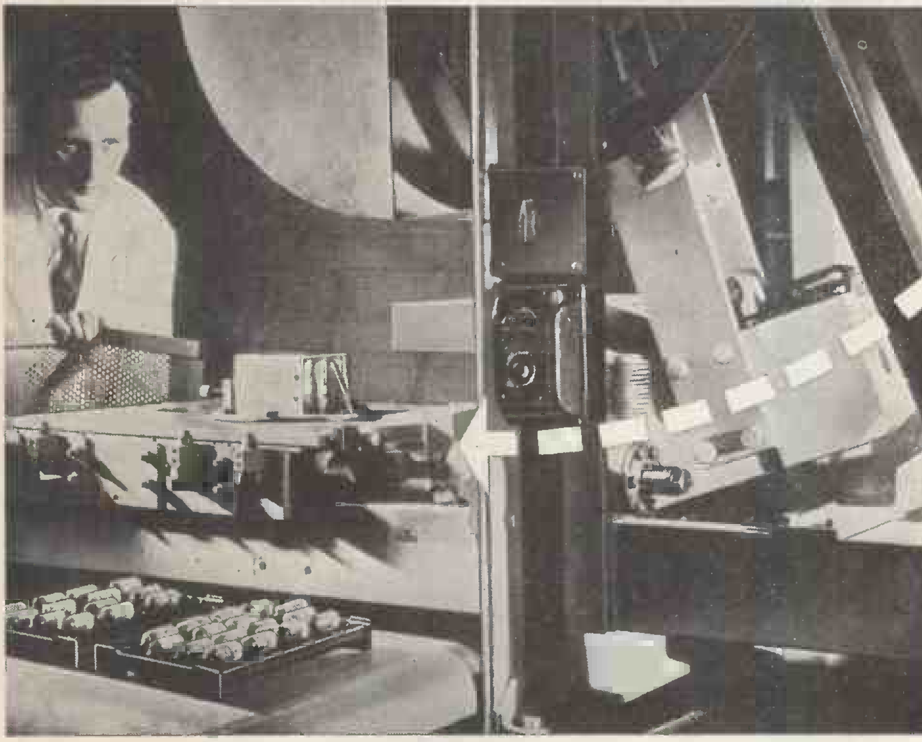

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Shocks of 500 g are given to the selected samples, which are afterwards retested electrically to ensure that their characteristics have remained within the normal limits. The valves are embedded in wax in a steel box which is clamped to the testing table, and a predetermined shock is transmitted to the valves by the hammer head of the pendulum striking the table. By changing the mounting of the box, shocks may be given in both directions along different axes.

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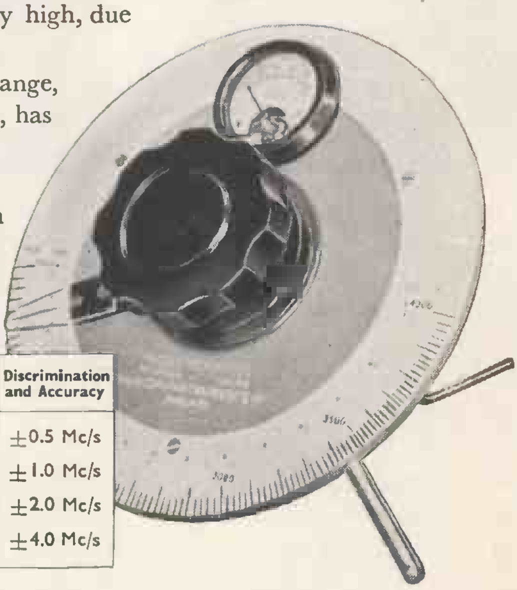
The meter covering the highest range, 2,000-4,000 Mc/s (instrument illustrated), has an additional wavelength calibration indicating in red each half-centimetre.

The meters are supplied, complete with appropriate feeder cables, etc., in polished hardwood carrying cases measuring 7 in. × $7\frac{1}{2}$ ins. × $8\frac{1}{4}$ ins.



Type	Range Mc/s	Temp. Coeff. per deg. C.	Discrimination and Accuracy
TF 1026/1	250/500	−1/30,000	±0.5 Mc/s
TF 1026/2	500/1,000	−1/25,000	±1.0 Mc/s
TF 1026/3	1,000/2,000	−1/50,000	±2.0 Mc/s
TF 1026/4	2,000/4,000	−1/50,000	±4.0 Mc/s

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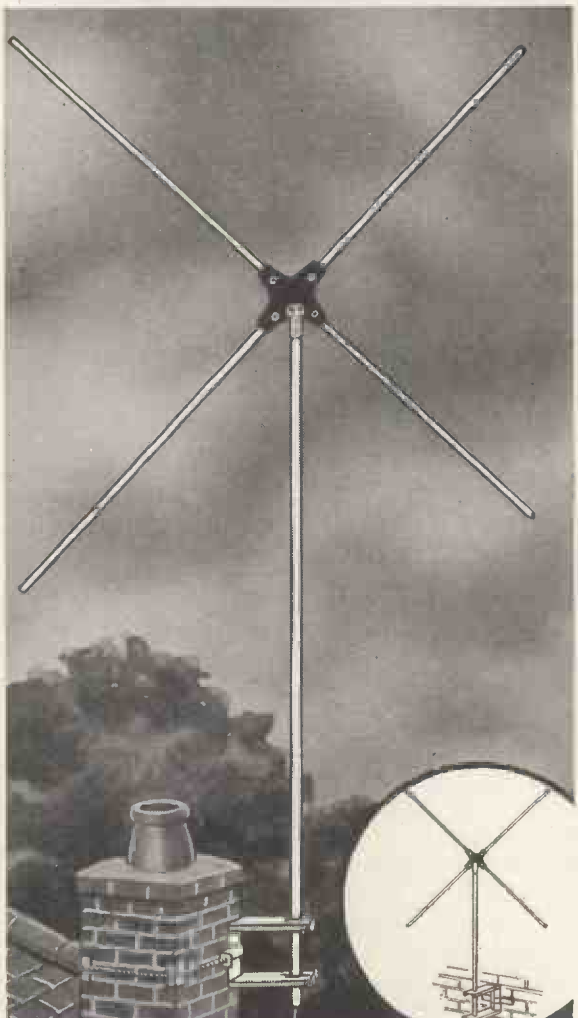

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MODEL X4W 'ANTEX' as above but with wall mounting bracket. LIST PRICE **66/6**

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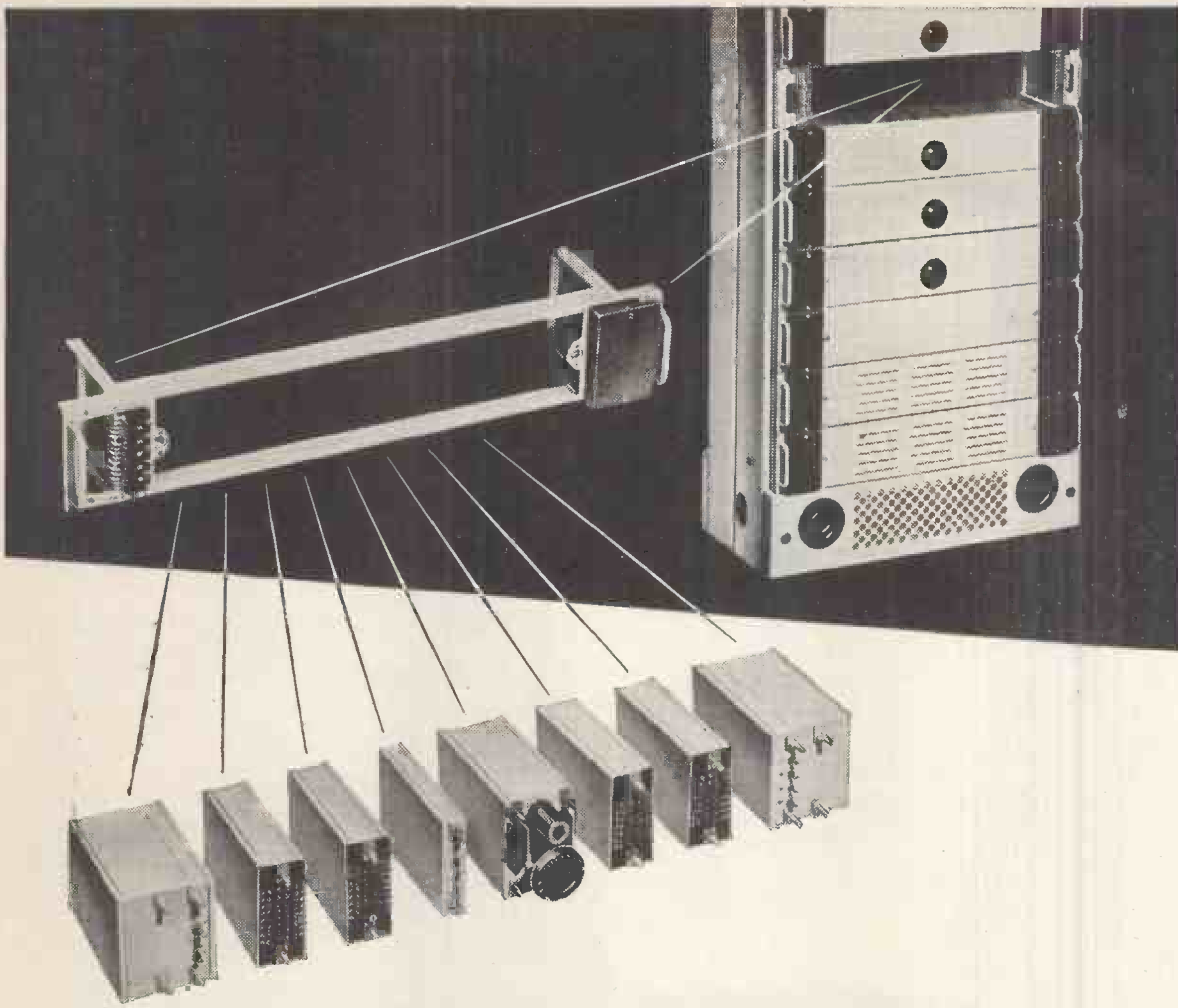

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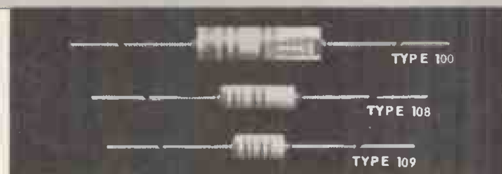

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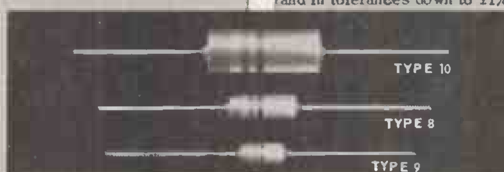

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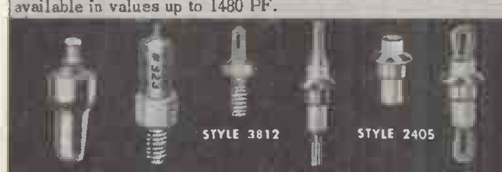

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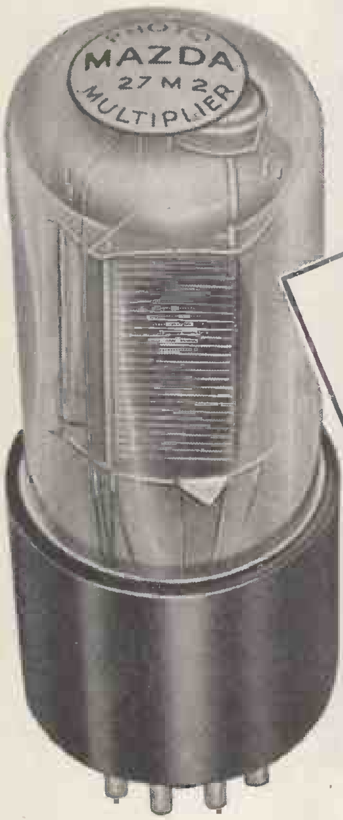

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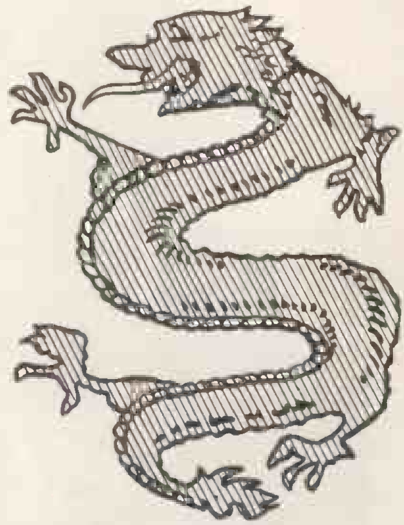

π Hi Fi

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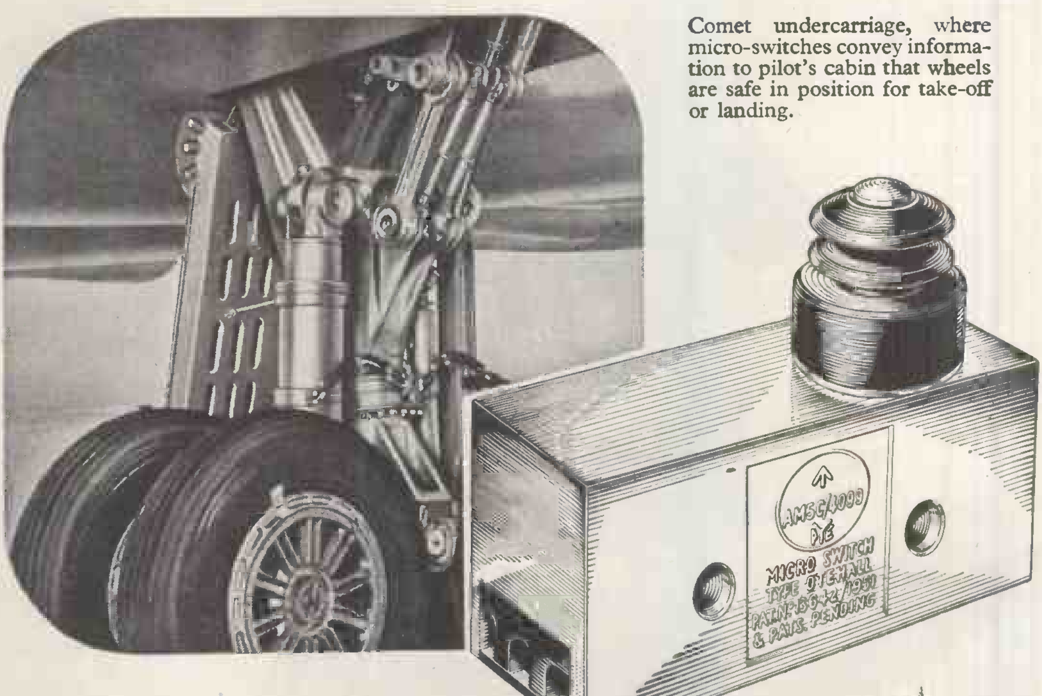
Precision

Precision engineering makes a major contribution to the success of finished products in all factories of the Pye Group. From time to time particular processes call for further mechanical aids and if these are not readily available they are designed and produced by the Group for its own use. A case in point is the new Pye micro switch which gives precise and positive switching between temperature extremes of 100°C. and —20°C. and has proved so successful that it is now marketed for the use of Electrical and Electronic Engineers in many industries. The Pye micro switch has been approved by R.A.E. Farnborough.

MICRO SWITCH

Comet undercarriage, where micro-switches convey information to pilot's cabin that wheels are safe in position for take-off or landing.

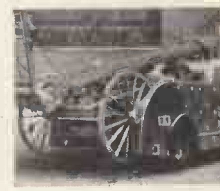


CAMBRIDGE · CENTRE OF SCIENTIFIC RESEARCH

THE PYE GROUP

Flexibility

The use of mobile V.H.F. radio-telephone equipment in this country was pioneered by Pye. Over two-thirds of the equipment now operating in the United Kingdom has been supplied by this company and exports for government and commercial applications overseas are made to more than fifty countries. With staunch faith in the value of its own products the Pye Group employs V.H.F. to maintain contact with all its delivery and service vehicles.



PYE Telecommunications
CAMBRIDGE ENGLAND

A police patrolman singled out by Selective Calling stops to receive instructions from H.Q. over the V.H.F. radio-telephone.

CAMBRIDGE CENTRE OF SCIENTIFIC RESEARCH

THE PYE GROUP

Research

Since 1896, when the company was founded, Pye Ltd. has exploited to the full its close association with Cambridge as the centre of scientific research and has recruited many scientists from this great University.

Among other things this has led to spectacular advances in the development of television camera tubes and, in particular, the "Staticon" tube used in the Industrial TV camera.

The Pye "Staticon" is small, simple in design, and can be produced relatively cheaply; it is sufficiently inexpensive, in fact, to be considered expendable when observing a highly dangerous experiment. This low cost also contributes to the fact that the Industrial TV camera costs only a third of the price of normal TV cameras.

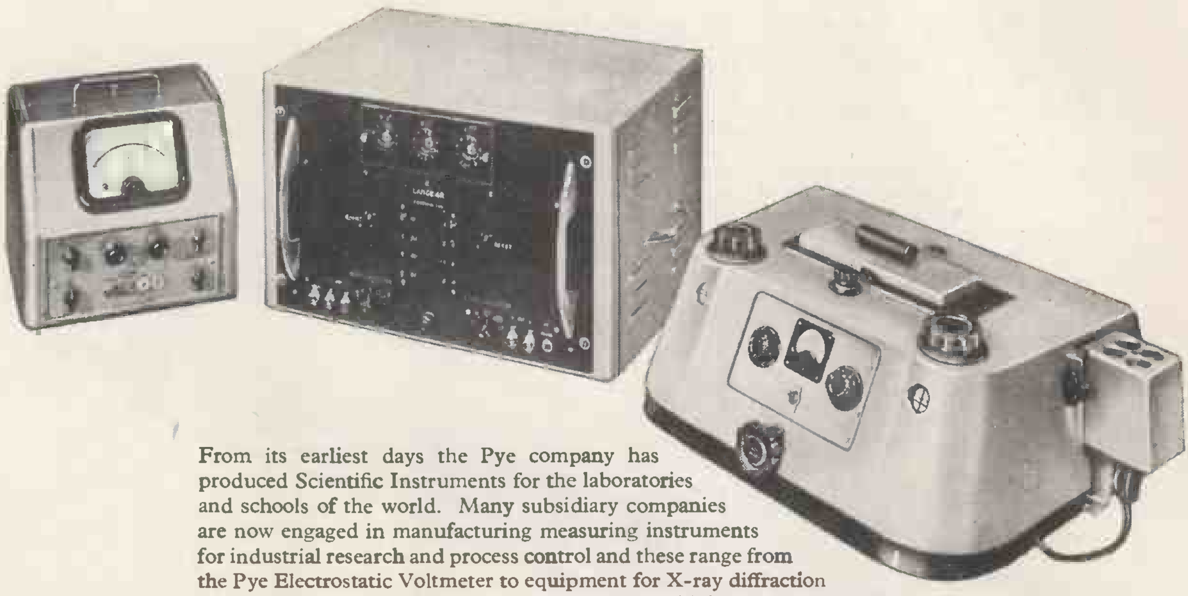
PYE

STATICON

CAMBRIDGE  CENTRE OF SCIENTIFIC RESEARCH

THE PYE GROUP

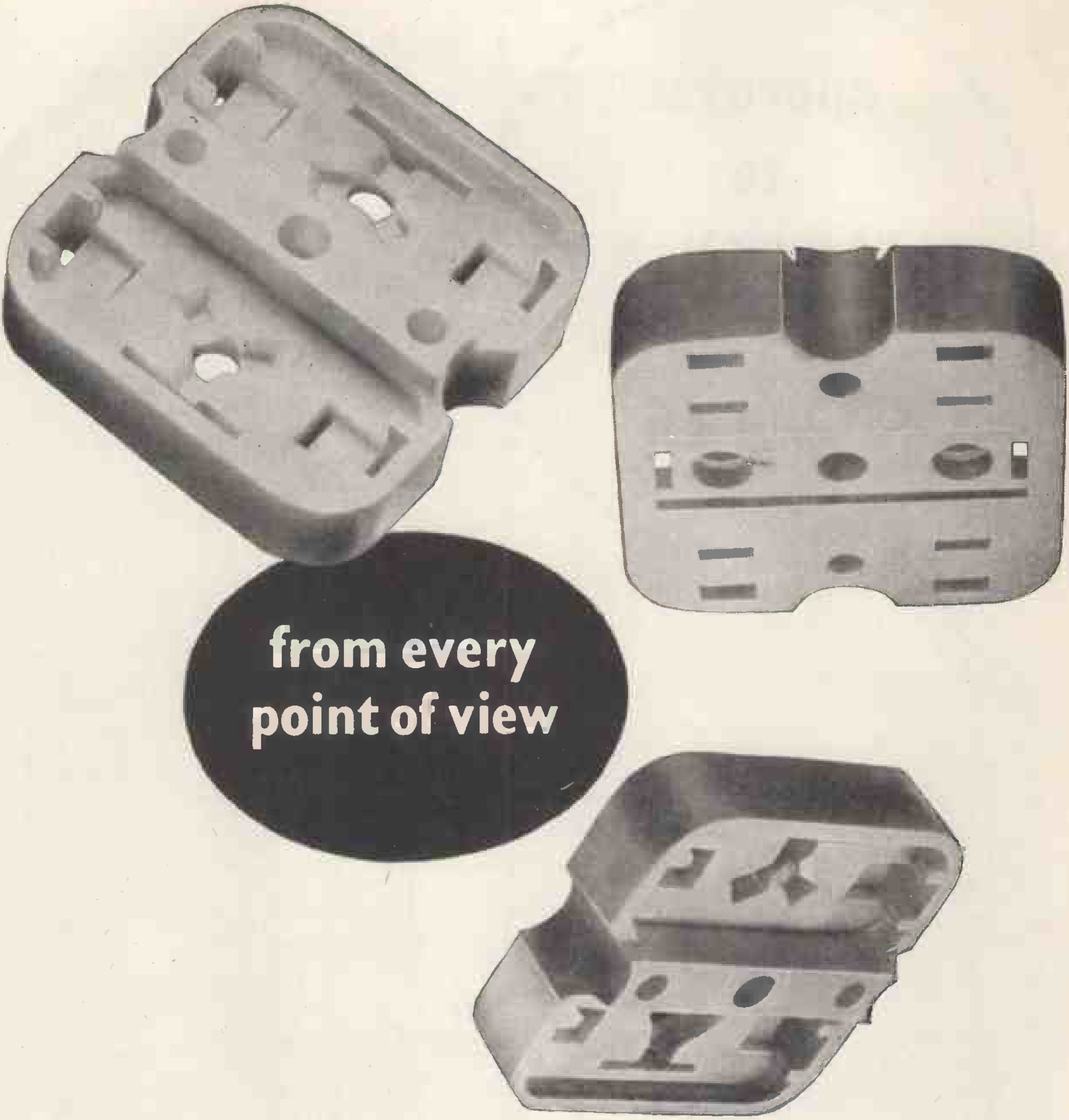
Quality Control



From its earliest days the Pye company has produced Scientific Instruments for the laboratories and schools of the world. Many subsidiary companies are now engaged in manufacturing measuring instruments for industrial research and process control and these range from the Pye Electrostatic Voltmeter to equipment for X-ray diffraction photography of crystal structure behaviour during high temperature changes. Conscious of its high position in the development of these instruments the Pye Group is always anxious to apply them to its own processes in the quest for finished products of the highest quality.

PYE Scientific Instruments

CAMBRIDGE · CENTRE OF SCIENTIFIC RESEARCH

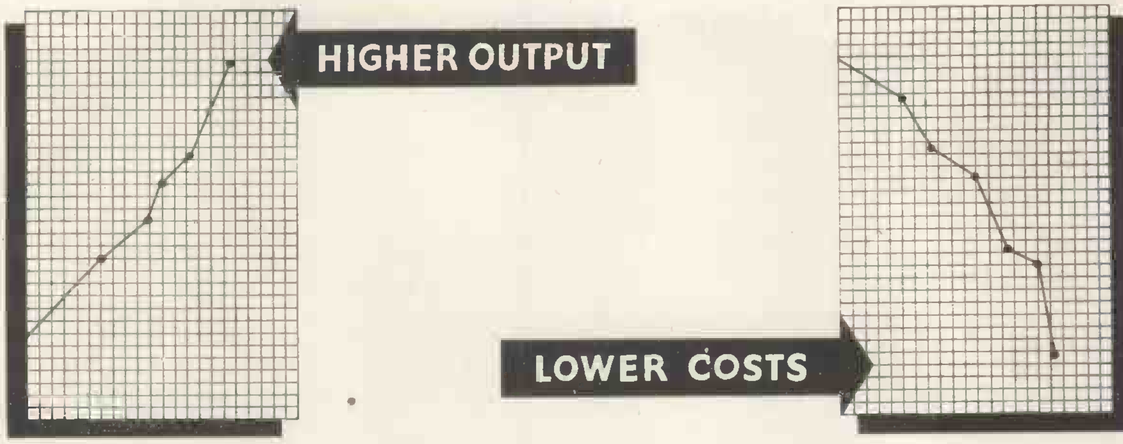


"Frequentite" is the most suitable insulating material for all high frequency applications. Seventeen years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

STEATITE & PORCELAIN PRODUCTS LTD.

Head Office: Stourport-on-Severn, Worcestershire. Telephone: Stourport 111. Telegrams: Steatain, Stourport

S.P.77



See the latest equipment for speeding production at Britain's fourth

MECHANICAL HANDLING

EXHIBITION & CONVENTION

OLYMPIA · LONDON · 9-19 JUNE 1954

MECHANICAL HANDLING is so important that no industry can function properly without it; unnecessary work is eliminated, bottlenecks are overcome, and production is increased many-fold. Britain's Mechanical Handling Exhibition and Convention—held every second year—is the biggest of its kind in the world. Nowhere else can you see such a comprehensive range of equipment, or hear experts in so many industries discuss the latest machines and methods.

This year's Exhibition will demonstrate the enormous strides made in handling techniques during the last two years, and bring to the Convention platform Britain's leading mechanical handling engineers who will point the way to higher output at lower cost. Plan *your* visit today! Post the coupon for details.

The world's largest display of
Conveyors, elevators, hoists, stackers, cranes, mechanical loaders and shovels, fork lift trucks, industrial trucks, coal handling plants, overhead runways, aerial ropeways, grain handling plant, wagon tipplers, pneumatic installations and ancillary equipment.

Many working exhibits
So vast is this exhibition that ample floor space is provided for much of the equipment to be demonstrated under working conditions.

Special Facilities:
Full information service; free consulting bureau; overseas visitors' reception and lounge; industrial cinema; post office, etc.

Organized by 'MECHANICAL HANDLING'—the journal of industrial mechanization

To: 'Mechanical Handling,' Dorset House, Stamford Street, London, S.E.1.

Please send me the 1954 Exhibition Brochure with details of Convention, free season ticket, etc.

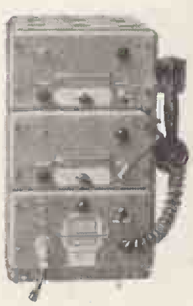
NAME ....

ADDRESS ....

.... AD

Air Sea Rescue?

The loss of one ship just over a year ago also cost more than 100 lives. The disaster occurred only 20 miles from land but search aircraft found the location too late because there was no ship–to–air communication. Further tragedies may well be avoided by ships being able to talk direct to each other and to aircraft. The RM.200 V.H.F. transmitter and receiver has been developed to meet this need.



TYPE RM 200 Multi-spot channel marine V.H.F. radio-telephone operating from A.C. Mains and/or Batteries. Amplitude Modulation.

Range: Ship-to-ship 25 miles; Ship-to-air over 100 miles.

Provides communication on the following INTERNATIONAL channels and 8 other channels.
121.5 Mc/s Aircraft Distress & Safety
156.3 Mc/s Marine Intership
156.6 Mc/s Marine Port Control
156.8 Mc/s Marine Safety & Calling

Price £210 Delivery, 4 months

RM

REES MACE MARINE LTD.

. . . . . . ONE OF THE PYE GROUP OF COMPANIES

Why...

is this Radiogram Chassis . . .

such a popular, such a fine all round performer? It is a success not only because it is priced within the enthusiast's means, but because it is designed to obtain the best results from modern gramophone techniques. We offer this de luxe radiogram chassis made by Tape Recorders (Electronics) Ltd., confident that you will gain the greatest satisfaction from the superior quality of both radio and record reproduction. So sure are we of the R.G.1's reliability that we give a two-year guarantee with every chassis. (Valves subject to usual makers' guarantee.)

THE BURGOYNE CUSTOM BUILT 8 VALVE Superhet Radiogram Chassis De Luxe

The R.G.I. costs only 22 GNS

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

HIRE PURCHASE
Deposit 154/- 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.

EXPORT
We specialise in speedy shipment to any overseas destination. Our price (exclusive of P.T.) for export buyers is £17/10/- sterling ex works.

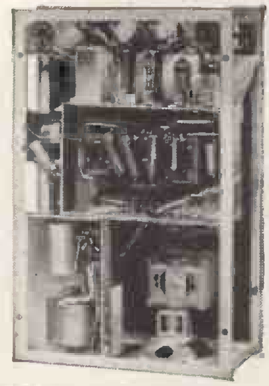
WE RECOMMEND
High quality 10in. or 12in. Goodmans, Wharfedale, and W.B. speakers for use with this chassis (3 or 15 ohms).

SPECIFICATION
★ Extra large fully illuminated coloured tuning scale 11½in. x 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. x 7½in. ★ Overall height 9½in. Chassis height 2½in. ★ 8 Mazda valves 6C9, 6F15, 6L1, 6LD20, UU7, 6MI and 2 x 6P25. ★ Speech coil impedance 3 or 15 ohms. ★ Extension speaker sockets. ★ Smoothed power supply 200-250 v. A.C. incorporated on chassis. ★ Specially designed for perfect reproduction of the LONG PLAYING as well as the standard record. ★ Brilliant reproduction on radio. ★ Long distance reception as clear as local stations. ★ TWO YEARS' GUARANTEE. ★ See our Loudspeaker list for suitable types of units.

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.

THE Editor SUITCASE TAPE RECORDER

Made by: Tape Recorders (Electronics) Ltd.

. . . is the smallest

lightweight portable fully automatic tape recorder,

it weighs only 33lb.,

it costs only 45 GNS

COMPLETE WITH MICROPHONE & TAPE

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.

ACCESSORIES
The "Editor" is supplied ready for use with a crystal desk microphone made specially for this equipment by RONETTE. A 1,200ft. reel of high coercivity BURGOYNE tape is supplied with every recorder. This especially recommended tape is available at 35/- per 1,200ft. reel or 21/- per 600ft. reel.

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 16⅜in. x 12in. x 5in. (7in. with lid). ★ Magic eye recording indicator. ★ Weight only approx. 33 lb. ★ 200-250 v. A.C. Mains. ★ Radio/Gram and Microphone Inputs.

M·O·S E. & G. **MAIL ORDER**

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The M.O.S. PERSONAL CREDIT PLAN

Any equipment in our vast range of merchandise may be purchased under this plan.

★ Three methods of purchase are available: CASH, CREDIT SALE OR HIRE PURCHASE. The second allows you to own your equipment on payment of a first instalment of nine which are spread over 9 months. We show the first instalment as one-ninth of the total purchase price, but if you so desire the first instalment can be any sum you please (within reasonable limits).

★ The third method secures delivery on payment of one-third of the cash price and the balance plus charges spread over any period up to 18 months.

★ Again, we show payments spread over 12 months, but this may be varied. Your enquiries and order will be dealt with confidentially whether by mail or personal shopping. We have years of experience behind us to advise and help you on your choice of goods.

★ We detail below a further selection of recommended items. If you do not see your need here, you may rest assured we can get it for you if it is available. Comprehensive lists are available upon request if you cannot call.

ITEM	CASH PRICE	CREDIT SALE OR H.P. TERMS 9 Mthly. Inst.	DEPOSIT	12 Mthly. Inst.
AMPLIFIERS AND ACCESSORIES				
Leak Point One TL/12	£28 7 0	72/-	£9 9 0	36/2
Leak Varislope	£12 12 0	32/4	£4 4 0	17/4
Rogers Baby de Luxe	£14 0 0	35/6	£4 13 4	19/-
Burgoyne A7 Pre-Amplifier	£3 10 0	11/-	£1 3 4	7/-
CABINETS				
TALLON VIEWMASTER				
12in. Table	£7 14 0	21/-	£2 14 0	11/8
12in. Console	£13 15 0	35/-	£3 15 0	20/-
9in. Table	£6 3 9	17/8	£2 3 9	10/-
9in. Console	£13 15 0	35/-	£3 15 0	20/-
Burgoyne Non-Auto Record Player (to fit GU4)	£3 10 0	11/-	£1 3 4	7/-
Burgoyne Auto Changer Record Player (to fit Monarch)	£3 10 0	11/-	£1 3 4	7/-
CATHODE RAY TUBES, ETC.				
MULLARD				
9in. (or Mazda)	£12 10 3	32/2	£4 3 6	17/2
12in. (or Mazda)	£16 13 8	42/2	£5 11 3	22/-
14in.	£19 9 3	49/2	£6 9 9	25/-
17in.	£23 12 8	59/10	£7 17 6	30/3
BRIMAR				
12in. Aluminised (or Mazda)	£17 14 6	44/-	£5 18 2	23/2
14in.	£20 10 0	53/2	£6 16 4	27/4
17in.	£24 13 6	62/-	£8 4 6	31/6
English Electric 16in.	£22 4 10	57/-	£7 8 3	28/6
E.M.I. 10in.	£14 18 11	38/-	£4 19 8	20/-
GRAMOPHONE UNITS				
B.S.R.				
Monarch	£16 10 0	42/-	£5 10 0	21/8
Regent (GU4/TOH)	£9 4 11	24/9	£3 1 4	13/3
GU4/DEH with 2 Decca XMS Heads	£12 18 0	33/-	£4 6 0	17/8
Connoisseur 3-speed	£23 8 11	59/11	£7 16 3	29/9
LOUDSPEAKERS				
WHARFEDALE				
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
Ditto (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
Ditto (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
Audiom 60	£8 12 6	23/6	£2 17 6	12/11
RECORD PLAYERS (with Amplifiers)				
E.A.R.				
Music Maker Non-Auto	£19 15 0	49/3	£6 11 8	25/4
Music Maker Auto	£24 17 6	62/-	£8 5 10	31/6

ITEM	CASH PRICE	CREDIT SALE OR H.P. TERMS 9 Mthly. Inst.	DEPOSIT	12 Mthly. Inst.
PICK-UPS				
Acos GP20	£3 6 0	11/-	£1 2 0	6/-
Connoisseur Super Lightweight (2 heads)	£9 5 6	25/-	£3 1 10	13/6
Decca XMS (2 heads)	£6 9 3	19/-	£2 3 1	10/-
RONETTE				
Miniweight (2 heads)	£3 9 6	11/11	£1 3 2	7/-
Miniweight (14,000 c/s) (2 heads)	£3 16 3	12/10	£1 5 5	7/4
RECORD PLAYERS				
BURGOYNE				
Auto 3-speed	£16 10 0	42/-	£5 10 0	21/8
Non-Auto 3-speed	£9 5 0	25/-	£3 1 8	13/3
RADIO RECEIVERS AND CHASSIS				
BURGOYNE				
RG1 Superhet 8 valve	£23 2 0	59/-	£7 14 0	29/-
RF1 Feeder Unit	£3 12 6	11/4	£1 4 2	6/4
Leak Tuner	£35 0 0	89/-	£11 13 4	46/6
TAPE RECORDERS and Accessories				
Baird "Sound Master" Recorder	£68 5 0	171/-	£22 15 0	86/6
Editor Recorder	£47 5 0	120/-	£15 15 0	60/-
Ferrograph Recorder	£79 16 0	203/8	£26 12 0	101/7
Grundig Recorder	£84 0 0	213/-	£28 0 0	106/9
Console Recorder	£99 15 0	254/-	£33 5 0	126/3
Emicorda	£94 10 0	242/-	£31 10 0	120/9
MSS PMR/3 Recorder	£99 15 0	254/-	£33 5 0	126/3
Sound Master Kit	£60 0 0	152/-	£20 0 0	75/-
Vortexion Recorder (Wearite Deck)	£84 0 0	213/-	£28 0 0	106/9
Lane Tape Table	£17 10 0	42/10	£5 16 8	22/-
Truvox Tape Table	£23 2 0	59/-	£7 14 0	29/-
Wearite Tape Deck 2A	£35 0 0	89/-	£11 13 4	46/6
Burgoyne Oscillator Unit	£1 17 6	7/-	12 6	4/-
TEST EQUIPMENT				
AVO				
Heavy Duty Meter	£15 0 0	38/-	£5 0 0	20/-
Model 7 or 40 Meter	£19 10 0	49/-	£6 10 0	26/-
Universal Minor	£10 10 0	27/6	£3 10 0	15/-
Signal Generator, Mains or Battery	£30 0 0	74/6	£10 0 0	39/-
Universal Bridge	£34 0 0	86/-	£12 0 0	42/-
Electronic Test Meter	£40 0 0	102/-	£13 6 8	50/-
Valve Characteristic Meter	£60 0 0	153/-	£20 0 0	75/-
D.C. Minor	£5 5 0	16/-	£1 15 0	9/2
Model 8 Meter	£23 10 0	60/-	£7 16 8	30/4
Leather cases for 7, 8, 40 and heavy duty meters	£3 0 0	9/6	£1 0 0	5/-
ADVANCE				
Audio Generator H.I.	£25 0 0	63/-	£8 6 8	35/-
Signal Generator E.2	£28 0 0	70/-	£9 6 8	36/6
Signal Generator J.I.	£35 12 0	90/-	£11 17 4	45/6
PULLIN Universal Test Meter Series 100	£11 11 0	30/-	£2 0 0	20/-
RC Bridge/Valve Voltmeter	£40 0 0	102/-	£10 0 0	57/6
AMPLION D.C. Test meter	£5 0 0	15/-	£1 0 0	10/-
B.P.L. Foundation Meter 1 m/a F.S.D. 3½in.	£3 10 0	11/9	£1 3 4	7/-
0-500 Microamps 3½in. Meter (Flush Mtg.)	£3 10 0	11/9	£1 3 4	7/-
Radar Kilovolter	£3 17 6	12/9	£1 6 0	7/6

Carriage and packing extra. *All above prices are ex warehouse.*

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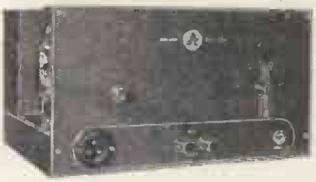

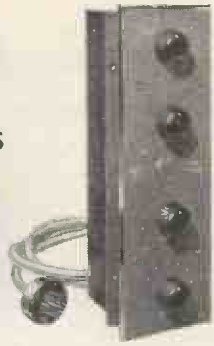

A 1254 12 Watts High Fidelity AC Mains.
(*As illustrated.*)
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A 1261 30 Watts Portable AC Mains.
A 1262 12 Volt Power unit for A 1261.
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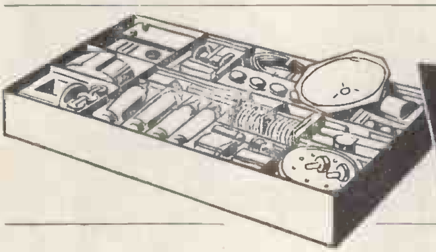
RADIO Outfit No. 1.—For carrying out basic practical work in Radio and Electronics, from first principles and leading to the design and building of simple Receivers.



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RADIO Outfit No. 2.—With this equipment, you are instructed in the design construction, testing and servicing of a complete modern Superhet Radio Receiver.

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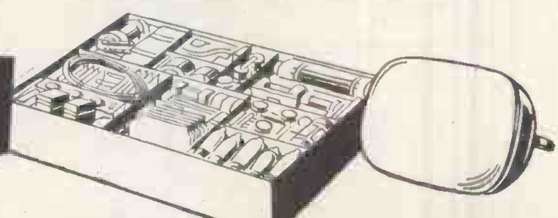
3



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ALONG WITH

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FOR ANY OF YOUR STANDARD
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Type No.	*Capacit. μμ F/ft.*	*Impedance ohms*	*O.D.*
C.44	4.1	252	1.03″
C.4	4.6	229	1.03″
C.33	4.8	220	0.64″
C.3	5.4	197	0.64″
C.22	5.5	184	0.44″
C.2	6.3	171	0.44″
C.11	6.3	173	0.36″
C.1	7.3	150	0.36″

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MICRO SECONDS TO 0·01 ?

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- H103—100 Kc/s 140μV/cm

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- DH103—Physiological
- DS103—250 Kc/s
- General Purpose

High Discrimination
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Micro Micro Micro watts
- 2502—Electrometer

High Sensitivity Double Beam

THE NAGARD-UNITEL SYSTEM OF

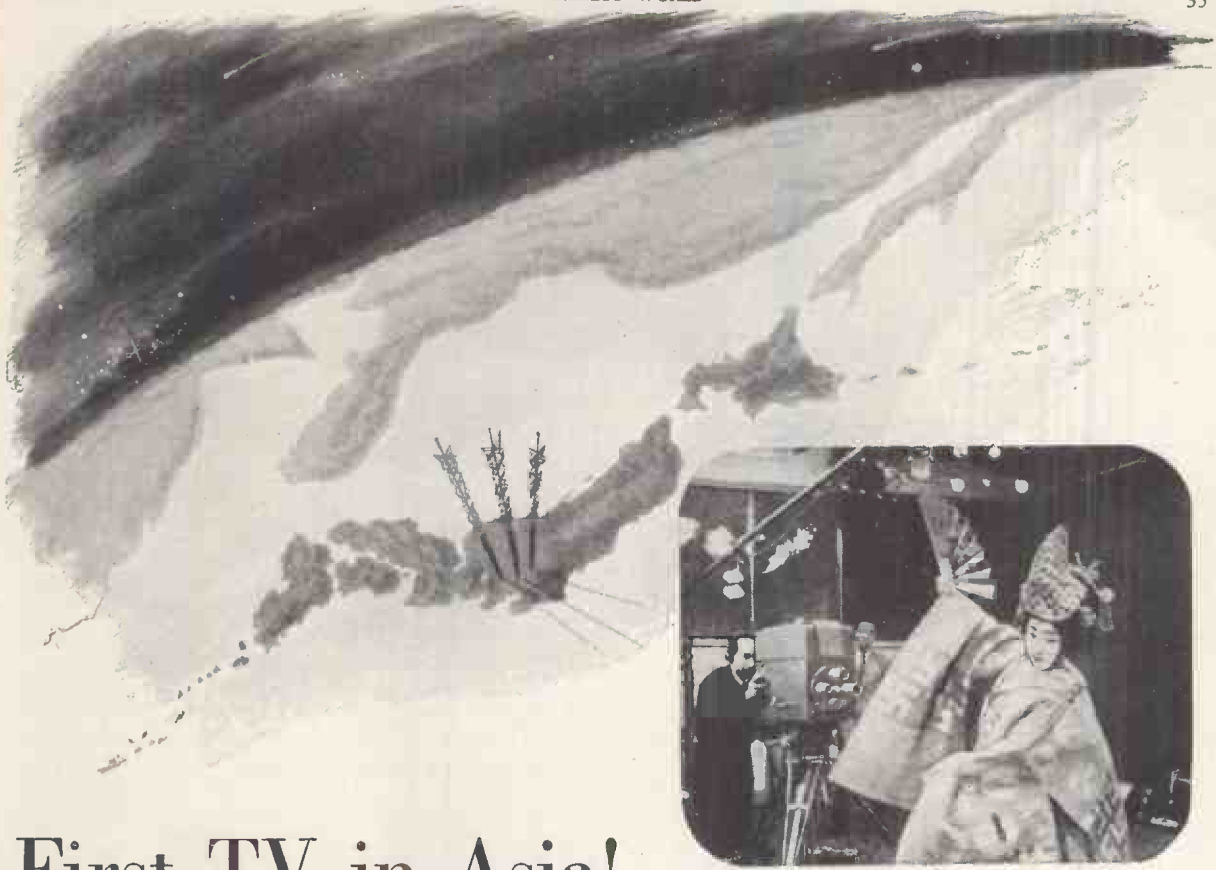
building up various combinations of instruments provides the ideal equipment of exceptional performance yet easily adapted to the next problem—using as the indicator—CRT Units—1001 single or 1002 double beam. There are time bases and amplifiers in many useful ranges for use with these CRT Units.

NAGARD LTD

18, AVENUE ROAD, BELMONT, SURREY. VIGilant 0345.

Specialists in Oscilloscopes and D.C. Amplifiers.

Your problems are our interest—Write for details.



First TV in Asia!

3 Tokyo stations, all RCA equipped

The ancient symbolism of Japan's art forms is now projected into the homes and schools of her people through a modern medium. Japan is the first nation in Asia to adopt the tremendous teaching capacity of television as a means of public enlightenment.

Three leading Tokyo broadcasting organizations are sponsoring the new stations which will reach a potential audience of some 12 million people. All three stations are RCA equipped. Microwave relay networks are being planned with auxiliary transmitters to cover the entire nation.

The list of countries installing RCA TV transmitters is growing steadily: Brazil, Canada, Cuba, Dominican Republic, Hawaii, Italy, Japan, Mexico, the Philippines, Thailand, Venezuela . . . with still others now planning video for their people.

Abroad, as in the U.S.A., where it is the preferred system, RCA has everything for television . . . from camera to antenna, from studio to transmitter to receiver. To date there are *170* RCA-equipped TV stations in the U.S.A. . . . and *22* in other countries. RCA also provides the service of distributors and companies long versed in the electronic needs of their countries.

Only RCA provides 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 be glad to tell you about RCA Television; or write to RCA International Division, New York, N. Y. "Marca Registrada"

World Leader in Radio
First in Recorded Music
First in Television

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

This is what an

M.R.S.T., Assoc. I.E.E., M.Brit. I.R.E.
F.T.S., A.Mus.T.C.L., M.I.M.I.T. ★

says about the

TRUVOX

TAPE DECK MARK III

"The Truvox Tape Deck is a winner . . . the best I have heard, disregarding the price. . . . a fine piece of precision engineering."

22 GNS.

A TRUVOX PRODUCT

★ *Mr. J. G. C. Gilbert pictured here with his complete "lash up" recorder, is Head of Northern Polytechnic Dept. of Telecommunications Engineering. He is better known to the public as John Gilbert of the B.B.C. Inventors' Club.*

The Deck is supplied with complete details of an amplifier specially designed to achieve maximum efficiency.

TRUVOX LIMITED, Sales Office, 15 Lyon Road, Harrow, Middx.

Please send me full details of the TRUVOX Tape Deck Mark III.

Name..

Address..

W.W.

....

new

EGEN

pre-set potentiometers

- **wire-wound linear, type 126**
- **carbon linear, type 127**

actual size

- *Completely enclosed in high-grade phenolic mouldings, keeping resistance elements dust-free.*
- *Solder tags are heavily silver-plated and designed to withstand soldering heat and bending without loss of rigidity.*
- *Spindles are fully insulated and provided with integral control knobs for finger or screwdriver adjustment.*
- *Tapped for 2-hole 6BA fixing on ¾" centres.*

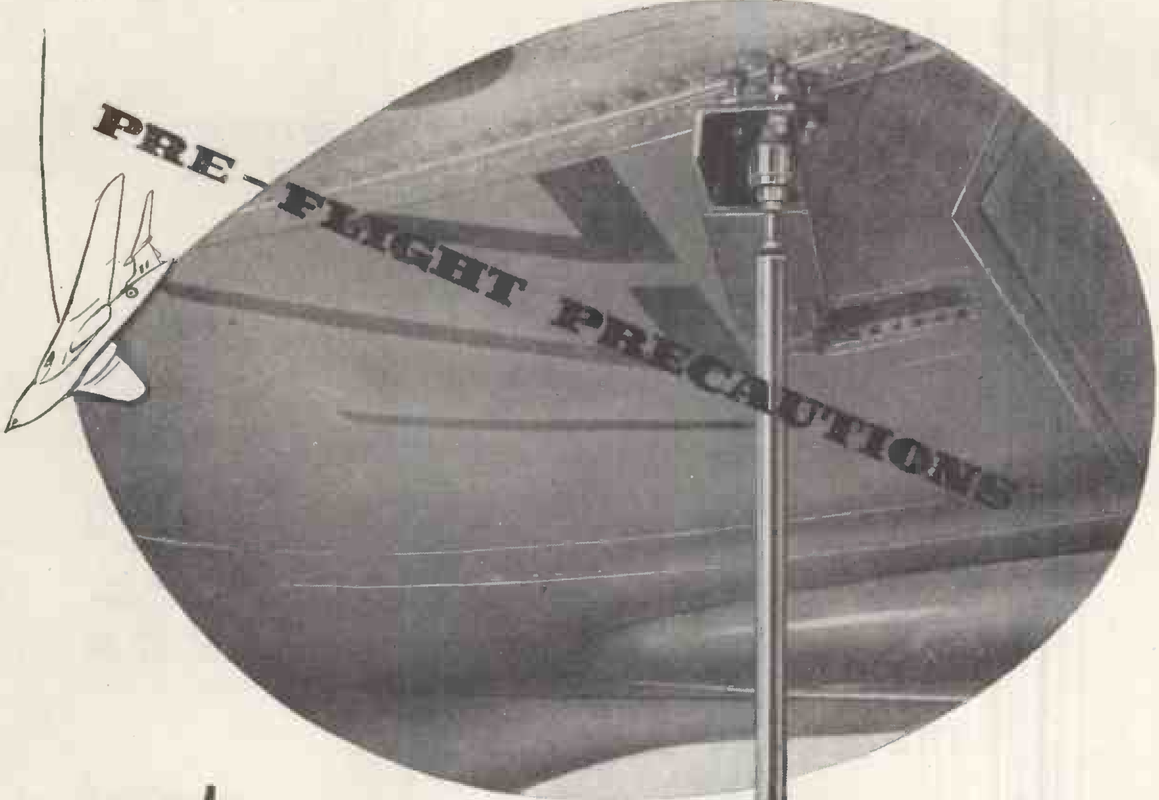
These Egen potentiometers are based on long experience of the needs of television and electronic equipment manufacturers.

EGEN ELECTRIC LTD

CHARFLEET INDUSTRIAL ESTATE · CANVEY ISLAND · ESSEX
'Phone: CANVEY 691 *and* 692

R.E.C.M.F. STAND 20 APRIL 6th–8th

Photograph by courtesy of Handley Page Ltd



PRE-FLIGHT PRECAUTIONS

with GOODMANS VIBRATORS

The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

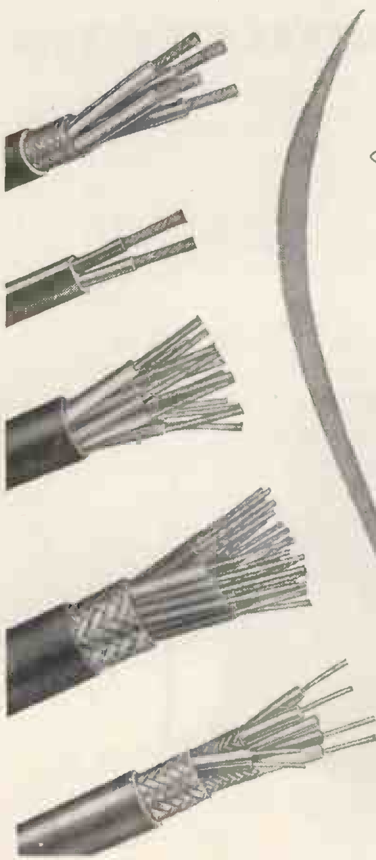
One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical ' flutter ' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Vibration Generators which were used to excite the Handley Page " Victor " for this very important test.

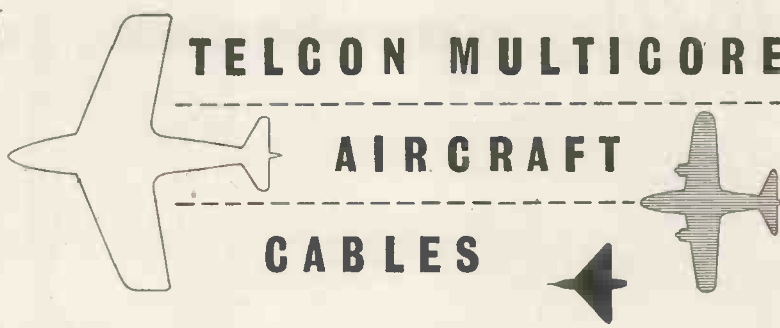
For wide frequency range vibration testing and dynamic response investigations, Goodmans Vibration Generators are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing ; maybe it can serve you—in which case our unique experience is at your service.

The range includes models from the 8/600 shown, developing a force of ± 300 lb., to the midget model, with a force of ± 2 lb., for optical cell research and hairspring torque testing, etc.

Just another of the wide applications of Goodmans Vibration Generators. Full technical data available from Vibration Division "W"

GOODMANS INDUSTRIES LIMITED, Axiom Works · Wembley · Middx · Wembley 1200 (8 lines)
GD





OC10
OC11
OC12

3 JUNCTION TRANSISTORS

for circuit experiments

Three types of junction transistor, the Mullard OC10, OC11 and OC12 are now available for circuit experiments.

In the past, the lack of supplies has prevented circuit designers in this country from gaining direct experience of junction transistors in their own laboratories. Now, however, the availability of the first junction types invites practical investigation into their many possible applications.

As junction transistors provide no current gain when connected with grounded base, they are more usually employed in grounded emitter circuits, where they function well as A.F. amplifiers. In both amplifier and oscillator circuits these transistors will operate with supply voltages as low as 1.5 V and with current consumptions of the same remarkably low order.

The OC11 is a general-purpose amplifier, while the OC12 is intended for operation in an output stage, although it can, of course, be used otherwise. A low-noise version of the OC11 is provided by the OC10, a special transistor for early stages in high-gain amplifiers.

Junction transistor type		OC10	OC11	OC12
Max. D.C. negative collector-to-emitter voltage	(V)	4	4	4
Typical D.C. collector voltage	(V)	2	2	2
Typical collector current	(mA)	–0.5	–0.5	–2
Current amplification factor (α') with grounded emitter		17	17	30
Output resistance with infinite A.C. source impedance (grounded base)	(KΩ)	700	700	500
Special low-noise characteristics		★	—	—

★ Superior type for these characteristics.

Information on these junction transistors and the point-contact types in the Mullard range of semi-conducting devices will be gladly supplied by the Industrial Technical Service Department at the address below.

● The OC10, OC11 and OC12 are readily available for experimental purposes at a price comparable with that of mains subminiature valves.

Mullard

MULLARD LIMITED, COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, W.C.2

MVT152

FIRST WITH THE NEW "LEAK"

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

AT

27 gns.

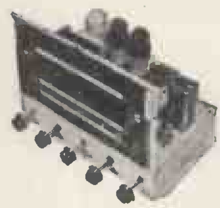
COMPLETE

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.

8-VALVE ARMSTRONG SUPERHET



8 watts push-pull output, Negative feedback, Bass and Treble controls, Short, medium and long wavebands.
£23/13/-.

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

SPEAKERS

Complete range, including Goodmans Axiom 101, £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. 60/6

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

BUILD YOUR OWN TAPE RECORDER

ALL PARTS PRECISION ENGINEERED

Main plate (Drilled—16½in. x 14¼in.)...	52/6
Capstan assembly 3¾/sec.	65/–
Switch unit	37/6
Tape Holder assembly	22/6
Pinch Roller assembly	15/–
Brake assembly	16/6
Capstans—7½in., 7/- ; 15in.	7/6
Motors each	38/6
(Send S.A.E. for detailed list)	
Decks : Wearite	£35
Truvox	22 gns.
Lane	£17/10
Motek	£17/17

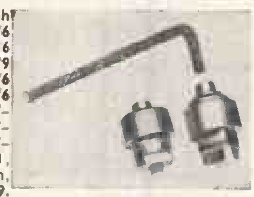
Completely built General Purpose amplifier suitable for most desks...... 16 gns.
R/P or Erase Heads............37/6 each. Also Complete "SOUNDMASTER" Kit.

"Q-MAX" CHASSIS CUTTERS

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

	each
⅝" or ¾"......	11/6
⅞"	12/6
1", 1⅛" or 1¼"	14/9
1⅜" or 1½" ...	16/6
1¾"............	18/6
2 3/32"	30/–
2½"............	35/–
1" square ...	23/–

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



Patent No. 619178

SPECIAL PRICE FOR COMPLETE SET, £10.

"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.

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 26/5
HGP.39/1—Std. or LP head ... 42/3
HGP.35/1—3 pin plug-in head 42/11
(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.

"POLYMAX" UNBREAKABLE INSULATORS

Stand offs : ½", 6d. ; 1", 9d. ; 1½", 1/-.
Beehives, 2/-.
Feed-throughs, 1/3.

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	13 0

THE "LINCOLN" OSCILLATOR COIL

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

Overall size, 1¼in. x 1¼in. x 1in. PRICE 12/6. (Post 6d.)

Complete Oscillator unit with valve, 50/-.

WE CARRY FULL RANGES OF MOST COMPONENT MANUFACTURERS, INCLUDING

BULGIN
T.C.C.
WELWYN, ETC.

BERRY'S (SHORT WAVE) LTD.

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TEL: HOLBORN 6231

Illustrated Catalogue 6d. post free.

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

An Announcement by the

H.A.HARTLEY Co. Ltd.

152, HAMMERSMITH RD., LONDON, W.6

Telephone : RIVerside 7387

It is with very great pleasure that the H. A. Hartley Co. Ltd. once again addresses itself to readers of this journal.

For some time past, we have had to forgo the benefits of advertisement in *Wireless World*, very largely due to the fact that the whole of our production has been sold in the Dollar Market.

HARTLEY SPEAKERS AND AMPLIFIERS ARE EARNING DOLLARS

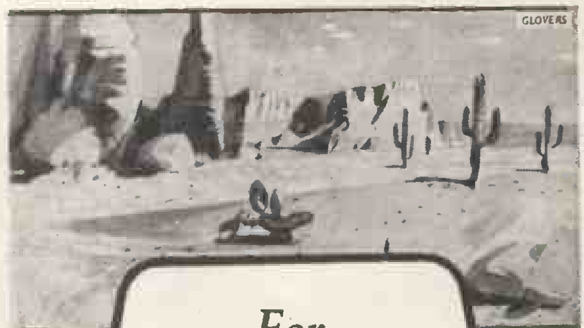
Even with a deliberate policy of restricting home sales we have found it well-nigh impossible to keep pace with the demand for the Hartley-Turner 215 Speaker, and the new Super Tone Control Pre-Amplifiers. Because of ever-increasing demands on our production, we have completed arrangements which place the resources of one of the largest manufacturing concerns in the country at our disposal. As a result, we are confident that we can now not only meet our export commitments in full, but that we can supply an increasing quota to the home market.

To those readers to whom Hartley-Turner is a household word, we need no introduction. For those who are newly converted to the enjoyment of High-Fidelity Gramophone Reproduction we summarise very briefly our range of Products. We are one of the very few United Kingdom manufacturers who design and manufacture all the following :—

HIGH-FIDELITY LOUDSPEAKERS
SUPER TONE CONTROL PREAMPLIFIERS
20-WATT AUDIO AMPLIFIERS

and we are the designers and sole manufacturers of the world-famous Non-Resonant Box Baffle (THE "BOFFLE"), only 18in. cube but equal in performance to a 4ft. diameter baffle.

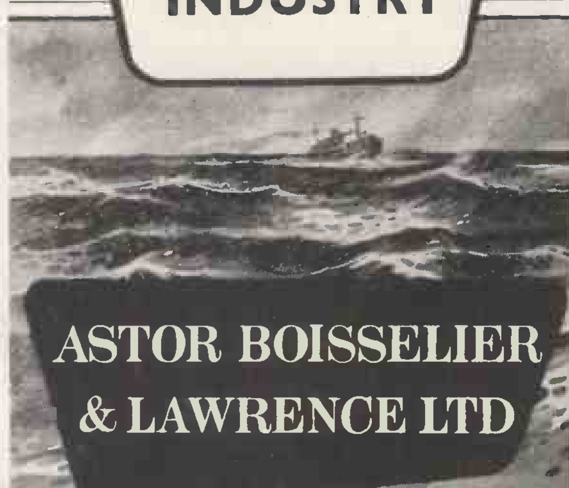
Why not send for our illustrated descriptive literature and price list, sent free and post free on request? We shall include full details of our Long Playing Record Supply Service.



For utmost dependability under all conditions

OKERIN WAXES AND DI-JELLS

for the ELECTRICAL INDUSTRY



9 SAVOY STREET, STRAND, LONDON, W.C.2
Telephone Temple Bar 5927
Works—West Drayton

THE ELPICO 'IMPRESARIO' COMPLETE ENTERTAINER

TAPE RECORDER

Guaranteed for 12 Months. *Patent applied for.*

The "Impresario" is a combination instrument that will make high quality tape recordings of live speech or music, gramophone or radio and telephone conversations, etc.

- **DUAL SPEED**: 3¾in./7½in. per sec.
- **SEPARATE BASS AND TREBLE CONTROLS.**
- **TWIN TRACK**: Up to 2 hrs. recording.
- **4 WATTS OUTPUT**: Neg. F/B.
- **INTERNAL MIKE RECORDING SYSTEM.**

The "Impresario" can also be used as a high quality radio, gramophone or microphone amplifier.

PRICE 49½ GNS.
(EXCLUDING TAPE)

RADIO RECEIVER

The "Impresario" is the first transportable tape recorder in Great Britain to provide power supply and internal space for a radio tuner unit with optional listening and/or recording.

DISTORTIONLESS SUPERHET 3-WAVE RADIO TUNER UNIT
May be fitted in a few minutes.

PRICE 14 GNS.
(TAX PAID)

PIEZO-ELECTRIC MICROPHONES
Hand unit in rubber grip...3 gns. Studio Floor-stand Pattern...6 gns.
Telephone Pick-up Stand...3 gns.

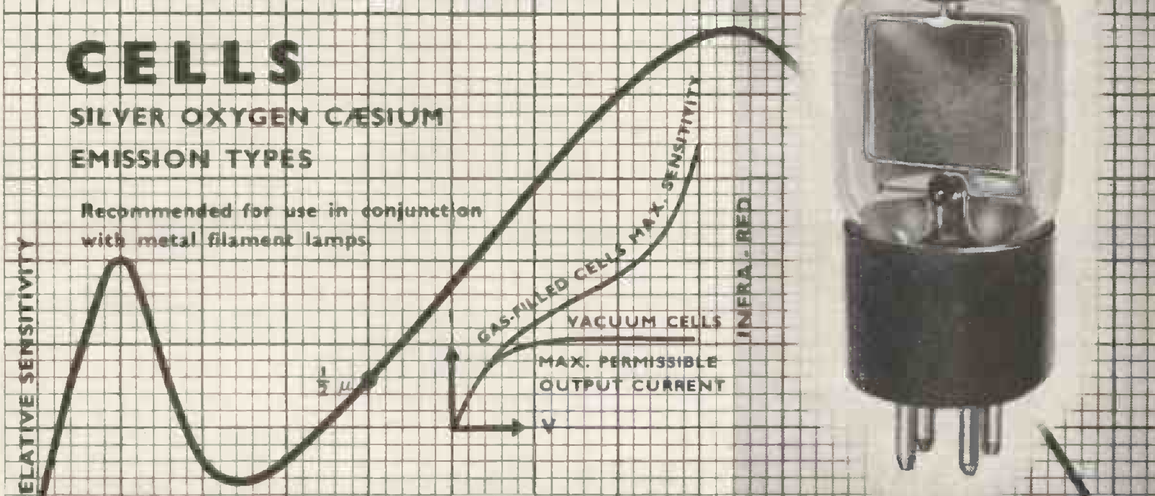
Send for "Impresario" Illustrated Brochure which also contains details of Radio Tuner Unit, Telephone Pick-up, Suitable Microphones and Recording Tape.

LEE PRODUCTS (GREAT BRITAIN), LTD., ELPICO HOUSE, GT. EASTERN ST., LONDON, E.C.2.

ELECTRICON PHOTOELECTRIC CELLS

SILVER OXYGEN CÆSIUM EMISSION TYPES

Recommended for use in conjunction with metal filament lamps.



TEST RESULTS AND OPERATING RECOMMENDATIONS INCLUDED WITH EACH CELL

RONALD TRIST & CO. LTD., BATH ROAD, SLOUGH.

Introducing

THE FIRST OF THE "ELAC" RANGE OF ELLIPTICAL LOUDSPEAKERS

This new addition to the wide range of ELAC loudspeakers is particularly recommended for use with Television Receivers. The speaker gives a fuller bass response and a considerably clearer top response. The Magnet System is completely shrouded, which reduces stray magnetic field to the absolute minimum. Available in Flux Densities 6,500, 8,000 and 9,500 gauss.

PRICES: 4 x 7G, 19/10 inc. P.T. 4 x 7D 25/1 inc. P.T.

ELAC

ELECTRO ACOUSTIC INDUSTRIES LTD.

STAMFORD WORKS, BROAD LANE, TOTTENHAM, N.15

When Fidelity Really Matters

then the MUSICMASTER TAPE RECORDERS

will be your choice

These 'quality first' tape recorders have been exported to over forty countries throughout the world and are in regular use by Industrial Organisations and Government Services. Price for price they offer unequalled performance. Unsolicited testimonies on file prove conclusively that the Musicmaster Tape Recorders are among the finest tape recorders available.

MODEL 2250B **£52**

MODEL 1200B **£45**

H.P. TERMS AVAILABLE

CONCERT-MASTER AMPLIFIERS

MODEL 2

A 3 watt high fidelity amplifier for outstanding reproduction of all types of gramophone records.

£12 - 12 - 0

DE-LUXE

A 15 watt high fidelity amplifier giving superlative reproduction from records or radio. Less than 0.1% distortion at 10 watts.

£30 - 0 - 0

Further details on request.

SPECIAL NOTE. Our Showroom is open 9 a.m.—6 p.m. daily including Saturday for demonstrations. WE STOCK A WIDE RANGE OF COMPONENTS FOR THE HOME CONSTRUCTOR AND QUALITY ENTHUSIAST. WHY NOT VISIT US FOR YOUR REQUIREMENTS? Regret no Mail Order for components at the moment.

DESIGNED FOR CRITICS

Trusound Ltd.

BY CRITICAL DESIGNERS

Showroom open daily for demonstrations

OFFICES & SHOWROOM: 196 KINGSLEY ROAD, HOUNSLOW, MIDDX. (HOUnslow 7947) WORKS: TWICKENHAM, MIDDX.

That Elusive Quality . . .

Discoursing light-heartedly yet intelligently on " HI-FI," a contributor to "The Observer" recently commented on the ability of the modern loudspeaker (aided by amplifiers, pre-amplifiers and other aids) to detect and faithfully reproduce such sounds as the closing of studio doors and the pages of a score being turned. He made reference to the achievement at the loudspeaker end of " perfect concert-hall balance."

Now what is, in fact, the secret of so-called " high fidelity " reproduction ? It is something that is not only or merely the expression of what can be graphically illustrated with a good frequency response curve. It is not only the faithful reproduction of all sounds within the range of the aural spectrum. It is not alone the perfect " balance " of high, middle and low frequencies. It is all these things conjoined to produce an elusive quality of realism that gives to the listener the illusion of being present at the actual original rendering.

This elusive quality cannot be measured with instruments or recorded in a response curve. The simplest way of expressing it in words is to say that when you are listening to a truly good loudspeaker, you feel that you are in the recording studio.

When a recent consignment of Goodmans " AXIOM " Loudspeakers arrived in New York, a leading expert there said, " This is the most revolutionary development in the reproduction of sound since the invention of the loudspeaker . . . it is superior in every way . . . the reason is that the engineers who designed the ' Axioms ' were aiming for PRESENCE."

If you want to know what this elusive quality " Presence " really is, take or make an opportunity to hear a Goodmans AXIOM Loudspeaker. You will then understand the enthusiasm of the American expert.

We will be pleased to supply free dimension 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.

AXIOM 22 MK. II £14 14.0 (*Tax free*)
AXIOM 150 MK. II £10 . 5 . 6 (*Tax free*)
AXIOM 102 £9 . 18 . 2 (*Inc. Tax*)
AXIOM 101 £6 . 12 . 1 (*Inc. Tax*)

GOODMANS

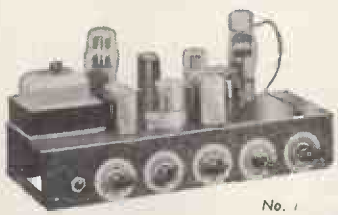
GOODMANS INDUSTRIES LTD.

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

REAL HIGH FIDELITY *at modest cost . . .*

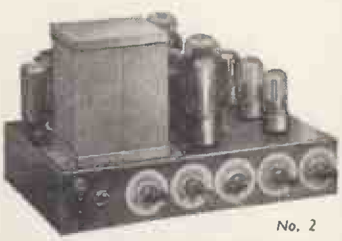
• *Manufacturer-to-Consumer policy saves you one-third cost ! !*

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 on these instruments. price : No. 1, **12 gns.** ; No. 2, **17 gns.** Carriage 5/-.

GARRARD 3-SPEED GRAM UNIT MODEL "T." With turnover Magnetic Pick-up Head or Turnover Astatic Crystal Head, **£10**, post and pack. 2/6.

MODEL "TA," as above, but fitted with the latest High-Fidelity Acos HGP35 Pick-up Heads (one for Std. and one for L.P.). Price **£12/3/9**, post and pack. 2/6. Heads only, **43/-** each, post 1/-.

MODEL "TB," as above, but with two separate Decca XMS Heads, **£13/7/6**, post and pack. 2/6. Or with two separate Acos HGP39 Heads, **£12/16/-**. Or with Garrard Head for fibres (78) and Acos HGP39 for L.P., **£12/5/-**.

GARRARD 3-SPEED AUTO-CHANGERS, Model RC80, plays up to ten records 7in., 10in. or 12in. at 78, 45 and 33⅓ r.p.m. Stylus pressure on L.P. 10 grammes (adjustable). New ultra-sensitive auto-trip mechanism and heavy loaded turntable to eliminate "wow." Price **£15/1/6** or with Garrard Magnetic or Astatic Crystal Turnover Pick-up Head, **£17/3/6.** With two separate Acos HGP39 Heads, **£19/12/6.** With two separate Decca XMS Heads, **£20/18/-.** Carriage 5/-. Optional Extras : A.C./D.C. Operation **£7/14/-.** Fitting in de Luxe rexine-covered Portable Cabinet, **£5.** Pick-up Head to take Fibre Needles, **25/-.**

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.

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

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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.** Finshed 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.

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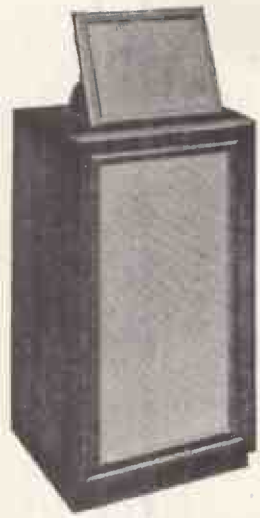

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"SYMPHONY" BASS REFLEX CABINETS, fully finished in figured walnut, oak or mahogany to above Registered Design and to match our Console Amplifier Cabinet, enabling the housing of a whole equipment in a two-piece suite, cost : 12in. speaker model, **£11/10/-** ; 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.

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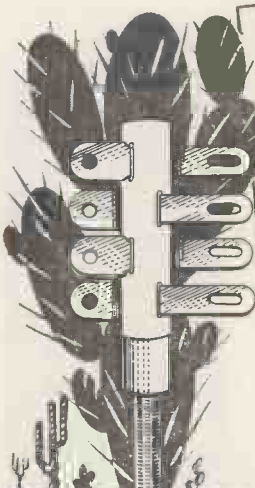

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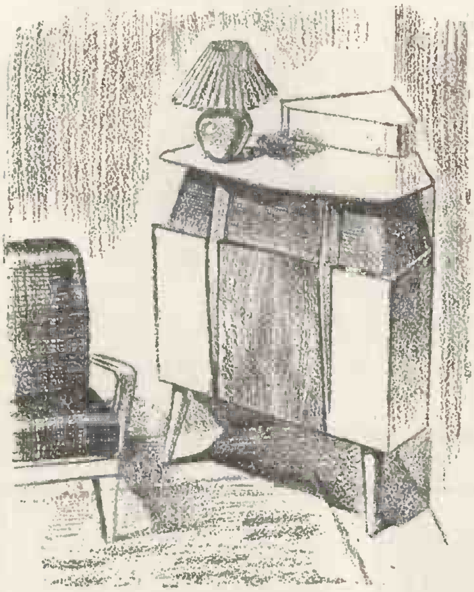

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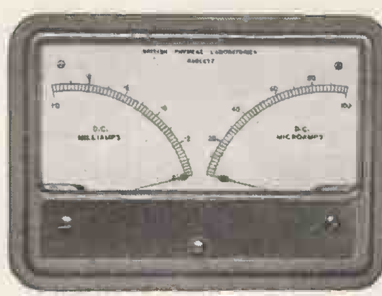

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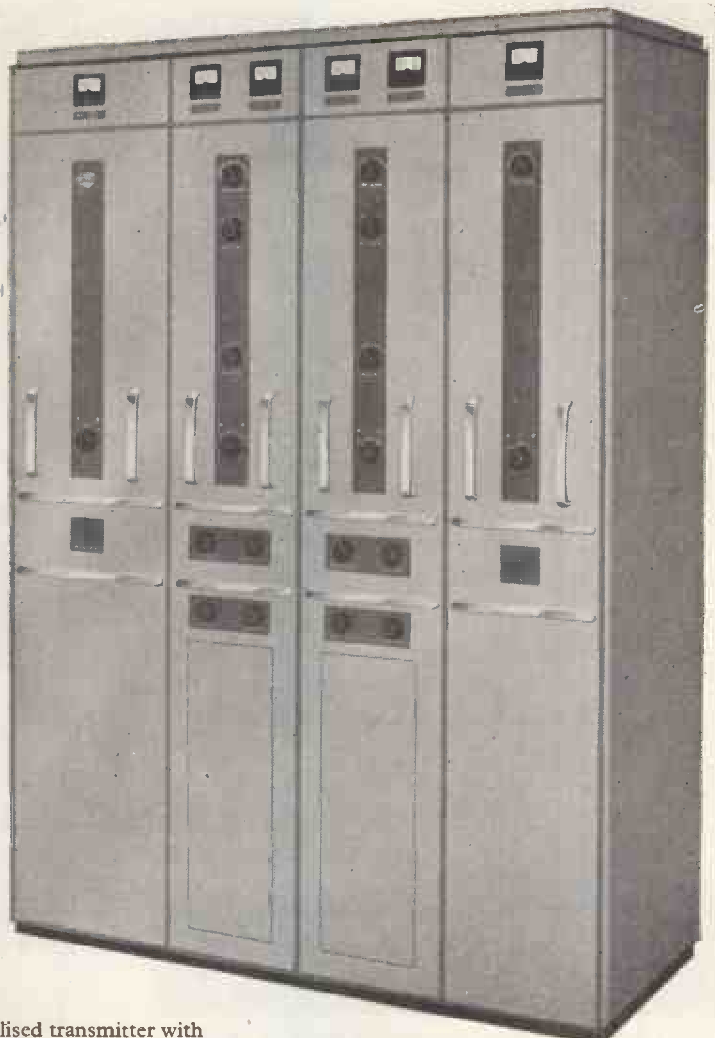

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Frequency Stability To Atlantic City, 1947, standards
Power Output 1 kW
Types of Emission c.w., m.c.w., telephony, frequency shift, single and independent sideband. (A1, A2, A3, F1, A3a and A3b)
Output Impedance 600 ohms balanced twin feeder
Power Supply 400V, 50-60 c/s, 3-phase

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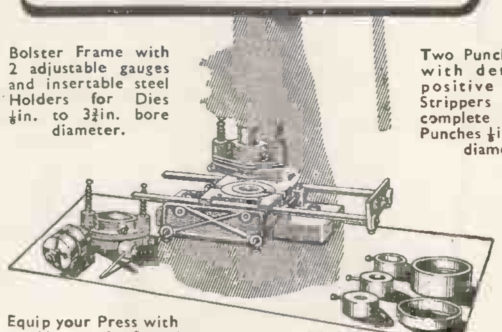

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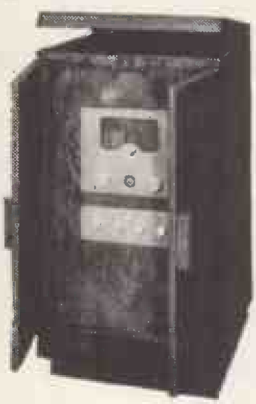

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CLASSIC CABINET	£27	10	0
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3

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4

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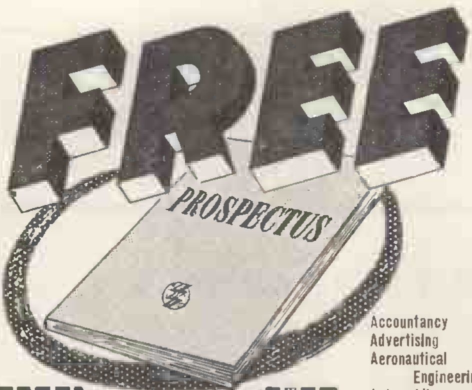

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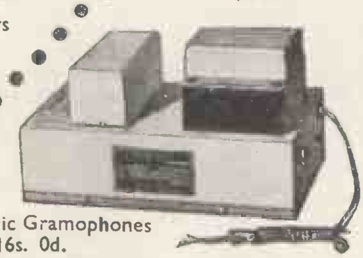

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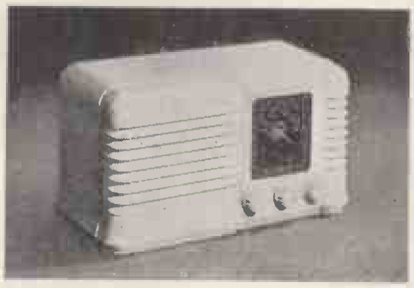

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1 Drive Spindle (Rear Drive)		1	6
1 Drive Drum		1	6
1 Drive Spring			3
1 Drive Pointer			4
1 2-band Dial		1	6
1 Front Plate		2	6
2 Dial Clips L.H.			6
2 Dial Clips R.H.			6
1 Length Drive Cord 15in.			3
TOTAL COST	£1	10	10

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

SECTION 2

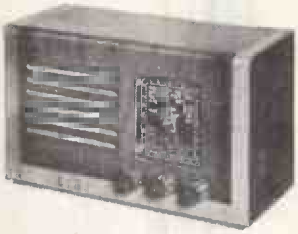
1 Aerial Coil (Green Spot) with Fixing Bar		2	9
1 Anode Coil (Red Spot) with Fixing Bar		2	9
1 Wavechange Switch		2	6
1 2-gang Variable Condenser with Trimmers		8	6
TOTAL COST		16	6

SPECIAL PRICE FOR COMPLETE SECTION 12/6 plus packing & postage 1/6.

SECTION 3

1 Choke		6	6
1 Heater Transformer T/LT3 PRY. 200/250 Volts SECY. 6.3 Volt 2 Amps Tapped at 5 volts		7	0
1 Output Transformer Ratio 45/1		5	6
1 Volume Control 10 K ohm with Switch		4	6
TOTAL COST	£1	3	6

SPECIAL PRICE FOR COMPLETE SECTION 17/9 plus packing & postage 1/6.



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*.

The PREMIER De Luxe PORTABLE MAGNETIC TAPE RECORDING KIT

Including ALL parts, Valves, Portable Cabinet, 8in. Loudspeaker, Tape-Table, Reel of 'Scotch Boy' Tape and Rewind Spool, and Microphone. **PRICE £37.4.0** (Plus 15/- Pkg., Carr. & Ins.)

THE 7-VALVE AMPLIFIER IS SPECIALLY DESIGNED FOR HIGH QUALITY REPRODUCTION

Brief Specification: VALVE LINE-UP: EF37A First Stage, 6SL7 Second Stage and Tone Control; 6V6 Output 6X5 Rectifier; VT501 Bias and Erase Oscillator: 7193 Record Level Amplifier; 6U5 Magic Eye Record Level Indicator. OUTPUT: 4 Watts. FREQUENCY RANGE: 50 c.p.s. to 9,000 c.p.s. CONTROLS: Volume; Record/Playback Switch; Treble Boost; Bass Boost—on/off.

A VISUAL MAGIC EYE Record Level Indicator is incorporated. The unit is housed in a superbly finished rexine covered portable cabinet which incorporates a compartment for the Microphone when not in use. Weight complete 35lb. Dimensions: 2ft. long, 12½in. deep, 9½in. high.

The RECORDER incorporates an entire NEW VERSION of the famous LANE TAPE TABLE.
Brief Specification: Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run is less than 1 min in either direction. WIND AND REWIND WITHOUT UNLACING OF TAPE INSTANTANEOUS BRAKING. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record playback head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half-track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED: 7½in. sec. For use on A.C. 200/250, 50 cycles mains only.

MICROPHONE: Crystal—specially designed for Premier by famous manufacturer

SEPARATE UNITS CAN BE SUPPLIED AS LICTED BELOW

AMPLIFIER KIT (including 8in. Speaker)	£11	0	0	plus 5/- pkg./carr.
AMPLIFIER (already built, wired and tested)	£14	15	0	plus 7/6 pkg./carr.
LANE TAPE TABLE & REWIND SPOOL	£17	10	0	plus 7/6 pkg./carr.
PORTABLE CABINET (rexine covered)	£4	19	6	plus 5/- pkg./carr.
MICROPHONE	£2	19	6	plus 1/- pkg./carr.
REEL OF NEW M.C.-2-III "SCOTCH BOY" TAPE (1,200ft.)	£1	15	0	plus 1/- pkg./carr.

★ **INSTRUCTIONAL BOOKLET** 2/6
This is credited if a complete kit of the Tape Recorder is ordered.

This Recording Outfit has been designed for use with M.C.-2-III "SCOTCH-BOY" Magnetic Tape. With this new and improved high-quality tape a frequency of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½ in./sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-.

As is usual in all PREMIER KITS every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included. When completed the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.

Supplied completely assembled 39 GNS. Plus 1 gn. Pkg. & Carr.

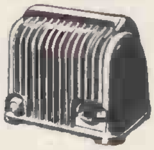
TERMS OF BUSINESS: *Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/-, unless otherwise stated.*

PREMIER RADIO COMPANY

ONLY A FEW LEFT!

THE FAMOUS 'SOBELL' 4-VALVE SUPERHET TABLE RECEIVER

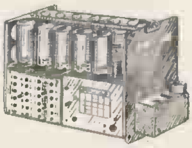
M. & L. WAVEBANDS



Valve line-up: 12J7, 35L6, 1487, 35Z4.
Entirely transportable and unusually sensitive 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.

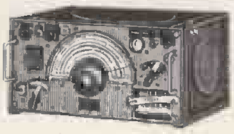
Fully covered by Manufacturer's Guarantee

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. **17/6**
Brand new in transit case 24/- plus 3/6 postage and packing.

1155 RECEIVER UNIT



In original cases complete with 10 valves. Frequency range 18.5 Mc/s.-75 Kc/s. in 5 wavebands. £11/19/6. Plus 10/6 packing and carriage.

POWER SUPPLY UNIT

for above, incorporating output stage. Supplies an output of 250 volts at 80 mA. which is ample 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.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6. Plus 15/- pkg. & carr.

R1355 RECEIVER AMPLIFIER

with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's, 1—5U4, 1—VU120, 1—EA50, 39/6. Brand new 55/-. Plus pkg. and carriage 5/-.

RF 24 UNITS

Frequencies covered 30-20 Mc/s (10-15 metres). Switched tuning, 5 pre-tuned spot freq. 3/VR65 (SP61). 12/6.

RF 25 UNITS

Frequencies covered 40-50 Mc/s (6-7.5 metres), switched tuning. 5 Pre-set positions complete with 3 VR65's, 17/6.

RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2—EF54, 1—VR137, 37/6.

RF 27 UNITS

Frequencies covered 85-65 Mc/s (3.5-5 metres). Otherwise as RF 26, 37/6.

We have a limited supply of RF26 and 27 Units with damaged dials at 27/6.

CORRECT ASPECT WHITE Rubber Mask—Round or Flat

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

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**

ACCUMULATORS

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

METERS

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

Full Scale Deflection	Scale Length in.	External Dimensions in.	Movement	
25 A	1½	2¼ round	R.F. Thermo	7/6
3.5 A	1½	2¼×2¼	R.F. Thermo	7/6
4 A	1½	2¼×2¼	R.F. Thermo	7/6
20 A	1½	2¼ round	M/C	8/6
40 A	1½	2¼ round	M/C	8/6
1.5 mA	1½	2¼ round		12/6
5 mA	2	3½ round		7/6
6 mA	2	3½ round		16/9
50 mA	1½	2¼×2¼	M/C	7/6
20 V	2	2¼×2¼	M/C	8/6
40 V	1½	2¼×2¼	M/C	8/6

At last!

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.

Limited supplies of C.R. TUBES

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

ALL BRAND NEW

VCR516
9in. blue picture, Heater volts 4 Anode 4 Kv. In manufacturer's original carton. £3/19/6. Plus 5/- pkg., carr., ins.

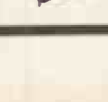
LOUDSPEAKERS

ELAC—2½in. dia., Moving Coil, 15 ohms 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 £8/8
Plus 5/- packing and carriage.
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)
These are brand new in Maker's Cartons. For only **47/6**
Plus 2/6 Pkg. and Carr.

"MASTERADIO" VIBRATOR PACK



6 v. input 180 v. 35 mA. output complete with valve rectifier and leads, 39/6. Plus 5/- pkg., 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.

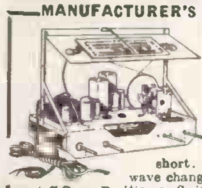
WILLIAMSON OUTPUT TRANSFORMER

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

MAINS TRANSFORMER SP425A

(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. SPECIFICATION:—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.15 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/-.

WEYMOUTH MINIATURE I.F. TRANSFORMERS

465 Kc/s., iron cored, permeability tuned, 10/6 pair.

WEYMOUTH MINIATURE COIL PACK

Covering Med./Long/Short wavebands. Iron cored coils, gram position on switch. Dimens.: Height, 1½in. Length, 3½in. Width 2½in. Spindle length 2in. Price 19/6.

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. Willcharge 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 21/-
2004 Charges 2, 6 and 12 v. accumulators at 1 amp. 24/6

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.

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.

A81

Wireless World

RADIO, TELEVISION AND ELECTRONICS

44th YEAR OF PUBLICATION

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

APRIL 1954

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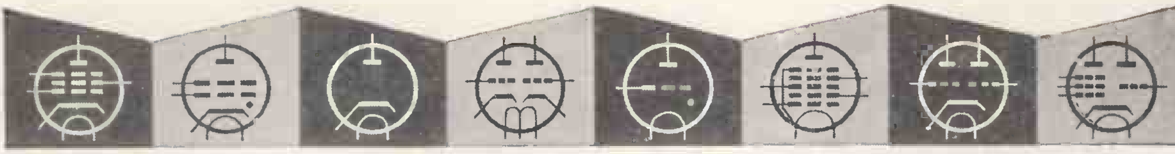

VALVES, TUBES & CIRCUITS

PCF80: A FREQUENCY CHANGER FOR BAND I AND BAND III TELEVISION

At Band III frequencies (174 to 216 Mc/s) the efficiency of a mixer stage is governed not only by the valve characteristics and the circuit components, but also by the 'invisible' components formed by VHF effects in the wiring and the chassis and by the deviations of the components from their nominal low-frequency values. Thus the following considerations of optimum valve performance must be supplemented by very careful circuit design.

The triode section of the PCF80 is designed for use primarily as an oscillator in a Colpitts circuit. The optimum drive voltage on the grid is 5 or 6 volts at the higher frequency end of the band where the circuit impedance is very low. At lower frequencies the anode impedance rises resulting in a higher oscillator voltage on the grid.

Design of the circuitry between the oscillator and the mixer must avoid the masking of poor oscillator performance by tight coupling. Inductive coupling is recommended, especially in a turret tuner. It allows adjustment to the most favourable value of mixer drive on each waveband, and it makes the whole of the oscillator coil available for the induction of an oscillator voltage into the grid circuit. With capacitive coupling it is difficult to arrange for alternative capacitors for the different wavebands. A single value, chosen for optimum drive on Band I, may give serious overdrive on Band III, thus necessitating an undesirably large compensating variation in triode oscillator drive.

The optimum conditions for the pentode mixer are determined by the conversion conductance, the input damping, and the bias and oscillator voltages on the signal grid. A cathode resistor of 820 Ω maintains a value of conversion conductance around 2 mA/V over the V_{osc} range from 2 volts to 5 volts, therefore a V_{osc} of approximately 3.5 volts is recommended. A slightly higher conversion conductance is obtainable with a cathode resistor of 330 Ω, but it requires a much more critical value of V_{osc}, and it is, therefore, oversensitive to valve-to-valve variations and to changes during life.

At the higher frequencies the valve damping largely determines the impedance of the input circuits between the mixer and the RF stage and, therefore, the gain and the bandwidth. Input resistance rises with rising drive, and input damping is improved with increasing cathode bias. In a practical bandpass circuit a cathode resistor of 820 Ω will give optimum performance at both high and low frequencies.

DATA

HEATER

I_h	0.3 A
V_h	9.0 V

CHARACTERISTICS

Pentode Section

V_a	170 V
V_{g2}	170 V
I_a	10 mA
I_{g2}	2.8 mA
V_g	−2.0 V
g_m	6.2 mA/V
r_a	400 kΩ

Triode Section

V_a	100 V
I_a	14 mA
V_g	−2.0 V
g_m	5.0 mA/V
μ (approx.)	20

TYPICAL OPERATING CONDITIONS

As a frequency changer

V_a	170	170	V
V_{g2}	170	170	V
R_{g1}	100	100	kΩ
R_k	820	0	Ω
I_a	5.2	6.3	mA
I_{g2}	1.5	2.5	mA
V_{osc} (r.m.s.)	3.5	4.0	V
I_{g1}	0	53	μA
g_c	2.1	2.05	mA/V
r_a	870	720	kΩ

BASE B9A

LIMITING VALUES

Pentode Section

V_a max.	250 V
p_a max.	1.7 W
V_{g2} max. (I_k = 14 mA)	175 V
V_{g2} max. (I_k = 10 mA)	200 V
p_{g2} max.	0.5 W
I_k max.	14 mA
V_{h-k} max. .... (heater negative)	150 V
V_{h-k} max. .... (heater positive)	90 V

Triode Section

V_a max.	250 V
p_a max.	1.5 W
I_k max.	14 mA
V_{h-k} max.	±90 V

Mullard

Reprints of this advertisement, together with additional data may be obtained free of charge from the address below.

MULLARD LTD., Technical Service Department, Century House, Shaftesbury Avenue, W.C.2

MVM267

All these acos products and more too, are at the service of *High Fidelity*

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

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STAND No. 76

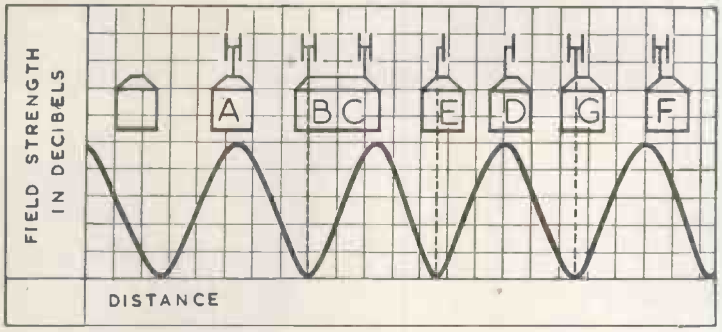
R.E.C.M.F. EXHIBITION

always well ahead

COSMOCORD LIMITED • ENFIELD • MIDDLESEX

THE "BELLING-LEE" PAGE

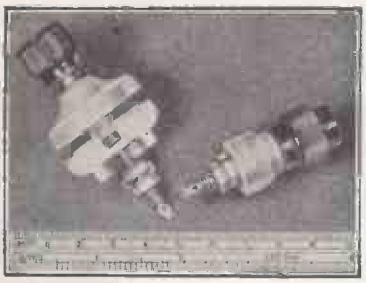
Providing technical information, service and advice in relation to our products and the suppression of electrical interference



It is well known to radio engineers that if field strength recording equipment is carried in a vehicle along a road, that the field strength of a given television transmitter rises and falls as much as ten decibels every few yards. We have attempted to show this graphically, but in practice the curve would be more irregular than shown.

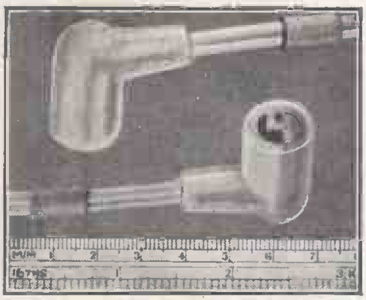
Now referring to our graph, assume that it is an area where normally an "H" aerial is required, "A," "B" and "C" have got their television receivers and are happy; no doubt "B" requires more gain than his neighbours but he is satisfied. "D" now wants to buy a television receiver and can ill afford the extra for the aerial and tries to get by with a dipole. He does, he needs a lot more gain but he does get by. His neighbour "E" is impressed. He buys a receiver, and as "D" is pleased with a dipole, it is good enough for "E." But no, he blames the set, he blames the dealer (who may have told him that an "H" is normally required); in the end he has to pay the dealer to come again with his ladders and put up an "H." Even if the dealer takes the dipole back into stock, it has cost more in labour than if the "H" had been put up in the first place. "G" is thinking of television and puts up a "Belling-Lee" "H" and gets a reasonable picture; "F" puts up another type of "H" and swears it is very much better than the "Belling-Lee" "H." "Belling-Lee" hear about it, and send their mobile research van to investigate the case, and find it just another "red herring" as "F" is getting a very much stronger signal than "G." It costs a lot of money to sort out these rumours of better aerials, but it is worth it, and that is how approximately 50% of the total numbers of aerials sold are still manufactured by "Belling-Lee."

High Leakage Resistance Terminals



High grade moulded polythene collars and bushes specially designed for instrumentation in nuclear physics, etc. The leakage resistance is 20 million megohms or more (large), 3.6 million megohms (small). Tests taken at 850 V. d.c., 55°F. and 70% relative humidity. Peak working voltage, large 5,000 V. small 2,500 V. These bushes may be fitted to our "B," "L" or "W" type terminals.

Magnetron Top Cap Connector (Bayonet)



L.798 designed in conjunction with leading manufacturers and the Services. Air Ministry pattern number 10HA/11156. It is expected that full Inter-Service type approval will be granted.

R.E.C.M.F. EXHIBITION STAND NO. 55.

As a company we resist any temptations to publish information based upon guesswork. We will show some models of general types of Band 3 aerials but we want to make it clear that they may never be made in the dimensions or styles shown.

Our customers are assured that we are watching the position very closely and when details of siting, polarisation, and power of the transmitters are officially announced, the appropriate aerials will soon follow—and they will function correctly. We do not design "square pegs for round holes."

The "Belling-Lee" range of components and accessories for the Electronics; Radio, and Electrical Industries has been further strengthened by the introduction of new lines and the redesign of some established lines.

The contacts on "Unitors" and "Screenectors" are now hard gold plated and this finish will be added to other lines as appropriate.

Actual size: 1¼*in.* x ¼*in. dia.*

Many ratings of the well-known general purpose instrument fuse-link, L.1055, are now manufactured by an entirely new technique which bonds caps, glass, and filament into one unit, caps being so securely held that they will not come off unless the glass is broken.

A new range of six fuseholders for Inter-Service use has been developed, and in addition to the existing types of sealed and neon indicating versions, forms a very comprehensive range.

Screened plugs and sockets with 4, 6 and 12-way assemblies have been introduced. Assemblies are interchangeable with existing screened coaxial types.

Three and four mm. resilient sockets with square faced nylon moulding are exhibited. Sockets can be mounted singly or in groups.

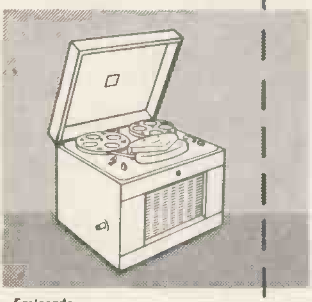
The range of suppressors includes new types effective at television or broadcast frequencies.

Written 26th February, 1954

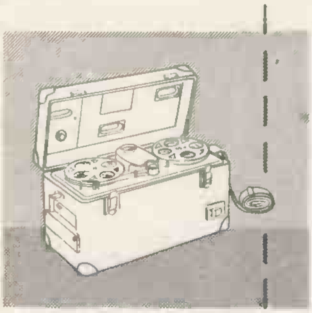
BELLING & LEE LTD

GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

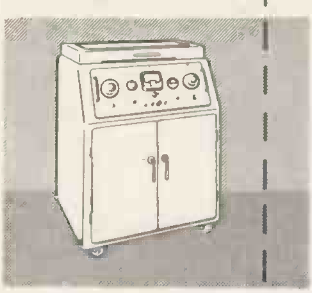
E·M·I RECORDING EQUIPMENT



Emicorda



Model L/2



Model BTR/2

Emitape

USED BY THE EXPERTS IN THE WORLD'S GREATEST BROADCASTING ORGANISATIONS AND LEADING RECORDING STUDIOS

Model TR/50

Model TR/50—A mains/transportable professional tape recorder available in two versions. Two speeds, either 15″ and $7\frac{1}{2}$″, or $7\frac{1}{2}$″ and $3\frac{3}{4}$″, per second.

EMICORDA—The home version of the famous E.M.I. Tape Recorders. Simple to operate, first class reproduction, figured walnut finish.

Model L/2—A battery-operated recorder with specially governed electric motor, completely self-contained, which is ideal for 'on the spot' recordings. Individual models for speeds of 15″, $7\frac{1}{2}$″, $3\frac{3}{4}$″ per second.

Model BTR/2—The high fidelity studio tape recorder developed after 50 years of research and experience in the science of sound recording and reproduction by the E.M.I. Group (H.M.V., Columbia and Parlophone).

EMITAPE—The world's finest magnetic tape. Available for all types of recorders. In two grades—Professional and Standard, including the popular standard 600 ft. (Type H60/6) 21/-, and 1200 ft. (Type H60/12) 35/-.

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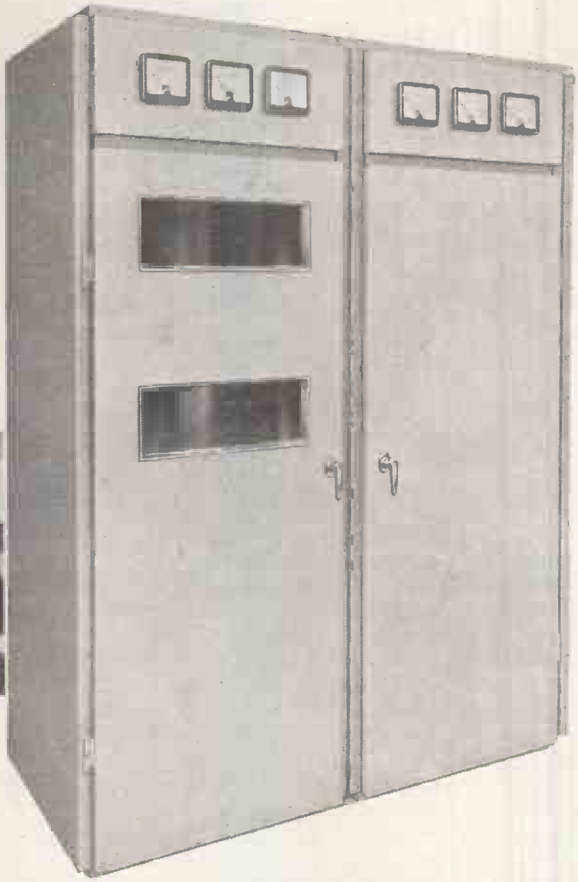
E.M.I. SALES & SERVICE LTD.

RECORDING EQUIPMENT DIVISION

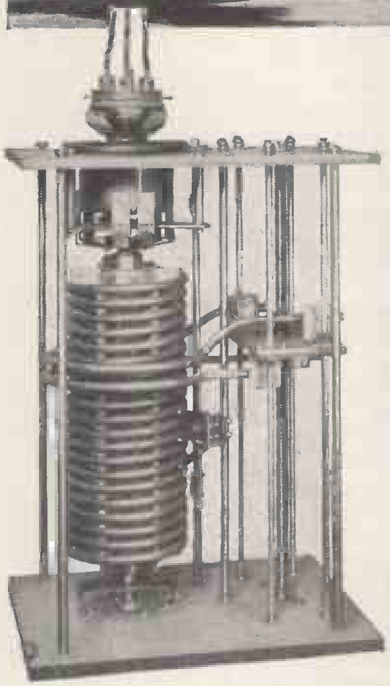
HAYES, MIDDLESEX Telephone: SOUTHALL 2468

EB 39



MARCONI HS SERIES

High Frequency Transmitters



The HS.31, 41 and 51 Series of Transmitters have ratings of 2.5 Kw, 10 Kw and 30 Kw respectively; all provide the following features: operation on any one of 6 spot frequencies or continuous tuning over the entire range, rapid frequency change between pre-set frequencies, easy and safe access for servicing; RF feed back to reduce distortion; air cooling throughout with dust filtering; high overall efficiency.

Service flexibility is the keynote of these transmitters, all of which are designed as linear amplifiers; ISB telephony, CW and frequency shift telegraphy, double sideband telephony, frequency shift diplex, can all be accommodated.

An outstanding feature of the HS series of transmitters is the compact mechanism employed for anode tuning. The inductance is mounted integral with the valve anode assembly and is continuously variable.

MARCONI

COMPLETE COMMUNICATION SYSTEMS

Surveyed, planned, installed, maintained

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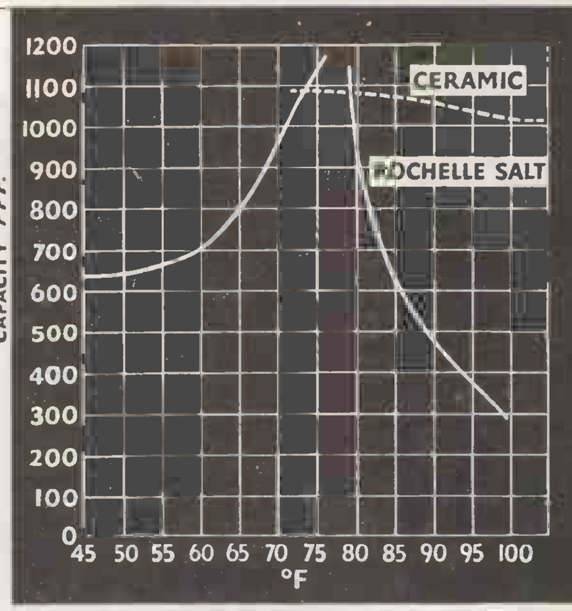
L.C.I

A NEW TREND IN PIEZO - ELECTRIC PICK-UP DESIGN



Variation of Self Capacity with temperature, of typical Rochelle salt and Ceramic pick-up elements.

The advent of microgroove records created a new fundamental problem in pick-up design. In order to attain the small groove spacings required for long playing records, the amplitudes of the low frequencies had to be considerably reduced below those recorded on 78 r.p.m. records. Consequently, the magnetic pick-ups which had hitherto been almost universally used were too insensitive in normal applications to reproduce adequately the low frequencies on these records. Even now the most sensitive moving iron pick-up will only give a tenth of a volt from the average microgroove recording level at 50 c.p.s., and even this standard is normally achieved only at the expense of frequency range, such a pick-up usually having an upper limit of response at about 3 kc/s.

Until recently the only practical answer to this problem was a pick-up utilising the piezo-electric effect of sodium potassium tartrate (commonly known as Rochelle salt).

"Bimorph" elements manufactured from the crystalline form of this material behave as amplitude sensitive transducers in contrast to the velocity sensitivity of magnetic types. As a result Rochelle salt crystal pick-ups tend to emphasize the low frequency recorded tones and restore the balance which is lost when using a magnetic pick-up with microgroove records. Sensitivity is also adequate for general purpose applications.

The temperature restrictions on the use of Rochelle salt crystals and the elaborate measures which have to be taken to prevent the access of any moisture to the crystals, are well known. What is not so well known is that the normal changes in temperature experienced in temperate climates cause noticeable variations in the impedance of a Rochelle salt pick-up. "His Master's Voice" radiograms incorporate additional circuits in the equalisation networks to minimise variation of frequency response or balance.

A "His Master's Voice" rotatable pick-up head employing ceramic cartridges.

The latest development in this field is the artificial piezo-electric material (polycrystalline, polarised barium titanate). This is the material used in "His Master's Voice" "Ceramic" pick-up cartridges.

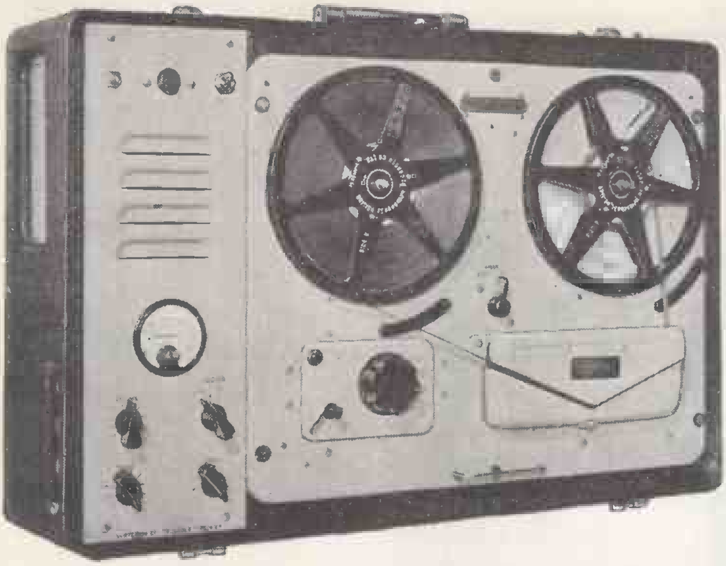
"Bimorph" elements suitably manufactured from this material are highly sensitive transducers.

They are completely impervious to moisture, their functioning being unaffected by any degree of humidity; and moreover, the impedance of the element is almost completely independent of temperature over the extreme climatic range. This can be seen from the graph showing the variation with temperature of the capacity of a typical Rochelle salt pick-up element compared with that of a ceramic pick-up element. As a result the special provisions in the equalisation network, necessary to prevent the frequency response variations with temperature of a crystal cartridge, are no longer required.

Thus ceramic cartridges give the same balance of reproduction at all temperatures when using the simplest equalisation circuits—for many applications a suitable resistive load is quite adequate—and they can be used with complete safety in all climatic conditions.

Summarizing then, the ceramic cartridge provides a dependable means of obtaining an adequate signal from microgroove records for all applications and particularly under tropical conditions.

VORTEXION TAPE RECORDER



★ 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.

The amplifier, speaker and case, with detachable lid, measures $8\frac{1}{4}$in. x $22\frac{1}{2}$in. x $15\frac{3}{4}$in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

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

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

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Two similar amplifier channels with an approximate gain of 2000 and an upper frequency response of 3 megacycles are features of this new Cossor Double Beam general purpose oscillograph. The repetitive or triggered time base has a sweep duration from 200 milliseconds to 5 microseconds.

The instrument will operate from power supplies of any of the various frequencies and voltages encountered in the Armed Services or from standard civil supply mains. The top and side panels are quickly detachable to allow inspection and a removable plate at the rear of the instrument allows access to tube plates, anode and modulator.

and Voltage Calibrator

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Primarily designed to be used with the new Cossor oscillograph the Cossor Voltage Calibrator model 1433 provides an accurate means of calibration of input voltages to the plates or amplifiers of any oscillograph. Calibrating voltages are read directly from a wide scale meter without any computation being necessary. Measurements can be made to an accuracy of ± 5% and the instrument can be used in any application where a source of accurately-known voltage is required.

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P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red, Orange, Pink, Yellow, White, Transparent. 4 coils for 10/-.

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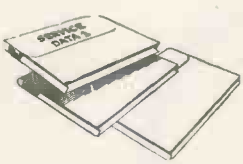
This really lovely loudspeaker fabric we offer at approximately a third of to-day's cost. It is 42in. wide and our price is 2/- per yard or panels 12in. × 12in., 1/9 each. This is also very suitable for covering plain wooden cases, for portable radio amplifiers, etc.



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100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster-Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly, a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this country. Names include Sparton, Emmerson Admiral, Crossley, R.C.A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.

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The simplest and quickest tool for cutting holes in aluminium or steel chassis. Comprises die and punch operated by Allen key. A separate die and punch is required for each size.

⅝" hole (B7G, etc.)	11/6
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Same key fits these three, price 10d.

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The amplifier is fitted with independent bass and treble control, both connected through different feed-back loops so that no "cut" at all in the ordinary sense is applied. The variation which can be achieved, by applying various degrees of negative feed back in the higher and lower ranges of the sound strata will accommodate all individual tastes.

We strongly recommend a 12in. speaker in order to make the fullest use of the instrument's potentialities. Booklet and set of components available at once at £3/19/6, post, etc., 2/6. Booklet separate 1/6. 12in. speaker to suit £3, postfree if brought with amplifier

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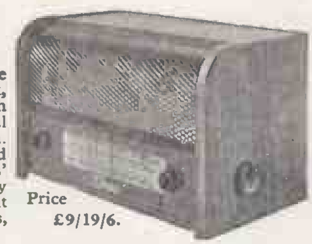
Long, medium and short wave in handsome wooden cabinet, illuminated glass dial with station names, A.V.C. and usual refinements: Size 11in. × 5½in. × 7in. with B.V.A. valves and built-in aerial. 12 months' guarantee. Limited quantity only, £9/19/6 or £3/6/6 deposit and balance over 10 months, carriage and insurance 5/-.



Price £9/19/6.

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Our latest publication, price 1/6, post free, describes the ideal gramophone playing unit for taking on picnics, beach, caravans, etc. The gramophone motor is the hand wound spring type and the amplifier is driven by dry batteries. Send for this booklet to-day, so be in good time for holidays.

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Has an output in excess of 10 watts, tapped for 3 and 15 ohm Speech Coils, and the Input has a Co-Axial Fly Lead which has enabled the designers to keep hum level extremely low. Separate Bass and Treble Controls are fitted in addition to the Volume Control. 6 valves employed, 2—6V6/GT, 5Z4G, 6SN7/GT 2—6AM5. Size of Chassis 12in. × 6in. × 2in. Price £9/19/6, plus 5/- carriage, packing and insurance. H.P. terms £3/6/6 deposit, balance over 12 months.

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This stands approximately 6ft. high, and was made originally for the G.P.O. The top panel contains the amplifier proper, which consists of an A.C. mains driven power pack, capable of delivery 200 mA. at 400 v. and, of course, the normal L.T. supplies and the amplifier itself uses an MHL4 feeder and two PX25s in the output stage, giving approximately 25 watts. This top deck also contains the heavy duty output transformer. The lower panel contains the feeder unit which can be used as a pre-amplifier for microphone and gramophone work. You will observe that on the rack there is ample space for fitting a monitor speaker and an R.F. unit if same are required. Note that the anode current of the PX25 valve is monitored by a 2½in. flush meter. Further note that these amplifiers were made by the famous MARCONI company. Complete as illustrated but less valves, unused and only very slightly storage soiled. Price £5/10/-, plus 12/6.

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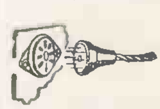

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Complete kit comprises Hi-craft 40 watt control unit starter lamp, lamp holders, clips and wiring diagram. Price, less tube, 22/6, plus 1/6 post. With tube, 30/-, plus 2/6 P.P. Tubes 7/6 each, carr. free, minimum quantity 6.

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A comprehensive valve tester which may be used to measure the mutual conductance of most types of British, American and Continental receiving valves. Supplied complete with detailed instruction book and separate valve chart giving full testing data for over 3,000 different valves. Long scale, sensitive moving coil meter.

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PROJECTION TELEVISION
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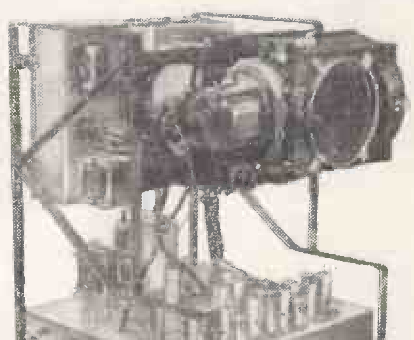

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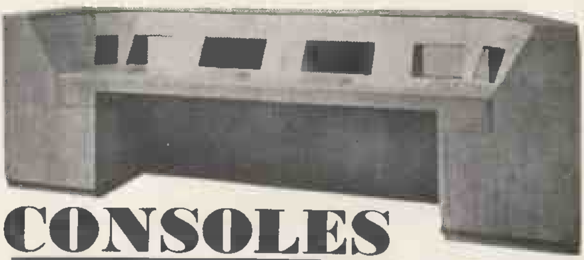

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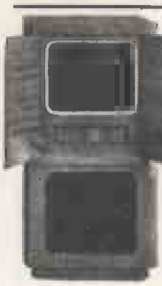

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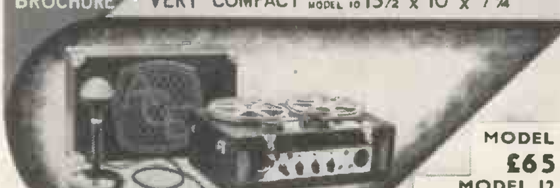

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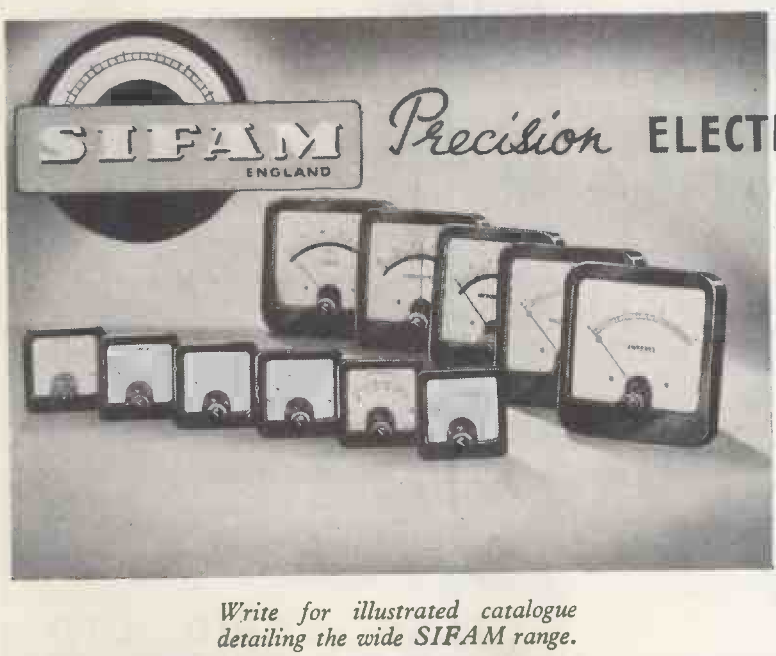

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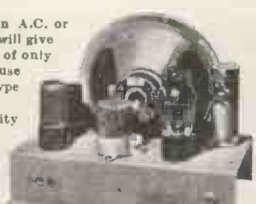

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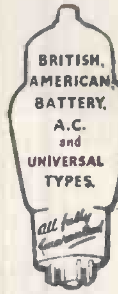

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1S5	16/5	12AU7	22/1	AZ31	13/3	EL3(N)	20/2
1T4	14/6	12AX7	22/1	AZ50(DW4)	13/3	EL33	16/5
3S4	14/6	12SA7GT	20/2	CBL1	22/1	EL37	22/1
3V4	14/6	12SK7GT	16/5	CL4	20/2	EL38	25/2
01A	7/4	12SQ7GT	15/1	CY1	13/3	EL41	16/5
1A4	13/3	25L6GT	16/5	EB41	11/4	EM1	16/5
1B4	13/3	35M5GT	13/3	EB91(6AL5)	11/4	EM4	16/5
1F4	10/2	50L6GT	16/5	EBC33	15/1	EM34	16/5
1E5G	12/-	10	12/-	EBL1	22/1	GZ34(GZ32)	18/6
1F5G	11/4	22	18/3	EBF80	18/11	EY51	25/2
1J6G	12/-	80	13/3	ECC40	22/1	EZ40	13/3
5Y3GT	13/3	81	18/11	ECH3	22/8	EZ41	13/3
6A4	15/1	71A	8/10	ECH25	20/2	PY80	15/9
6AL5	11/4	112A	12/-	ECH42	20/2	PY81	18/11
6AQ5	11/5	1A7GT	18/11	ECL80	23/4	PY82	13/3
6AT6	15/1	1C5GT	14/6	EF9	19/6	PL81	16/5
6AU6	22/1	1H5GT	14/6	EF37A	22/1	PL82	16/5
6BA6	16/5	1N5GT	14/6	EF39	16/5	UBC41	15/1
6X4	13/3	3A4	18/11	EF40	22/1	UBL21	20/2
6J6	31/6	3A5	31/6	EF41	16/5	UCH21	20/2
6SA7GT	20/2	6X5G	13/3	EF50	22/1	UF41	16/5
6SK7GT	16/5	1561(1W4)	13/3	EF80	22/1	UL41	16/5
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The one you require enclosed if available in a dozen assorted of our best choice. **10/6**

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RECEIVER 6A.
Channel checking Unit working on 49-100 metres, Contains 5/VR91 (EF50), 1/6K8, 1/VR55 (EBC33), 1/VR53 (EF39) Valves. Thermal switch breaking at 85 degrees F., etc., etc., in metal case 8¼in. x 7in. x 10in.
ASK FOR X/H477A. **29/6** CARRIAGE 2/6 EXTRA.

AERIAL SYSTEM TYPE 62.
U.H.F. Antenna on streamlined moulding with VR92 (EA50) untuned detector stage. Overall dim.: 13in. x 4¾in. x 2¾in. Antenna 22.5 cm.
ASK FOR X/H496. Circuit 1/3d. each. **3/6** each. POST 9d. EXTRA

CERAMIC AERIAL SPREADER
Individually boxed. Length overall 11in., between centres 9⅛in.
ASK FOR X/H718. **1/-** per pair POST 3d. EXTRA

POWER UNIT TYPE 266.
In Transit Case. Input 80 v. 1.5 K/cps., A.C., Outputs HT 120 v. D.C., bias 3 and 9 v. LT 2 v. Smoothed and stabilized. Complete with 5U4G valve VS110 stabilizer. 12 v. 1 a. metal Rectifier, etc., etc., in attractive metal case with handles. Dim.: 11 x 9¼ x 7½ ins.
ASK FOR X/E870. **22/6** each. CARRIAGE PAID

GLASS DOME INSULATOR.
With Threaded Terminal Top and Metal Lead-through Rod. Dome dim.: 2½in. x 1¾in. high, lead-through projects 6½in. Overall length 9¾in.
ASK FOR X/H54. **2/-** each. POST 3d. EXTRA

BLACK PLASTIC CHAIN AERIAL INSULATORS.
Comprising 3 links, 3½in. long, 1¾in. wide, each link. Total length 7½in. A.M. ref. 10A/1275.
ASK FOR X/H525. **9d.** per pair. POST 3d. EXTRA

WIRELESS REMOTE CONTROL UNIT D.
No. 2, Mk. 2, ZA.20491. Wooden box 7¾in. x 6¾in. x 5½in., with hinged lid, containing 3 relays. 1 make, 500 ohms, 1 make 20 ohms, and H.D. double coil type 1,750 ohms coil makes, 200 ohms coil breaks, plus QMB Switch and 8 brass terminals.
ASK FOR X/H803. **7/11** each. POST PAID

EX R.A.F. V.H.F. CONTROL PANEL TYPE 3A.
Input 24 volts, D.C. Intercom. Control, Contains 3 induction coils type 21A, 3 Retardation coils type 39A, 6 relays, type 26A running hand generator, type 25 twin bell set, plus plugger key switches, Key Switches, panel indicator lamps, etc., etc. Panel finished grey with handles. Unit dim.: 19in. x 11in. x 9in.
ASK FOR X/E945. **21/-** each. CARRIAGE PAID

SUPPRESSOR UNIT 5C/870.
Contains 4 H.F. chokes and 4 Tubular Condensers 0.1 mfd. 250 v. D.C., carrying 5 amps. (2 sets on each lead), each choke and condenser separately screened in compartments of Aluminium Alloy Box 4½in. x 4in. x 2in., 4 hole fixing.
ASK FOR X/H907. **2/6** each. POST 1/- EXTRA

Still Available as detailed previously

R1155 Receiver Unit, Reconditioned and Tested, used, good condition. In Transit Case.
ASK FOR X/H916. **£8.19.6** each. CARRIAGE PAID

Also **R1155,** as above, but loose stored.
ASK FOR X/H898. **£5.19.6** each. CARRIAGE 7/6 EXTRA
Circuit and data 2/3.

T1154B Transmitter Unit, in Transit Case.
ASK FOR X/E5A. **39/6** each. CARRIAGE 7/6 EXTRA
Circuit 2/3.

Receiver Unit Type 25, Ref. 10P/1L. Part of TR1196, Range 4.3–6.7 mc/s.
ASK FOR X/H299. **35/-** each. POST PAID

WS-18 Receiver Chassis, with valves.
ASK FOR X/H22. **25/-** each. POST PAID
Circuit and data 2/3.

WS-18 XMTR/Receiver Chassis. Partly stripped by the M.O.S.
ASK FOR X/H349. **33/6** each. CARRIAGE PAID
Circuit 4/6.

Receiver Chassis. Range 150–200 mc/s. Less Valves.
ASK FOR X/H940. **21/-** each. POST PAID

MIDGET MOTOR, Ref. 5U/2705
Input 24 v. D.C. 2 a., R.P.M. 2,800 drive pulley each end. Overall dim. 2in x 2in. x 5½in.
ASK FOR X/H98 **7/6** each POST PAID

26 Watt Output Transformer. Parmeko type AF5084/1A. Mfg. Surplus.
ASK FOR X/H565. **19/6** each. POST PAID

Driver Transformer. Ref. 110K/117. Part XT-3202 for ET-4336 Transmitter.
ASK FOR X/E562. **18/6** each. POST PAID

Jefferson Travis UF-2 Transceiver Chassis (U.S.A. made). Less valves and partly stripped by the M.O.S.
ASK FOR X/H518. **17/6** each. CARRIAGE PAID
Circuit 2/6.

BC-456 Speech Modulator Unit. Part of SCR-274-N "Command Equipment" U.S.A., with valves, less dynamotor. In original carton.
ASK FOR X/E42A. **27/6** each. POST PAID

Also **BC-456,** as above, but loose stored.
ASK FOR X/E42. **17/6** each. POST PAID
Circuit 1/3.

Transmitter Tuning Units, loose stored.
TU7B. Range 4,500–6,200 K/cs. Ask for X/H29.
TU8B. Range 6,200–7,700 K/cs. Ask for X/H30.
TU9B. Range 7,000–10,000 K/cs. Ask for X/H467.
ANY UNIT **10/-** each. CARRIAGE 2/- EXTRA

Amplifier A1368, for Battery Operation. Less Valves.
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Rotary Convertor Type 195. Input 24 volts D.C. Output 230 volts A.C. 100 watts.
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ASK FOR X/H300. **£9.19.6** each. CARRIAGE PAID

14in. f/5.6 Lens, for F24 Aircraft Camera.
ASK FOR X/H563. **£6.19.6** each. CARRIAGE PAID

Camera Control Electrical Type 35. No. 20, Ref. 14A/3208. Input 24 volts D.C.
ASK FOR X/H962. **15/-** each. POST 1/6 EXTRA

Recorder Mk. II, for 24 volts D.C. Uses 16 mm. film, has f/4.5 lens but is less cassette. Used, good condition. Transit box.
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ASK FOR X/H358. **£3.10.0** each. CARRIAGE PAID

Plotter Field, Mk. IV. Ref. OS.729A.
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Magnetic Marching Compass, Mk. I.
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INEXPENSIVE T.V.

INDICATOR UNIT TYPE 62.
In original wood case.
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INDICATOR UNIT YTPE 62.
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In original wood case.
ASK FOR X/E777. **89/6** each. CARRIAGE PAID

INDICATOR UNIT TYPE 305.
Brand New. Ref. 10QB/6504. Contains VCR524A VCR525. 7 EF50's, etc.
ASK FOR X/H943. **£2.19.6** each. CARRIAGE PAID

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In original carton. 6in. electrostatic type, heaters 6.3 v. 0.6 a.
ASK FOR X/H529. **19/6** each. POST PAID

ION TRAP MAGNET ASSEMBLY.
Mfg. Surplus. Type IT/6 by Elac, for 35 mm. tube neck.
ASK FOR X/H919. **2/6** each. POST 3d. EXTRA

POWER UNIT TYPE 285.
Ready made for T.V. A.C. mains. Input 230 v. 50 c.p.s. Outputs E.H.T. 2 kV., 5 mA., H.T. 350 v. 150 mA., L.T. 6.3 v. 10 a. and 6.3 v. 5 a. Fully smoothed and rectified with valves VU120, 5U4G, VR91 (EF50), plus cond. resistors, etc.
ASK FOR X/H947. **£4.19.6** each. CARRIAGE PAID

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In Transit Case. With valves, I.F. frequency 7.5 mc/s. Dim.: 18 x 8½ x 7¼ins. Used, good condition.
ASK FOR X/E770B. **32/6** each. CARRIAGE PAID

R.F. UNIT TYPE 24.
In original carton. Switched tuning 20–30 Mc/s. with valves, etc.
ASK FOR X/H580. **22/6** each. POST PAID

R.F. UNIT TYPE 25.
In original carton. Switched tuning 40–50 Mc/s, with valves, etc.
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R.F. UNIT TYPE 27.
With broken dial. Variable tuning 65–85 Mc/s, with valves, etc., used, good condition.
ASK FOR X/E771. **39/6** each. POST PAID

Order direct from:—
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R.1155 RECEIVERS

BRAND NEW AERIAL TESTED BEFORE DESPATCH

These well-known ex-Air Ministry Receivers need no further introduction. Supplied complete with 10 valves. and full circuit data.

LASKY'S PRICE £11.19.6

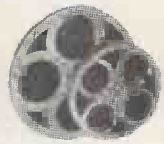
USED MODELS £7.19.6

Carriage 12/6 per unit extra, including 10/- returnable on packing case. 10s. 0d. rebate will be given on power packs for the R.1155 when purchased with the receiver.

Fully Assembled Power Pack and Output Stage, for R1155 Receiver. For use on 200-250 volts. A.C. mains.
LASKY'S PRICE 79/6
Carriage 5/- extra.

The above power pack fitted with 6½in. speaker.
LASKY'S PRICE £5.5.0 Carriage 5/- extra.

MAGNETIC RECORDING TAPE. SPECIAL OFFER



By famous British manufacturer. On Cyldon metal spools.
600ft., **6/11.**
1,200ft. **14/11.**
Postage 1/6 per reel extra.

LASKY'S RADIO

BUY NOW AND SAVE CASH—LIMITED QUANTITY ONLY

METAL RECTIFIERS

6 or 12 volt. F.W. Bridge

2 amps	9/-
3 amps	9/11
4 amps	12/11
6 amps	21/-
10 amps	32/6

6 volts		12 volts	
½ amp.	2/6	½ amp.	3/11
1 amp.	4/6	1 amp.	6/6

AERIAL ROD SECTIONS

Steel, heavily copper plated. 12in. long, ¼in. diameter. **PRICE** 2/6 per doz. POST FREE.

CONDENSERS

A large selection always available. Send us your requirements.

CAR RADIO AERIALS.

Chrome 2 section telescopic. Extends to 75 inches. 2 bolt side fixing. Complete with 48 inches of co-axial cable. Suitable for t.v. use.
LASKY'S PRICE 15/-.
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1-lb. REELS OF RESIN CORED SOLDER.

LASKY'S PRICE 8/6.

SUPERHET COILPACKS.

For 465 Kc/s. **No. 1** L.M.S., 29/6. No. 2 M.S.S., 16/-.

"THE HARROW" Baffle Radio Cabinet

Build a second set to be proud of. Pleasing design cabinet, with drilled chassis, dial, drive and back. Finished in satin mahogany veneer. Outside dims.: 17¼in. wide, 11½in. high, 5in. deep.
Receiver design uses 2-6K7, 6V6 and 5Z4. Total cost to build is less than £5/10/-.
LASKY'S PRICE 36/6
Carriage 2/-.
Circuit for receiver 1/6.

RESISTANCE AND CAPACITY BRIDGE

For A.C. mains 200/250 volts. Complete with valve rectifier and 6H6 and EM34 (magic eye) valves. Uses external standard.
Ranges: Ohms Factor of 0.1 to 10. Farads. Factor of 0.1 to 10. In metal case, black crackle finish, 12 × 6 × 8½ inches. Without handles. This unit is ideal for breaking down and rebuilding as another type of instrument.

LASKY'S PRICE 45/-
Carriage 3/6 extra.

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For V.H.F. 100 to 124 Mc/s. Uses 11 valves, 5 m/a. meter. Large slow motion tuning dial. In grey metal cabinet, size 18 x 10 x 11in.
LASKY'S PRICE 20/- less all valves.
Carriage 7/6 extra.

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Grade 1. New 79/6. **Grade 2.** Soiled 49/6. **Grade 3.** Secondhand, 39/6, Carriage 10/- extra.

TEST PRODS.

Fully fused with retractable points. 4/11 PER PAIR. (1 red, 1 black).

TRIMMERS

Paxolin. Up to 100pf. 6d. each, 5/- per doz. **Ceramic.** Up to 100pf. 9d. each. 7/6 per doz.

VALVES!!!

ALL TYPES—ALL SORTS

SEE OUR LIST

MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. primary. Finest quality, fully guaranteed.
M.B.A./3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 v. An ideal replacement trans. **Price 18/-.**
MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6.
MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 v. **Price 18/-.**
MBA/8. 235-0-235 v. 60 mA., and 6.3 v. 3 a. **Price 12/6.**
MBA/9. 400-0-400 v. 60 mA., 6.3 v. 1 a.; 4 v. 2.5 a. **Price 12/6.**
AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watts. **Price 17/6.**

J/RA/3 AMPLIFIER

12-15 watts. Cine projector type with case, as previously advertised. A FEW ONLY LEFT. PRICE £9/19/6. Carriage 15/- extra.

PLESSEY RECORD PLAYERS

Slightly Soiled

For use on 200-250 v. 50 c.p.s. mains. Complete with 10in. turntable, and magnetic pick-up. Automatic stop and record selector start.
LESS THAN HALF PRICE.
LASKY'S PRICE 69/6
Carriage 2/6 extra.

CAR RADIO SPECIAL—Partly assembled car radios.

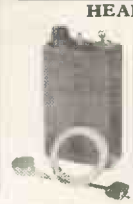
Small size case, 12 × 4 × 6in. Will fit most cars. For either 6 or 12 volts, depending on vibrator. Chassis supplied with 5 octal valve holders, medium wave aerial and oscillator coils, output transformer, volume control, sundry resistances and condensers, dial and knobs. Case finished in brown crackle. Dial calibrated 150-550 metres. 5 valves to suit. One each, either GT or metal: 6SA7, 6R7, 6V6, 6K7, OZ4.

LASKY'S PRICE £5/5/-. Carriage 5/- extra.
Or less valves, 69/6. Carriage 5/- extra.

Other chassis in various conditions of completion are available for personal callers only.

CIRCUIT for 5 valve car radio, using above chassis. **PRICE 1/6.**

HEARING AIDS



By well-known Manufacturer. In metal case, size: 2½in. × 4½in. × 1in. Complete with batteries and 3 sub-miniature valves, earpiece and cord. Only two controls: volume and on/off. Fitted with internal crystal microphone.

Suitable for reconstruction into midget radio receiver.

MADE TO SELL FOR 22 GNS.
LASKY'S PRICE 99/6
Postage 3/6 extra.

Ready for use. Perfect working order. Slightly soiled, but new and unused. A few hearing aids available, less earpiece, cord and batteries. PRICE 50/-. Carriage 2/6 extra.

ETRONIC T.V. LINE E.H.T. TRANSFORMERS

From 32/6.

GRAM MOTORS

Shaded Pole

Rim drive, synchronous. For 200-250 v. 50 c.p.s. Many uses.
LASKY'S PRICE 9/6

WILL MAKE A SUPER RADIO-GRAM

LIMITED QUANTITY (Frustrated Export). 5 WAVEBAND CHASSIS.

Circuit has RF stage, Magic Eye Tuning Indicator, and many other features. For use on A.C. mains 100-250 volts. Waveband coverage: 11.5 metres to 550 metres. In 5 bands.
Valve line-up: 2 EF39; 1 ECH35; 1 EBC33; 1 EL33; 1 5Z4; 1 EM34.
LASKY'S PRICE £8-19-6
Complete with valves, less dial, and drive spindle.
Carriage and packing 15/- extra.

SOLON SOLDERING IRONS

220-250 volts

Latest model instrument iron	19/8
Standard model	19/-

TANNOY PRESSURE UNITS

10 watts. 7.5 ohms impedance. Last few only.
PRICE 59/6
Carriage 4/6 extra.

MINIATURE 2 GANGTUNING CONDENSER.

.0005 mfd. With trimmers.
LASKY'S PRICE 6/6
Other types in stock.

CRYSTAL DIODES

Glass type, wire ends. 1/6.

I.F. TRANSFORMERS

465 Kc/s Iron dust cores in cans, midget type. Size 1½in. × 1in. × 2½in. By Plessey. Price 8/6 per pair.

WEARITE TYPE 550. 445-520 Kc/s. 8/6 per pr.

WEARITE TYPE 500. 450-470 Kc/s. 8/6 per pr.

Latest Miniature Type. Size: ¾ × ¾ × 2¼in. 465 Kc/s. PRICE 9/6 pr.

A LASKY'S RADIO ADVERTISEMENT. SEE OVER.

LASKYS RADIO

TRIPLEX DARK SCREEN FILTERS
14 × 12½ × 3/16 in. 7/6
15½ × 13½ × 3/16 in. 9/6
Postage and packing 5/- per piece extra. (This charge is necessary owing to extra packing required.)

POT/METERS. All values. Wire Wound from 3/6. Depending on wattage and length of spindle. **Carbon.** Less switch 2/11 each
With s.p. switch .... 4/3 each
With d.p. switch .... 5/6 each

VCR97 C.R. TUBES, new unused. 35/-. Carriage 5/-.

Screen Enlarger for VCR97. Filter or clear, 17/6. Postage 2/6.

C.R.T. Neck Protectors, 2/6.

10 K.V. METROSIL E.H.T. REGULATORS. By Metrovick. Pencil type, 5/- each.

S.T.C. SENTERCEL RECTIFIERS

	K3/40, 3.2 kV. 6/-
R.M.1 . . 3/10	K3/45, 3.6 kV. 8/2
R.M.2 . . 4/3	K3/50, 4.0 kV. 8/8
R.M.3 . . 5/–	K3/100, 8.0 kV. 14/8
R.M.4 . . 18/–	K3/160, 12.8 kV. 21/6

6- AND 12-VOLT VIBRATORS
4-Pin type. Soiled. S/H. 4/6
New 9/6
W/W 12/6
State voltage required.

8-PIN JONES SOCKETS. For 1155 Receiver, etc., 1/9 each.

R.F. E.H.T. OSC. COILS
For use with 6V6 valve, and EY51. Circuit and full data supplied.
6-10Kv. **PRICE** 19/6
6-18Kv. **PRICE** 25/–

R.F. OSC. COIL KITS
Consisting of R.F. oscillator E.H.T. coil with EY51 heater winding, EY51 rectifier, 6V6 valve and base. All necessary condensers and resistances. Full circuit and data supplied.
6-9Kv. **LASKY'S PRICE** 47/6
9-15Kv. **LASKY'S PRICE** 53/6

WIDTH AND LINEARITY CONTROLS. On one panel. 5/11 complete.

SPECIAL C.R.T. OFFER
Brand new and unused 12in. ion trap cathode ray tubes. 6.3 volt heater, 7-9 Kv. E.H.T. 35 mm. neck. Black and white picture. By famous manufacturer.
PERFECT **£12.19.6**
Carriage and insurance 15/- per tube extra.

MANUFACTURERS' SURPLUS T.V. COMPONENTS
Wide Angle Scanning Coils. Low imp. line and frame .... pair 19/6
Scanning Coils. 35 mm. Low imp. line and frame 12/6
Frame output transformer. Standard .. 10/6
Focus Coil. 35 mm. electro magnetic 12/6
Line or Frame B.O. transformer. Auto .. 4/6
Wide Angle Frame B.O. trans. 10/6
P.M. Focus Magnets. With vernier, 35 mm.
Tetrode 15/–
Triode 17/6
Wide Angle P.M. Focus Unit. For all 38 mm. tubes. With vernier and picture shift, Ferroxdure 25/–

PLESSEY
Scan coils per pair .. 25/–
Width Control 6/6
P.M. Focus magnet .. 12/6

Co-Axial Cable. 70-80 ohms impedance.
Single core, 8/- doz. yards.
Twin core, 12/- doz. yards.
Twin feeder, 6/- doz. yards.
Co-Axial Connectors. For standard ¼in. cable, 1/6.

WX6. WESTINGHOUSE MINIATURE RECTIFIERS
Wire ends. 1/6 each.

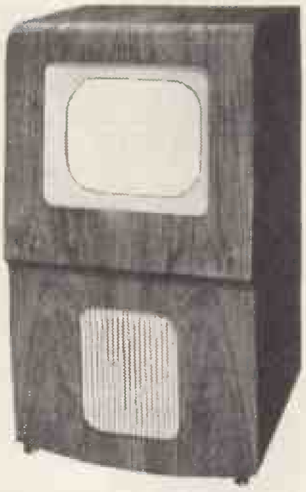
C.R.T. MASKS
Brand New
LATEST ASPECT RATIO
9in. 7/–
10in. 7/6
12in. 15/–
12in. Flat Face 15/–
12in. Old Ratio 9/6
14in. Rectangular.... 12/6
15in. Cream rubber.. 17/6
15in. With fitted safety glass 22/6
16in. Plastic, white .. 12/6
16in. Double D 31/6
17in. Rectangular.... 15/–

Duodecal (B12A) bases. VCR139 c.r.t. bases. 1/- each. 10/6 dozen.

DE LUXE T.V. CABINETS

Our new 12 inch model. Mark II

This cabinet is now supplied complete with mask, glass, castors, shelf, bearers, c.r.t. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium, light or dark walnut veneer, with high polish. Suitable for most home constructor T.V. receivers, including the "Viewmaster," "Practical Television," "Tele-King," "Magniview," "Wireless World," etc. Can be supplied with cut-out for 16in. c.r. tube at no extra cost.



An allowance of 4s. 6d. will be made if the mask is not required.

Inside Dimensions: Depth 16½in.; width 17¾in.; height 28in. Overall height 32in. and width 18½in.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL.

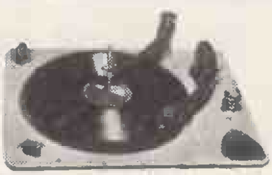
Adaptor frames for fitting 9in. or 10in. c.r. tubes can be supplied if required.

LASKY'S PRICE **£8 . 10 . 0**
Carriage 12/6 extra.

THE "UNIVERSAL" LARGE SCREEN AC/DC TELEVISOR
By A. S. Torrance, A.M.I.P.R.E., A.M.T.S.
A 28-page booklet giving full instructions for building a large 17-inch screen televisor.
★ A.C. and D.C. mains.
★ P.M. focussing.
★ Mullard valves and c.r. tube.
★ 5-channel superhet.
★ Table model.
★ Convertible into radiogram console.
★ Incorporates all latest developments.
3d. POST FREE.

THE VIEWMASTER
Construction envelope 7/6. POST FREE
Wide Angle Conversion 3/6. POST FREE
All components in stock. Write for price list.

COLLARO 3-SPEED AUTOMATIC RECORD CHANGERS
MODEL 3RC/521



Brand new and unused in maker's original carton.
Pleasing cream or fawn finish. Complete with hi-fidelity "studio" crystal turnover head.

LASKY'S PRICE **£9 . 19 . 6**
Carriage Free.

PERSPEX. 13½in. × 10½in. × ⅛in. Neutral shade slightly marked, 4/11 per piece.

TOGGLE SWITCHES, BULGIN
S.P.S.T. 1/6
D.P.S.T. 2/6
D.P. Change over 3/6

ELAC DUO-MAG FOCALISERS
For wide angle c.r. tubes. Low medium & high flux 37/6 each.

TYPE AT/9 T.V. MAINS AUTO-TRANSFORMER
200, 220, 250 and 375 volt tappings. 250 mA. Also 5 v. 3 a.; 6.3 v. 7 a., and 6.3 v. 3 a. secondaries. Price 25/-.

ION TRAPS
All types. Price 3/-. State tube type number when ordering.

INTERCOM UNITS
4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet.
Suitable for use as baby alarm.
MASTER UNIT, £5/19/6.
Carr. 5/- extra.
Extension Units. Price 21/- each complete. Carriage 2/- each extra.

LASKY'S LINE TRANSFORMER
RF.EHT for line flyback. 6-8 Kv, with EY51 heater winding. Suitable for home construction T.V., 19/6 each.

PLASTIC ESCUTCHEON SAFETY MASKS
Incorporating dark screen filter.
12in. Round Face 12/6
12in. Double D. Round Face 15/–
16in. for metal tubes 25/–

SOILED, NEW ASPECT RATIO MASKS
9in. 5/–
12in. 7/6
12in. with fitted armour plate glass, cream 11/6
12in. do. Black 8/6

ARMOUR PLATE GLASS
16in. Actual size 17½ × 15½ × ¼inch 7/11
15in. Actual size 16⅝in. × 13in. × ¼in. 6/11
12in. Actual size 13in. × 10½in. × ¼in. 4/–
9in. Actual size 9in. × 8in. × ¼in. 3/–

TELEVISION TABLE TROLLY

Superb walnut finish. High polish. Size: Top, 20×24in. Height from floor, 26½in. Large size castors for easy running, rubber tyred. Will take the largest table T.V. with ease. Packs flat when required.

Lower shelf suitable for books, radio receiver, *Radio Times*, etc.

LASKY'S PRICE **75/-** Carriage 5/- extra

THE TELE-KING 16" 17"

A practical 5-channel SUPERHET TELEVISION RECEIVER

Using the new 16 and 17 inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

Alexandra Palace, Sutton Coldfield, Holme Moss, Wenvoe, Pontop Pike, Belfast, Kirk o'Shotts.

ALL COMPONENTS IN STOCK WRITE FOR LIST

ALLEN WIDE ANGLE COMPONENTS
D.C. 300 latest type Ferroxcube Coils 39/6
GL. 16 Coil 7/6
GL. 18 Coil 7/6
Focus Coil 31/-
FO.305 trans. 21/-
Fram B.O. transformer 15/-
Line EHT. transformer 40/-

CHASSIS
Power pack Sound-vision and Scan chassis. PRICE 11/- each. All other metal work available from stock.

CONDENSERS
All condensers as specified. Manufacturers' surplus. £3/16/-.
COILS 13 all exactly as specified. Price 44/6.

RESISTANCES. 72 Resistances, all exactly as specified. 18/-.

CABINET
As illustrated here. £8/10/-. Carriage 12/6 extra. Supplied with mask and glass.

WIDE ANGLE CATHODE RAY TUBES

14in. MW36–22	....	£19 9 3
14in. C14B	....	£20 10 1
16in. MW41–1	....	£22 4 10
16in. T901	....	£22 4 10
17in. MW43–64	....	£23 12 8
17in. C17BM	......	£24 13 0

Carriage and insurance extra.

LASKY'S RADIO

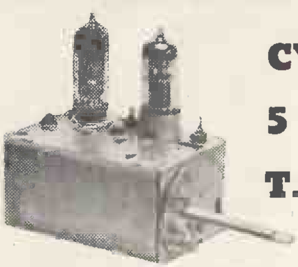
NOTICE TO ALL PURCHASERS OF THE ENGLISH ELECTRIC 16 inch C.R.T. TYPE T.901
The first and only reconditioning service. By English Electric. A reconditioned 16in. metal tube costs £12 and carries maker's full guarantee. Write for further details.

NOW IN STOCK
MULLARD
PCC84 .... 23/3
PCF80 .... 24/7

P.M. LOUDSPEAKERS
All with 3 ohm speech coil.
2½in., 15/-; 4in., 9/6; 6½in., 15/-; 3in., 14/6; 5in., 14/6; 8in., 15/-; 10in., 17/6.

TWO SUPER SCOOPS

BRAND NEW AND UNUSED. Below Makers Cost

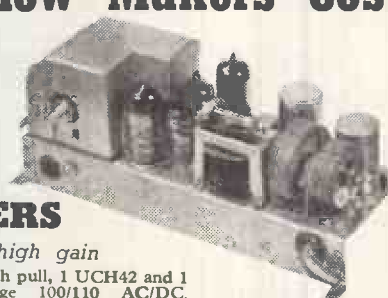


CYLDON 5 CHANNEL T.V. TUNERS

Uses two valves, EF80 (6BW7) as R.F. amp. and ECC81 (12AT7) as frequency changer. Instant and positive selection of any channel by switching incremental inductances. Power gain 24dB, I.F. frequency output 9.5-14 Mc/s or 15.5-22 Mc/s. With full details. Supplied less valves. Size :— 4½ x 2¾ x 2¼ins.

12/6
POST 2/6

3-WATT MIDGET AC/DC AMPLIFIERS



Push pull, very high gain

4 valves: 2 UL41 in push pull, 1 UCH42 and 1 UAF42. Input voltage 100/110 AC/DC. Very easily converted to 230 volts. Supplied with circuit diagram and full details. Size:— 9 x 4 x 4 inches. Uses 2 metal rectifiers, 1 each RM2 and RM3. Ideal for ships record players, tape recorders, home record players, baby alarms, etc., etc. Supplied complete, fully assembled and wired, with 4 valves.

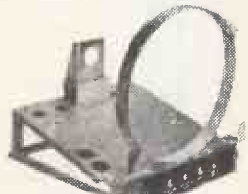
69/6
CARRIAGE 3/6

LASKY'S T.V. CONSTRUCTORS' PARCELS

No. 1. All brand new components by Igranic. Comprises E.H.T. flyback line transformer, 7-10 Kv. with ferroxcube core and rectifier heater winding; scanning coils; frame output transformer; Elac focus unit with vernier adjuster, U37 E.H.T. rectifier and brand new 12-inch cathode ray tube with ion trap, mask and glass.

LASKY'S PRICE FOR THE COMPLETE PARCEL, £15/19/6. Carriage and insurance, 15/- extra.

No. 2. The Constructors' Parcel as above, but less the cathode ray tube and ion trap. **LASKY'S PRICE 79/6.** Carr. 3/6 extra.



No. 3. Complete set of metalwork, as illustrated here. Unassembled. Comprising main chassis, tube supports and valveholders. (Less sound-vision chassis.) **PRICE 25/-.** Carriage 3/6 extra.

No. 4. RESISTANCES. ½ Watt. 85 resistances your choice. **PRICE 18/-. POST FREE.**

LASKY'S RADIO

Lasky's (Harrow Road) Ltd.,

370 HARROW ROAD, PADDINGTON, LONDON, W.9
(Opposite Paddington Hospital)

MAIL ORDER AND DESPATCH DEPARTMENTS, 485/487 HARROW ROAD, PADDINGTON, LONDON, W.10
Telephones: CUNningham 1979 and 7214. ALL DEPTS. Hours : Mon. to Sat. 9.30 a.m. to 6 p.m. Thurs. half day 1 p.m.
TERMS: Pro forma, Cash With Order or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra : £5—2/- extra : £10—3/6 extra. Over £10 carriage free, unless specifically stated otherwise.

Henry's (RADIO LTD.)

RADIO COMPONENTS
ELECTRONIC & TELEPHONE EQUIPMENT

5 Harrow Road, Paddington, W.2

PADdington 1008/9 and 0401

OPEN MONDAY to Sat. 9—6. THURS. 1 o'clock.

SEND STAMPS FOR NEW 1954 28-PAGE CATALOGUE

★ TAPE-DECK AMPLIFIER AND POWER UNIT ★

This unit is specially designed for the "Truvox" unit and we believe this quality amplifier lifts tape recording from the novelty, into the quality class.

AMPLIFIER SPECIFICATION:
★ 2—6BR7, 2—V6GT, 1—6J5, 1—6U5G ★ Variable selective negative feed back circuits ★ Variable tone control ★ Magic eye level indicator ★ Four watts undistorted output ★ Amplifier complete with valves, £13/5/-.
Chassis size 10in. x 6in. x 2½in.

POWER UNIT (AC200/250 volts)

Chassis size 9in. x 5in. x 2½in., complete with 5Z4	£4 15 0
Amplifier and Power Unit complete	£16 16 0
COMPLETE KIT OF PARTS for Amplifier and Power Unit	£13 10 0

CALL FOR DEMONSTRATION OR SEND FOR FULL DETAILS

SPECIAL OFFER!

Our TAPE-DECK AMPLIFIER AND POWER UNIT (List £16/16-).
As above and TRUVOX TAPE-DECK MARK III (List £23/2/-).

£36 . 0 . 0

CONSOLE CABINETS NOW AVAILABLE.

RADIO-GRAM CHASSIS

3 Wave-band Superhet. Med., long and short.
5 Latest Type MULLARD Valves.
4 Position Switching. Gram., med., long and short.
Provision for A.C. Mains. Extension Speaker. 110/250 volts.
Chassis 11in. x 7in. x 2½in. Scale 8in. Square. Or Chassis 13½in. x 6½in. x 2½in. Dial 10in. x 5½in. PRICE £10/5/-.
BRAND NEW AND GUARANTEED CARR., PACKING AND INS, 10/-.

R.F. OSCILLATOR UNIT

6—18 kV., including rectifier winding, 25/-

ROTARY POWER UNIT TYPE 104

Input 12 v., Output 230 volts 65 mA. and 6.3 volts 2.5 amps. Fully filtered and smoothed and noise suppressed. Ideal for car radio, etc. BRAND NEW ONLY 15/- (postage, etc., 2/6).
ALSO 24 v. type 15/-.

AMERICAN 12 v. DYNAMOTOR

Output 250 volts. 60 mA. Weight 5 lb. Suitable for Car Radio or Electric Razors, 22/6.

62A INDICATOR UNIT

Complete with VCR97 or 517C, 12—EF50, 4—SP61, 3—EA50, 2—EB34.
Built on double-deck chassis.
Absolute new condition.
99/6. Carr. 7/6.
Or less Tube, 69/6. Carr. 7/6.

BOWTHORPE CONTINUITY METER

Dual scale 0-500 ohms and 100-200,000 ohms moving coil operated from 4½-volt internal battery. Size 6in. x 3in. x 4in. Original price £8/8/-. Our price, brand new, £3/5/-.

PYE 45 MC/S. STRIP, TYPE 3583 UNITS

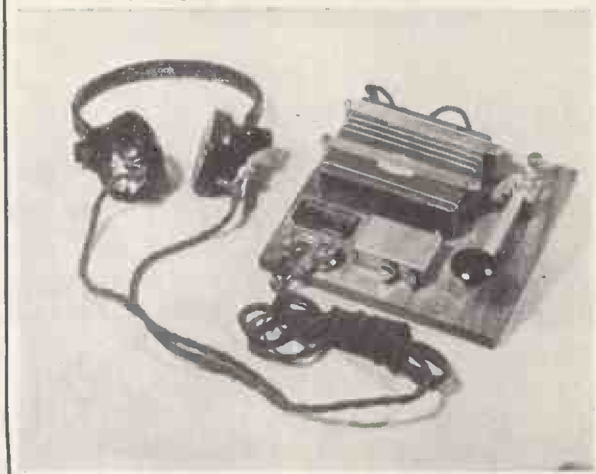
Size 15in. x 8in. x 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5. Carriage paid.

RECORDING TAPE G.E.C.

600ft. Reels	10/-
1,200ft. Reels	17/6

BUY NOW—
UNREPEATABLE BARGAIN.

MORSE PRACTICE KIT



Beautifully balanced Key mounted with audible note buzzer, battery, and phone terminals on hardwood panel, 6½ x 6½ x ½in., plus pair of Headphones.
Could be used by two persons, one coding and keying the message, the other de-coding and recording. BRAND NEW, 15/- complete. Post paid. Or less Battery and Headphones, 6/-, post paid.
Two kits could be used to send and receive messages in a similar manner.

INDICATOR UNIT TYPE 182A

Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (less relay) in original packing cases at 67/6. Plus 7/6 carr.

RECEIVER R1355. As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 ea. 5U4G, VU120, VR92. Brand new in original packing cases 55/- carriage 5/-.

No. 38 "WALKIE TALKIE" TRANS-RECEIVER, complete with Throat Mike, phones. Junction Box and Aerial Rods in canvas bag. Freq. range 7.4 to 9 Mc/s. Range approx. 5 miles. All units are as new and tested before despatch, £4/10/-.

T.V. PRE-AMPLIFIER FOR LONDON AND BIRMINGHAM. Complete with 6AM6. Ready to plug into your set, 27/6. P.P. 2/6.

R.F. UNITS

Type 24
20-30 Mc/s.
Switched Tuning.
With 3—SP61
15/- EACH
BRAND NEW.

Type 25
40-50 Mc/s.
Switched Tuning.
With 3—SP61.
19/6 EACH
BRAND NEW.

R.F. UNITS

Type 26
50-65 Mc/s.
Variable Tuning.
2—VR136. 1—VR137
45/- EACH
BRAND NEW.

NEW, BUT SLIGHTLY SOILED

R.F. 24's	12/6
R.F. 25's	15/-
R.F. 26's	35/-

CRYSTAL MICROPHONE INSERTS

8/6 POST FREE

8/6 POST FREE

Ideal for tape recording and amplifiers. No matching transformer required.

CATHODE RAY TUBES

VCR139A. 2½in. C/R Tube. Brand new in original cartons (carr. free)	£1 15 0
VCR97. Guaranteed full T/V picture (carr. 2/-)	£2 0 0
VCR517 or 517C. Guaranteed full T/V picture	£1 15 0
VCR138	£1 10 0
3BP1, with shield suitable for T/V or 'scope (carr. 1/6)	£1 5 0
MU-METAL SCREENS for VCR97 or 517. P.P. 1/6	10 0
6in. ENLARGER for VCR97 or 517. P.P. 1/6	17 6

PHOTO CELLS CMG25. Brand new, 25/-.

WANTED
813. 723A/B. 931A & XTALS. ANY QUANTITY.

INDICATOR UNIT TYPE SLCS

This unit is ideal for conversion for a 'Scope Unit or basis for Midget Television. It contains C/R Tube type ACR10 (VCR193A) complete with holder and cradle, also earthing clip. 1-VR66, 2-VR65, 24 mfd. 550 v. wkg. condenser potentiometers and a varied assortment of resistors and condensers. These Units are in new condition and packed in wooden transit cases. The C/R Tube will be tested before despatch. Dimensions: 8¼in. x 6¼in. x 11¼in., 45/-.

6 WATT AMPLIFIER (UNDISTORTED)

Manufactured by Parmeko and Sound Sales for Admiralty. 4 valves, PX25, MS/PEN, AC/HL, MU14. Output Matching and 3Ω and 15Ω, 100/250 v. A.C. COMPLETE IN STEEL GREY AMPLIFIER CASE, WITH CRYSTAL HAND MICROPHONE £12/10/-. *Call for demonstration.*

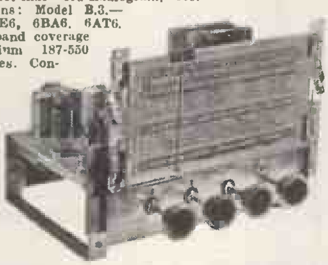
PLEASE ADD POSTAGE. ARTICLES UP TO 10/-, 1/-. £1, 1/6. £2, 2/-.

Modernise your old Radiogram for only £25

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 100/200 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, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage short 16-50 medium 187-550 long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wave-change 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 × 8½in. high. Dial size 9½in. × 4½in.

Price complete and READY FOR USE, excluding speaker, £12/12/- (carr. and Ins. 7/6 extra).

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.).

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.).

This AUTOCHANGE UNIT by a Famous Manufacturer is offered for £11/14/6

(Plus 7/6 Carr. and Ins.). (Normal price is £16/10/-).

We will supply this 3 speed Autochanger and the Model B.3 Chassis on the left together with a 10in. (or 8in.) P.M. Speaker for £25 or with the B.3.P.P. for £28/7/6 or with the Model B.3 P.P. / R.F. for £31/5/-. Carr. and Ins. 10/-.

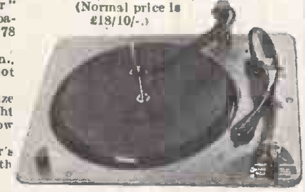
- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 16in. × 12½in. with height above 5½in. and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The COLLARO 3RC/521 3-Speed AUTO CHANGE UNIT £9/19/6

(Plus 7/6 Carr. & Ins.). (Normal price is £18/10/-.)

We will supply this 3 speed Autochanger and the Model B.3 Chassis on the left together with a 10in. (or 8in.) P.M. speaker for £23 or with the B.3.P.P. for £26/5/-, or with the Model B.3.P.P./R.F. for £29 Carr. and Ins. 7/6 extra.

- 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 4½in. and below baseplate 3in.
- Brand new in Maker's Cartons, complete with Mounting Instructions.



ANNOUNCING A NEW DESIGN THE STERN'S "SUPER SIX"

A COMPACT AND HIGHLY EFFICIENT RADIO-RADIOGRAM RECEIVER CHASSIS.

- Covers 3 wavebands, 18-50 metres, 190-550, 800-2,000 metres.
- DELAYED A.V.C. on ALL WAVEBANDS.
- 4 POSITION TONE CONTROL.
- Provides INDEPENDENT MAINS SUPPLY FOR RECORD PLAYER (if required).
- Employs 6 VALVES having PUSH PULL for 5-6 WATTS OUTPUT.
- PRE-SELECTIVE FEEDBACK.
- REAL QUALITY BOTH RADIO and GRAM.
- FOR A.C. MAINS SUPPLY 200-250 volts 50 cycles.

THE COMPLETE ASSEMBLY MANUAL IS AVAILABLE FOR 2/-. This gives very detailed practical drawings and layouts and includes complete price list. THE COMPLETE RECEIVER CAN BE BUILT FOR £10/7/6 including the OCTAL VALVE LINE-UP or for £12/7/6 with the MINIATURE VALVES.

HIGH-FIDELITY PICK-UP

Incorporating the famous CONNOISSEUR Light Weight Moving Iron Head and including the Connoisseur matching Transformer (1/- carr. and Ins.). 39/6

THE LATEST "ACOS" MODEL

GP 20 H.G. PICK-UP incorporating the new "High G" Crystal Head. £3/8/8

"MINI-TWIN" 1-VALVE BATTERY SET

A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption. Drilled chassis and practical diagrams make it the ideal set for the beginner to build.

The complete chassis, including valve, can be built for 37/6 plus 8/11 P/Tax, the attractive plastic case is 9/6, and suitable headphones, 14/9.

The complete assembly instructions, layouts and a component price list are available for 1/6.

This Receiver also performs excellently, without modification, as a tuning unit, and, in addition, with simple modifications for which a complete diagram is provided, makes a first-class pre-amplifier for pick-up or microphone.

DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPIFIER and TONE CONTROL UNIT provides a fulcontrol of bass and treble in conjunction with a main Volume/Mixer Control.

It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long-playing, without recourse to pick-up correction.

The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12-watt amplifier advt.

The unit measures only 7in. × 4in. × 2in., including self-contained power supply and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data are available separately for 1/-. Completely assembled and ready for use, £5/5/-.

The COLLARO Model A.C. 514 Record Player £3/19/6

(Plus 5/- carr. and ins.) RIM DRIVE 78 r.p.m. complete with the COLLARO Plug in type MAGNETIC HEAD and 10 inch TURNTABLE. These are COMPLETE BRAND NEW UNITS for A.C. Mains 200-250 Volts.

THE DENCO ULTRA MIDGET SUPERHET COIL TURRETS WITH A ROTARY TURRET ACTION

Type CT9 consists of a four-station "pre-set" unit from which any three stations on medium waveband and one on long wave can be received by a turn of the turret switch. Price 39/6.

Type CT10, is a 3 waveband coil pack incorporating a fourth switch position for Gram. Complete coverage is long waveband 700-2,000 metres, medium waveband 190-570 and short wave 15-50 metres. Price £2/8/-.

A complete receiver circuit and all necessary data are included with each turret. These can be supplied separately for 6d.

— JUST ARRIVED —
— A FEW ONLY —

5-valve SUPERHET CHASSIS covering the standard Short, Medium and Long Wavebands.

COMPLETELY ASSEMBLED AND READY FOR USE £11/5/- Plus 7/6 Carr. & Ins.

Brief Specification:

- Incorporates the latest type of MULLARD VALVES.
- Has a 4 position switch for Gram., Medium, Long and Short Waves.
- Has Pick-up and EXT. Speaker sockets.
- Includes a separate MATCHED 8in. P.M. Speaker.

VARLEY HEATER TRANSFORMER

Input 200-250 volts. Output 4 volts (tapped at 2 volts) 5 amps 14/9 (1/- post).

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We have had very considerable experience in assisting customers to build this T/V and can supply SPECIFIED COMPONENTS EX STOCK. The assembly instructions showing practical layouts and price list are available for 7/6 for London, Sutton Coldfield, Holme Moss, Kirk-o-Shotts and Wenvoe.

A Famous Manufacturer's SHADED POLE RIM DRIVE GRAM MOTORS 9/6

(Plus 1/- carr. and ins.) Clockwise rotations and incorporates a Mains Adjustment Panel. Could also be used as Recording Take Up or Rewind Motor.

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Plus 1/- carr & Ins. Complete with screened lead List Price £2/2/-.

FILAMENT TRANSFORMER

6.3 v. 1½ a.	5/9
4 v. 1½ a.	5/9

SELENIUM RECTIFIERS

6 or 12 Volt 1 amp. rating	7/6
6 or 12 Volt 2½ amp rating	12/6
6 or 12 Volt 4 amp. rating	17/6
6 or 12 Volt 6 amp rating	£1/7/0

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109 & 115, FLEET STREET, E.C.4
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R.S.C. MAINS AND OUTPUT TRANSFORMERS

Fully Guaranteed, Interleaved and Impregnated

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

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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**; 0-4-9-15-24 v. 3 a., **22/9**; 0-9-15-30 v. 3 a., **23/9.**

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Primaries 200-230-250 v. 50 c/s.

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
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/11
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**

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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

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.

SMOOTHING CHOKES

250 mA., 7-10 H. 200 ohms Shrouded	16/9
250 mA., 3 H. 50 ohms	11/9
100 mA., 15 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

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
Williamson type, exact to author's specification	85/-

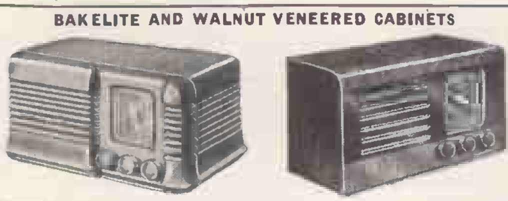
MICROPHONE TRANSFORMERS
100 : 1 ..... **5/9**

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.**

BAKELITE AND WALNUT VENEERED CABINETS



Size approximately 12in. × 6½in. × 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 waveband with circuit	6/9
Drum Drives, complete	2/6

EX-GOVT. AUTO TRANSFORMERS 50 c/s

Double Wound 100 watts, 5-0-115-125 v. to 10-0-10-210-230 v. or reverse	18/9
15-10-5-0-215-235 v. 200 watts	25/9
Double Wound 220/240 v. input. Output 51 v. to 250 v. 21 amps. in steps of 11 v.	85/-

EX-GOVT MAINS TRANSFORMERS

All 230 v. 50 c/s. input 48 v. 1 a. output	9/6
Outputs 250-0-250 v. 40 mA., 6.3 v. 2 a., 5 v. 2 a.	10/9
350-0-350 v. 150 mA. 5 v. 3 a.	17/6

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.**

EX-GOVT E.H.T. SMOOTHING CONDENSERS

.02 mfd. 5,000 v. Bakelite Tubulars	1/6
.02 mfd. 8,000 v. Cans	1/11
.1 mfd. 2,000 v. Blocks	2/9
.25 mfd. 5,000 v. Blocks	4/9
.5 mfd. 3,500 v. Cans	3/3
.1mfd. plus .1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

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.

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.**

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.**

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.

SELENIUM RECTIFIER

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	350 v. 50 mA.	7/9
6/12 v. 6 a.	19/9	250/350 v. 80 mA.	8/9

CO-AXIAL CABLE. 75 ohms ¼in., **7d.** yard.

SPECIAL PURPOSE EX-GOVT. VALVES (GUARANTEED)
VR91, **5/9,** SP61 (VR65), **2/9,** VR56 **3/11,** 807 **6/11,** 6J6 **10/6,** 6SH7Met **6/11,** 12SC7GT **6/11,** VU120A **2/9,** VS110 **1/9.**

EX-GOVT. SMOOTHING CHOKES

250 mA., 10 H. 50 ohms	14/9
250 mA. 20 H. 250 ohms. Tropicalised	13/9
250 mA. 10 H. 100 ohms	14/9
250 mA. 3 H. 50 ohms. Potted	7/6
150 mA. 10 H. 50 ohms	10/11
100 mA. 10 H. 100 ohms. Tropicalised	6/9
100 ma. 5 H. 100 ohms. Tropicalised	4/6
90/100 mA. 10 H. 100 ohms. Potted	8/9
70 mA. 5-10 H.	3/9
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.

1250-0-1250 v. 250 mA., 4 v. 3 a.	25/-
400 v. C.T. 150 mA. 4 v. 6 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a.	22/9

EX-GOVT. BLOCK PAPER CONDENSERS
4 mfd. 500 v. ... **2/9** 10 mfd. 1500 v. **7/9**
4 mfd. 1500 v. ... **4/9**
4 mfd. 400 v. plus 2 mfd. 250 v., **1/11.**

EX-GOVT. CATHODE RAY TUBES
VCR517 (guaranteed full picture) (carr. 5/-) **29/6** ea.

EX-GOVT. TRANSMITTER-RECEIVER TYPE TR9D, complete with all valves, only **47/9,** plus carr. 5/-.

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.

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 12in. Not intermixed. Mains input 200-250 v. Limited number available at only **£9/15/-,** plus carr. 5/-.

COLLARO RECORD PLAYER UNIT. Type AC/514. Standard 10in. turntable. Speed normal 78 r.p.m. Crystal pick-up. Mains input 200-250 v. A.C. Brand new cartoned **£3/19/6,** plus 5/- carr.

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. accumulator at 2 amps., **31/6.**
To charge 6 v. or 12 v. accumulator at 4 amps., **49/9.**
ABOVE KITS CONSIST OF BLACK CRACKLE LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT. The mean charging rates are as indicated above, and complete safety is ensured by fusing of both input and output. Chargers supplied 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.**

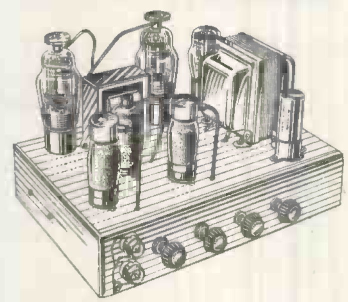
R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen—Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring 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" as illustration 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 5¼-4-1½in.

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. 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.

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Offer Guaranteed Used Equipment at Attractive Prices

- **C.D.P. Disc Recorder**, 78 R.P.M. less amplifier. As new £15 0 0
- **M.S.S. Portable Disc Recorder**, 1948 model, less amplifier, as new £25 0 0
- **Garrard Changer, RC65A**, in maker's carton. 3 only. Each £9 0 0
- **Avo 7**, as new £12 10 0
- **Avo 8**, as new £16 0 0
- **Avo Minor**, as new (universal) ... £6 10 0
- **Avo Valve Characteristic Meter** as new £35 0 0
- **Avo Wide-range Signal Generator**, latest model, as new... £19 0 0
- **Taylor 65C Signal Generator**, as new £10 10 0
- **Taylor 65B Signal Generator**, as new £7 10 0
- **Eddystone 640 Receiver**, complete with valves £19 0 0
- **H.R.O. Senior**, with H.R.O. power-pack and coils (6). Perfect £28 10 0
- **Advance Model E.2 Signal Generator**, as new £17 10 0
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- **E.M.I. Ribbon Tweeter** with TX from 5 ohms crossover frequency 5 kc/s. £20 0 0
- **BC221's** with correct charts, as new £25 0 0
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- **Taylor Windsor Model 170a Electronic Test Meter.** As new. Price £16 10 0
- **Grundig Portable Tape Recorder**, single speed, as new, with mike. Price £45 0 0
- **Acoustical** (QUAD) amp. and tone control, as new. Price ... £21 0 0
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- **Avo 1948/9 All-wave Sig. Gen.**, Perfect. A.C. mains. Price £8 10 0
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- **Evershed 500 v. Bridge Megger**, As new. Price £25 0 0
- **Philips PCR I** with A.C. P.P. As new £12 10 0
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WE URGENTLY REQUIRE FIRST CLASS NEW OR USED STANDARD OR SUB-STANDARD SIGNAL GENERATORS OF EVERY DESCRIPTION. TEST EQUIPMENT, ETC., CONVERTERS, MOTORS, AMPLIFIERS, RECORDERS, ETC. WE ARE AN OLD ESTABLISHED FIRM. WE WILL PAY THE VERY TOP PRICE. DO NOT BE MISLED. WE REALLY DO PAY MAXIMUM PRICES FOR FIRST CLASS EQUIPMENT. WHEN SENDING GOODS STATE WHETHER T.M.O. OR CHEQUE REQUIRED.

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THESE ITEMS ARE ONLY A SMALL SELECTION FROM OUR STOCK OF EQUIPMENT. YOUR ENQUIRIES FOR ANYTHING THAT YOU MAY NEED WILL BE WELCOME. **WE HAVE OTHER EQUIPMENT ARRIVING DAILY!**

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MIDLAND INSTRUMENT CO.

VENNER 24-VOLT TIME DELAY SWITCHES, consists of a high-grade clockwork motor with external wind, 2 electro-magnets, 5-pole cam operated contacts, in smart metal cases size 3½in. × 2½in. × 2¼in., fitted 4-way terminal block, brand new boxed, cost ££s, our price **10/-**, post 1/-.
PROJECTION UNITS, consist of an enclosed lamphouse, fitted 24-v. 15-watt lamp, highly polished reflector, attached mount containing 2 lenses, one a concave/convex, the other a Dallmeyer bloomed "Achromatic" 40 mm. dia., 3½in. focal length lens, taken from new equipment, **10/-**, post and packing 1/-.
CHARGER KITS, consists of a G.E.C. 12-v. 1½-amp. full-wave bridge rectifier, with a Douglas 200/230/250-v. transformer, specially designed for this rectifier, giving the correct A.C. input voltages, to charge a 2, 6 or 12-v. battery at 1½ amps., 2 brand new components, complete with circuit diagram, and instructions, **25/-**. post 1/6.
AIR COMPRESSORS, or vacuum pumps, Romec rotary vane type, develops constant 40/50-lb. sq. in. pressure, fitted 2in. long ½in. dia. splined shaft, size (less shaft) 6in. long, 4in. by 4in. dia., brand new in sealed cartons, **20/-**, post 2/-.
TELEPHONE SETS, consists of 2 combined receivers and microphones, provides perfect 2-way communication (up to 1-mile with extra flex) self-energised, no battery required, 20-ft. connecting flex, complete ready for use, brand new boxed, **12/6**, post 1/-.
VARIABLE RHEOSTATS, wire wound on ceramic, laminated wiper, 50-ohms at 1-amp., easily altered to 12.5-ohms at 2-amps., new boxed, **5/-**, post 1/-.
PLESSEY MOTORS, 200/250-v. A.C. mains, shaded pole, as fitted to the 3-speed gram. units, size 3in. × 3in. × 2½in., brand new boxed, **12/6**, post 1/2.
BUZZERS, 3 to 6-v. high note, platinum contacts, knob note control, fraction of original cost, new, unused, **5/-**, post 1/-.
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CROMPTON PARKINSON METERS, 4in. scale, graduated 40-45-50-55-60 cycles, with sub-division, incorporates Westinghouse metal rectifier, flush panel mounting, brand new, boxed, **30/-**, post and packing 2/-.
DETECTOR UNITS TYPE 66, a self-contained unit, fitted CV-271 (IT4 type) valve, various components, compartment to take a U2 cell, switch, etc., 7in. long, 1½in. dia., new, unused in rubber waterproof cases, **5/-**, post 1/-.
SUPPRESSORS, car plug fitting, standard 15,000 ohms, for easier starting, T.V. and car radio suppression, brand new stock, current price **2/6** each, our price, set of 4, **3/6**, post 3d., sealed cartons of 100, **62/6**, post 1/6.
THERMOSTATS, close at low temperatures, adjust. 30-60 deg. F., ideal for greenhouses, car heaters, frost warning, etc., **2/6**, post 4d.
SWITCHBOXES, black matt finish alloy, size 3½in. × 2½in. × 2in., fitted 2 Wylex 250 v. 10 amp. A.C. on/off toggle switches, new unused, **2/6**, post 9d.
G.P.O. TYPE 3000 RELAYS, 100 plus 100-ohm balanced, 4-pole, 1-make, 2-break and changeover contacts, new, unused, **5/-**, post 9d.
H.S. RELAYS, 145-ohm, s.p.c.o., **2/6**, post 6d. **IMPULSING MECHANISMS**, actuating switch, 12/24-v., **1/6**, post 1/-. **BOSTIK CEMENT**, ½-lb. tubes, **1/6**, post 7d. **EMPIRE TAPE**, 1in. wide, 50-yd. rolls, **2/6**, post 9d. **SLYDLOK FUSES**, 250 v. 15 amp., **1/6**, post 3d. **TEST PRODS**, 6in. long, fitted red and black flexible, **1/6** pair, post 4d. **THROAT MICROPHONES**, electro-magnetic, boxes of 2 microphones, **1/6**, post 4d. **TOGGLE SWITCHES**, 24-v. 20-amp. on/off, **1/-**, post 3d. **GERMANIUM CRYSTALS**, **2/-**, post 3d. **CRYSTAL SET COILS**, med. and L-wave, with circuit, **2/6**, post 3d. **BOMB COMPUTORS**, **40/-**, carriage 10/-, Scot., **12/6**, N.I., **15/-**. **UNIVERSAL SWITCHES**, twin press-button, 250 v. 5 amp. A.C., boxed with circuits, **1/9**, post 4d. **WIRE STRIPPERS**, usual toolshop price 15/-, our price, new, boxed, **5/-**, post 6d. **ARROW SWITCHES**, 250 v. 25 amps., 4-way rotary, 3-heat and off, series parallel, **2/6**, post 1/-. **PNEUMATIC DASHPOTS**, 3in. long, ⅝in. dia., plunger movement 2in., **1/9**, post 6d.
Many other bargains to offer; send 6d. for lists.

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I KW TELEGRAPH TRANSMITTERS. Two HF 300's output. Operation 3.5 mc. to 16 mc.

BC610 TRANSMITTERS with speech amplifier, aerial tuning unit, etc. Brand new.

RCA TRANSMITTERS. Type ET-4336. Complete with original speech amplifier, crystal multiplier and VFO units. Unused and reconditioned. Can be supplied with very large quantity of spares.

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SCR510's, SCR610's, both complete with Power Pack and telescopic aerial.

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All above items in excellent working condition.
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Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

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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.

Drop thro' 110-110 60 mA., 6 v. 0.5 amp., 8/6.

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/-.

1000-0-1000 v. 250 mA. 4 v. 3 amp. 37/6. P. & P. 5/-.

Used Resistance and Capacity Bridge in leatherette covered case with carrying handle, size 12½ × 8½ × 6½in. 10 pF to 100 mfd. in 3 ranges. 1 to 10 meg. in 3 ranges. Power factor check. 200, 300, 400 and 500 v. flash test, Magic eye, rectifier, triode and neon. These require re-checking. £3/19/6. P. & P. 4/-.

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/-

P. & P. on the above 1/- each.
10in. less trans., 19/6. P. & P. 1/6.

Truvox BX11. 12in. P.M. 3 ohm speech coil, 45/-. P. & P. 3/6.

8½in. M.E. Speaker, 1,000 ohm field 15/-. P. & P. 1/6.

R. & A. T.V. Energised 6½in. speaker with O.P. trans., 6V6 matching, field coil 175 ohms. Requires a minimum 150 mA. to energise, maximum current 250 mA. 15/-. P. & P. 2/-.

Extension Speaker Cabinet, in contrasting walnut veneer, size 15 × 10½in. Will take 6½ or 8in. speaker 17/6. P. & P. 2/-.

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., .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. & 50K., 3/6 each. ½ and 1 meg., long spindle double pole switch, miniature, 5/-. P. & P. 3d. each.

Trimmers, 5-40 pf., 5d.; 10-110, 10-250, 10-450 pf., 10d.

Twin-gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6. P. & P. 1/-.

Line Cord, 2-way 0.3 amp., 60 ohms per foot, 1/3 per yard.

Twin-Gang .0005 with feet, size 3½ × 3 × 1½in., 6/6.

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T.V. Coils, moulded former, iron-cored, wound for re-winding purposes only. Ali-can 1½ × 1½in., 1/- each, 2 iron-cores ali-can 2½ × ¾in., 1/6 each.

Line and E.H.T. Transformer 9KVA, using ferocart core complete with built-in line and width control. Mounted on small ali-chassis. Overall size 4½ × 1½in. EY51 rec. winding, 27/6. P. & P. 2/6.

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/-. 15in. Cream, 17/6 plus 1/6 P. & P.

T.V. Width Controls, 3/3.

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/-, p. & p. 1/6.

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.

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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/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquires and lists, S.A.E.

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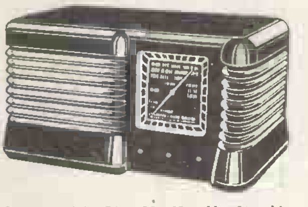
HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer. 600 ft. on aluminium spool, 8/-. 1,200 ft. on aluminium spool 17/6, post paid.



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 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 IF'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.

USED 5-VALVE A.C. MAINS 200/250 3 WAVEBAND SUPERHET. Complete in outstanding walnut cabinet, size 22 × 14 × 10½in. Valve line-up: 6K8, 6K7, 6B8G, 6F6, and U50 rec., 8in. P.M. speaker. In first-class working order. £7/19/6. P. & P. 12/6. We have a few of these in A.C./D.C., price as above. or £2/10/- dep., 6 monthly payments of £1/1/-.

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 PUSH-PULL TRANS. Pri. 6,000 ohms, sec. 15 ohms (2 L66's in push-pull) £1. P. & P. 2/-.

FULLY SHROUDED CHOKE 15 Henry 180 mills, 15/-. P. & P. 2/-.

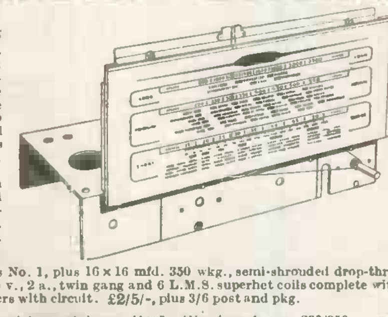
FULLY SHROUDED CHOKE 5 Henry 120 mills, 8/6. P. & P. 2/-.
These last four items by very famous manufacturer.

USED C.R.T. 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 110 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 × 4¼in. Size of scale 6½ × 3½in., 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. P. & P. 4/-.

CONSTRUCTOR'S PARCEL No. 1 comprising chassis 12½ × 8 × 2in., cad. plated 18 gauge, v/h., IF 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. P. & P. 1/9.
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.

BATTERY CHARGER KIT comprising metal case 4½ × 5 × 4½in, transformer 230/250 v., and metal rectifier. Will charge 6 or 12 v. battery 1½ amp. 19/6. P. & P. 2/6.

PERSONAL PORTABLE CABINET. In cream-coloured plastic: size 7 × 4½ × 3in. Complete 4-valve chassis. Scale and 3 knobs. Takes miniature 90 v. and 7½ v. batteries 9/-. post and pkg. 1/6.
3in. P.M. Speaker to fit above, 10/-, Miniature output transformer, 5/-. Miniature wavechange switch, 1/6. Miniature 1-pole 4-way used as Volume and Off, 1/6. 4B7G valve holders, 2/4. Midget twin gang ¾in. dia., ¾in. long and pair medium and longwave TRF coils ¾in. long × ¾in. wide; complete with 4-valve all-dry mains and battery circuit 8/6. Condenser Kit, comprising 11 miniature condensers, 3/6. Resistor Kit comprising 16 miniature resistors 4/-. The above receiver (less valve and batteries) could be built for approximately 51/-. All valves to suit above available. Point to Point Wiring Diagram 1/-.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250.

300-0-300 60 mA. 6.3 v. 1 a., tapped at 4 v. 6.3 v. 2 a. tap 4 v., 13/6.

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 ali-chassis. Overall size 4½ × 1½in., EY51 rec. winding. 27/6. P. & P. 2/6.

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
Ex-Govt. 8 mfd., 500 v. wkg., size 3½ × 1½, 2 for	2/6
16 × 32 mfd., 250 wkg.	6/-
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. P & P 2/-

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. & P. 1/6.
P.M. Focus Unit for Mazda, 12in., with Vernier adjustment 17/6. P. & P. 1/6.
Wide Angle P.M. Focus Units, Vernier adj., state tube, 25/-. P. & P. 2/-.
Energised Focus Coil, low resistance mounting bracket, 17/6 plus 2/- P. & P.
Scan Coils, low line low impedance frame, complete with O.P. transformer. 17/6. P. & P. 2/-.

Ion Traps for Mullard or English Electric tubes, 5/- post paid.

465 kc. I.F.s, size 2½ × 1½in. Q.110 removed from American equipment. 5/- per pair. Standard 465 Kc. iron-cored IFs. 4 × 1½ × 1½in., per pr. 7/6. Wearite standard iron-cored 465 Kc IFs, 3½ × 1½ × 1½in., 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, ¾in. 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 .3 amp. 700 tapped 680, 640, 600, 3/6. P. & P. on each 3d.

G.W. SMITH & Co. (RADIO) LIMITED

V.H.F. Wavemeters. Type 4. Ref. AM.10T/534, Cavity Tuned, complete with VU39 4 volt rectifier, SP61, VR92, C.V.51 Magic Eye Tuner, Brand New in sealed boxes. 39/6 each.
Power Packs, Type S441, B, Input voltage 200/250, 50 cycles A.C. Outputs 300 volts 200 mA., L.T. 12 Volt 3 Amp., also separate 12 volt 1 amp. supply operating built in Londex overload relay, with 5U4G valve. Supplied in grey mottled cabinet size 13½in. x 7½in. x 6¾in., 62/6 each.
Multi Way Switch Boxes, ex bcmb release, fitted with 16 toggle switches, ideal for model control, brand new and boxed, 9/6 each.
Swinging Chokes. Parmeko. 150 M/a. 4.2/20 Henry, size 3in. x 3in. x 3½in. 7/6 each.
Ex Am. Switch Boxes. Moulded Bakelite. Totally enclosed. 3 Way 1/9 each, 5 Way 3/6 each.
F24 Camera Control Boxes. Type 35 No. 20, Brand new, 27/6 each.
A.C. Mains Transformers, Ex-Admiralty, input voltage 100/250 A.C. at 50 cycles, Outputs 670 x 670 volt at 200 mA., 6.3 volt 4 amp., 5 volt 3 amp. 49/6 each.
P.O. Automatic Telephone Circuit Diallers, Type 1, 25 bank, Type 2, 50 bank, 12/6 each. These precision built units have hundreds of potential uses each one being fitted with clockwork control motor.
2 Volt Accumulators, Brand New. Capacity 3 Amp. Hours, size 4¼in. x 1¼in. x 1¼in. 3/6 each.
R.1155 2 Speed Slow Motion Motor Drives. "A" type with double knobs, 4/- each.
Amplifier Cabinets, Ex-Well Known Manufacturer, sloping desk type, well constructed with ventilated cover, chassis drilled for 5, I/o holders, size 13in. x 9in. x 7in. Sprayed attractive yellow. 15/6 each.
R 1155 Receivers, used models, aerial tested, and in perfect working order, complete with valves. £7/19/6 each.
A.C. Voltmeters. BSI Grade, reading 0-300 volts at 50 cycles, 3½in. flush panel mounting, supplied complete with leads and case. 39/6 each.
Transmitter Units, Type 39. Covering V.H.F. frequencies, complete with A.C. mains 230 volt 50 cycle E.H.T. and L.T. supply, condition as new at £5/19/6 each.
Uniselector Switches. 4 Bank double wiper 32/6 each ; ditto 8 Bank 45/- each.
Handsets. Standard P.O. telephone type 12/6 each.
Ceramic Switches. 3 pole 4 way 4 bank, standard size wafer, 10/6 each.
American Rotary Transformers. 12 volts D.C. input. Output 255 volt at 65 M/a. Size 4½in. x 2½in. For Car Radio Operation. Also suitable for running Electric Shavers from your car supply, 22/6 each. Brand new.
Muirhead Switches. Precision built. 8 pole 2 way. Key switch action, brand new, boxed, heavy contacts, 4/6 each.
Ceramic Transmitter Switches. With extra heavy duty silver-plated contacts, 3 bank single pole 6 way, spacing between contacts 1in. spacing between wafers 1½in. and 5in., 9/6 each.
Mains Isolation Transformers for industrial purposes. 230 volt A.C. 50 cycles input. Output 230 volt 50 cycle 1,000 watts, supplied complete in heavy duty metal case, size 13in. x 10½in. x 8in. Price £6/10/-.
Smoothing Chokes. Heavy duty. 20 Henry 300 M/a., 2,000 volt insulation test. Admiralty rating will pass 500 M/a., 17/6 each.
Mains Transformers. 230 volt Primary, Secondary 500 x 500 at 170 M/a., 4 volt 4 amp. C.T. W.D. rating insulation test 3,000 volts. Ample space for additional 6.3 winding if required, 22/6.
H.R.O. 6 volt Vibrator Power Packs. Output 165 volt 80 M/a., 6·3 volt at 3 amps., 6 x 5 rectifier. Choke condensers smoothed, complete in self-contained crackle cabinet size 7in. x 7½in. x 6in., battery leads with croc. clips supplied. Brand new, 29/6.
Ceramic Switches. Standard spacing, 4 pole 3 way 3 bank. Special price 6/6 each. Brand new and boxed.
Smoothing Chokes. Ex-W.D. 15 Henries at 275 M/a. Ministry rating, resistance 125 ohms, 10/6 each.
Meter Switches. Standard Yaxley Wafer Type, 8 bank, single pole 9 way, 11 way or 12 way. Size 2½in. diameter, switch length 5½in. plus spindle, 2½in. Price 7/6 each.
A.C. Mains Transformers, 0/230 to 250 volt 50 cycle input. Outputs 250 volts h/w 60 M/a., 6.3 volt 1½ amps. Size 3in. x 2½in. x 2½in., with fly leads, brand new, 8/6 each.
Microamp Meters. 0-100 Microamps. 2½in. Flush Panel Mounting scaled 0-1,500 yards. Brand new and boxed. 42/6 each
Rotary Convertors. 24 volt D.C. input. Output 230 volt A.C. mains 50 cycle at 100 watts. 92/6 each, ditto 12 volt input, 102/6.
Mains Transformers. Input : voltages 200/250 at 50 cycle. Output 350 x 350 volt 180 M/a. Lt. Windings 6.3 volt, 5 amp., 5 volt 3 amp. Brand new. Ex-W.D. 29/6 each.
Chokes. Heavy Duty Ex-W.D. 20 Henry 120 M/a., size 3in. x 4in. x 2½in., 10/6 each.
Please print your name and address clearly, also include postage or carriage on all items.
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SPECIAL THIS MONTH!

INDICATOR UNIT, TYPE 233. Complete with VCR97 C.R.T., 3-VR91 (EF50), 3-VR65 (SP61), 3-VR54 (3-EB34), 2-VR92 (EA50) valves, resistors, .1 mfd. 2.5 K. condensers, pots, etc. Price 49/6 plus 5/- carr. In transit cases.

INDICATOR UNIT, TYPE 157. Has same line-up as INDICATOR TYPE 62, viz. VCR97 C.R.T., mask and Mu screen, 16-SP61, 2-EB34, 4-EA50 valves, 15 potentiometers, resistors, condensers, Muirhead S.M. dial, etc. **BRAND NEW IN TRANSIT CASE.** Price £3/7/6 Plus 7/6 carr.

BOMBSIGHT COMPUTER. MARK XIV. With 2 24 volt AC/DC motors, a 24 v. repeater motor, gyro unit, dozens of gear wheels and anaroids, etc. Ideal for model makers, etc. Brand New in cases (the cases are worth at least 15/-). Price 37/6 each. Plus 7/6 carriage.

MAINS TRANSFORMER FOR THE 1132A RECEIVER or 1155A POWER PACK. INPUT : 200-210-220-230-240-250 v. OUTPUT : 200-0-200 v. 150 mA. OR 250-0-250v. 150 mA., 6.3 v. 4.5 amp., 5 v. 2 amp. These transformers are brand new and we offer them at the very low price of 19/6 each. Plus 2/6 carr.

MAINS TRANSFORMER (sub-standard). Input 200-250 v. Output 250-0-250 v. 60 mA. 6.3 v. 1½ a., 6.3 v. (tapped 5 v.) 1½ a. Price 7/6, plus 1/- post.

144 MC/S TRANSMITTER (LESS VALVES). A compact TX unit (10½in. × 6in. × 4½in.). Covering 2 metre band. Valve line-up : 2-6C4's at Push-pull V.F.O., 832 amp. and 832 (or 829) final amp. variable inductance tuning all stages. V.F.O. coils missing. Can be used as TX, or driver for larger TX, a snip at 21/- each.

SANGAMO MOTOR UNITS. These are brand new pre-paid meter movements, with dozens of gears, and a Sangamo-Weston 200-250 v. A.C. 50 cycles motor (silent running). Has numerous applications (clockmaking, etc.) Price 10/6 each. Plus 1/3 post.

AMPLIFIER UNIT, TYPE A1271. Containing EF36 valve, 400 Ω Relay (4 makes, 2 breaks), 10,000 Ω Pot., resistors, condensers, etc., in black metal case 5in. × 5in. × 5in. Brand New at 7/6 each, plus 1/6 post.

R.F. UNITS. TYPE 24. The well-known unit used with the 1355 receiver for TV. Complete with valves. Slightly soiled on outside. An absolute bargain at 14/6 each, plus 2/- post and packing.

METERS. BRAND NEW AND BOXED.

0-30 mA., Moving Coil, 2½in. circular panel mounting	8/6 each
0-150 mA. (scaled .15A) Moving Coil, 2in. square panel mounting	7/6 each
0-200 mA., Moving Coil, 2½in. circular panel mounting	8/6 each
0-300 mA., Moving Coil, 2½in. circular panel mounting	8/6 each
0-6 amp., Thermo-Couple, 2½in. circular panel mounting	6/6 each
0-15 v. A.C., Moving Iron, 2½in. circular panel mounting	8/6 each
0-5 amp., Moving Coil, 2in. square panel mounting	8/6 each
0-3.5 kV. Moving Coil, 3in. projection	8/6 each
0-350 v. A.C., 3in.	14/6 each
0-350 v. D.C., 3in.	12/6 each

Please add 1/- per meter for postage.

ROMAC VACUUM PUMP (rotary vane type) ideal where air pressure is required, viz. paint sprayers, etc. Brand new at 15/- each. Plus 2/- post.

COLLINS MIKE TRANSFORMERS. Ratio 41 : 1. Price 4/6 each.

VALVES. EF50, 5/- each. VR65, EA50 at 2/6 each.

GERMANIUM CRYSTAL DIODES. G.E.C. wire ends, 2/- each ; 18/- per dozen.

VIBRATORS. 4 pin 12 volt (ZA4878) made by Mallory (Type 650) also 4 pin 6 volt at 4/6 each ; 48/- per doz.

VALVEHOLDERS. Ceramic B7G, with screening cans, 1/3 each ; 12/6 doz. Ceramic B9G (EF50) at 9d. each ; 8/6 doz.

KARAMOT (LOADED EBONITE) RODS. 2¾in. × 26in. long. 6/6 each, plus 3/- carr. ½in. dia. × 20in. long, 4/6 doz. Plus 1/- carr.

194 I.F. STRIP. The well-known I.F. Strip for TV conversion. Complete with all valves, viz. : 6-VR65, 1-VR92 (EA50), 1 VR53. A few only available at 35/- each, plus 2/6 postage.

THROAT MIKES. (Magnetic type). Complete with leads, 2/6 each, plus 6d. post.

CARBON MIKES INSETS (MARK IV), at 1/6 each. Power mike inserts (multi-carbon) at 2/6 each.

HIGH INDUCTANCE R.F. CHOKE. Suitable for use in **RINGING CHOKE E.H.T. UNIT** as described in "W.W." Dec. 1953 (page 603). This choke used with 807 valve gives 4kV. 350 mA. Brand new at 5/- post paid.

POLYTHENE RODS, $\frac{5}{16}$in. dia., 12in. long, 6/- doz.

TRANSLUCENT PROJECTION SCREENS (size 15½in. × 12in.). As used in projection television and epidiascopes. Price 7/6 each.

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COMMUNICATIONS RECEIVER R1155. The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges 18.5-7.5 Mc/s, 7.5-3.0 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. These are IN EXCELLENT CONDITION IN MAKER'S ORIGINAL TRANSIT CASES, ONLY £11/19/6.

A few of the R1155N model can also be supplied. This is the latest version which covers the Trawler Bands, and in addition is fitted with ultra slow motion tuning. Used, but tested working before despatch. ONLY £17/19/6.

A factory made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied at ONLY £5/10/-. Operates receiver immediately.

DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Please add carriage costs of 10/6 for receiver, and 5/- for power pack.

100 MICROAMPS METERS. 2½in. circular flush mounting. Widely calibrated scale of 15 divisions marked "yards" which can be rewritten to suit requirements. These movements are almost unobtainable to-day and being BRAND NEW IN MAKER'S CARTONS are a snip at ONLY 42/6.

METERS. BRAND NEW, MOVING COIL, FLUSH MOUNTING. 1 mA. 2½in. square, 15/- ; 5 mA. 2in. square, 7/6 ; 100 mA. 2½in. round, 12/6 ; 500 mA. 2½in. round, 12/6 ; 20 amp. 2in. round, 7/6 ; 40 amp. 2in. round, 7/6 ; 500 mA. thermo couple 2in. square or round, 5/-, or 3 for 13/6 ; 30-0-30 amp. moving iron, car type, 5/-.

POWER UNIT TYPE 3. Made for use with the R.1132A, this is a standard rack mounting job to match the receiver, and is for 200/250 v. 50-cycle mains with outputs of 250 v. D.C. 100 mA., and 6.3 v. 4 amp. Fitted with H.T. current meter and voltmeter this is a first-class unit, and can be used for a variety of receivers. Used, but tested working before despatch. ONLY 90/- (carriage, etc., 5/-). Connecting Cable with Jones Plugs for receiver and power unit, 10/-.

AMPLIFIER A1135A. Complete with 3 valves, 1 each EL32, EK32, EBC33. A handy little unit for conversion or breakdown. ONLY 17/6 (postage, etc., 2/6).

TR1196 TRANSMITTER SECTION. In perfect condition, less valves. ONLY 12/6 (postage, etc., 2/6).

OSMOR H.O. COIL PACK. The 3 wave superhet pack recommended for the TR1196 Receiver conversion. ONLY 48/-. 1196 conversion data supplied with coil pack, or separately 1/-, post paid.

500 KCS. CRYSTALS. Standard 2-pin mounting. Ex. new equipment and perfect. ONLY 15/- (postage, etc., 1/-).

159 RECEIVER UNIT. Contains 1 each valve, types EF50, EA50, SP61, RL37 and 24 v. selector switch. ONLY 12/6.

VACUUM PUMPS. For Handymen and Model Makers. Ex-R.A.F. Type B3-Mk. III, made by Romec. BRAND NEW IN MAKER'S CARTONS, ONLY 15/- (post 2/-).

TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded, normal primaries 425 v.-0-425 v. 250 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., 50/-.
350 v.-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., 42/6.
350 v.-0-350 v. 150 mA., 6.3 v. 5 a., 5 v. 3 a., 32/6.
250 v.-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., 32/6.
Please add 2/- per transformer postage.

TRANSFORMERS, FILAMENT. 6.3 v. 2 a., 7/6 ; 6.3 v. 3 a., 10/6 (postage 1/-).

TRANSFORMERS, EHT. Upright mounting.
EHT for VCR97 Tube 2,500 v. 5 mA. 2 v. -0-2 v. 1.1 a., 2 v.-0-2 v. 2 a., 37/6.
EHT 5,500 v. 5 mA., 2 v. 1 a., 72/6.
EHT 7,000 v. 5 mA., 2 v. 1 a., 82/6.
EHT 7,000 v. 5 mA., 4 v. 1 a., 82/6.
Please add 2/- per transformer postage.

TRANSFORMERS, EX-W.D. AND ADMIRALTY, built to more than 50 per cent. safety factor with normal A.C. mains primaries. All brand new and unused, 330-0-330 v. 100 mA., 4 v. 3 a., 22/6.
E.H.T., 1,400 v. 2 mA., 520 v. 10 mA., 300 v. 10 mA., 2 v. 1.5 amp., 21/-.
L.T. 6.3 v. 7.7 amp., 4.2 v. 2.5 amp., 4 v. 1 amp., 19/6.
L.T. 4 v. 20 amp. C.T., 30/-.
Please add 2/6 per transformer postage.

INTERNATIONAL OCTAL PLUG. Fits into I.O. valve-holder, 2/- (post 3d.).

GANGED POTENTIOMETERS. Double 50K and double 1 meg., 7/6 each.

CERAMIC 2-WAY 3-BANK SWITCHES, 7/6 each.

P.M. SPEAKERS. 6½in. ROLA with transformer, 17/6, 10in. LECTRONA with transformer, 27/6. 12in. GOODMANS, less transformer, 15 ohms speech coil, 99/6. ALL SPEAKERS BRAND NEW IN MAKER'S CARTONS. Postage 2/- each please.

AMERICAN 12 v. DYNAMOTORS. Output 255 v. 60 mA. ONLY 22/6.

C.R. TUBE VCR97. Tested full screen. BRAND NEW IN MAKER'S CRATES. ONLY 42/6.

METAL RECTIFIERS. Selenium full wave bridge 6 or 12 volts ; 1 amp., 7/6 ; 2 amp., 11/3 ; 3 amp., 12/6 ; 4 amp., 15/-.

Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only.

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Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

MILLIAMP METERS, 0-500, 0-300, 0-30, 2½in. round, flush panel mounting .... 10/6 each

CONDENSERS Per doz.

16 x 8 Mfd. Metal Cans Electroyltic, 350 v. 1/6 each 15/-
32 Mfd. Metal Cans Electrolytic, 350 v. 1/6 each 15/-
32 x 8 Mfd. Metal Cans Electrolytic, 275 v. 1/9 each 18/-
64 Mfd. Metal Can Electrolytic, 350 v. 2/6 each 24/-
2 Mfd. 150 v. Tubular Paper (aluminium tubes). 1/6 each 15/-
8 Mfd. 450 v. Electrolytic. 1/9 each 18/-
16 Mfd., 350 v., Electrolytic. 2/- each 21/-
24 Mfd., 350 v., Electrolytic. 2/3 each 24/-
32 Mfd. 450 v. Electrolytic. 2/6 each 27/-
8 x 16 Mfd., 350 v. 1/6 each 15/-
Condenser clips for above 3/-
100 Mfd. 50 v. Metal Cans. 1/- each. 25 Mfd. 50 v. Tubular Cardboard 10/6
12 Mfd. 50 v. Tubular Paper (aluminium tubes). 1/- each 10/6
100 Mfd. 6 v. Tubular Paper (aluminium tubes). 1/- each 10/6
.00005 Tubular Miniature 4/- per doz. .02, 500 v. 4/- per doz. .001, 350 v. 4/- per doz. .05, 350 v. 4/- per doz. .005, 200 v. 4/- per doz.

MIDGET MICA CONDENSERS: .0001, .0002, .0003, .0004, .0005 4/-
200 Assorted Moulded Micas. Popular Values £2 10 0
200 Assorted Silver Micas. Popular Values £2 10 0
200 Assorted Carbon Resistors: ¼, ½ and 1 watt. Good selection £1 10 0

CARBON RESISTORS: ¼ watt 2/6 ; ½ watt 3/- ; 1 watt 4/- ; 2 watt 6/- ; 5 watt 9/- per doz.

HIGH STABILITY RESISTORS:

Tolerance:	1%	2%	5%	
¼ watt	1/-	9d.	6d.	each
½ watt	1/3	1/-	9d.	each
1 watt	1/9	1/3	1/-	each
8-40 MEG 2 watt		2/6 each		

COPPER SQUARE MESH 11½in. x 8in. .... 2/- each
GERMANIUM CRYSTAL DIODES .... 2/- each
PYE PLUGS AND SOCKETS .... 1/6 pair

W/W AND VITREOUS RESISTORS. 5 watt, 1/6 ; 10 watt, 2/6 ; 15 watt, 3/- ; 20/30 watt, 3/6 each.

W/W V/CONTROLS. COLVERN and B-NSF. 5K PRESET and other values, 2-3 watt, 2/- each. 10K Isolated Spindle .... 2/- „
500 ohms, 1K, 20K, 25K, 50K, with spindle .... 3/- „

V/CONTROLS WITH SWITCH: most values, B-NSF .... 2/6 „

V/CONTROLS: Less Switch, Preset and Spindle. MOST VALUES 1/9 „

TWIN MIDGET GANGS, .0005, with trimmers, PERSPEX COVER .... 5/6 „

4-WAY PUSH BUTTON UNITS. 1/6 each .... 15/- doz.

PUSH BUTTON KNOBS .... 3/- „

TAG STRIPS: 3-way, 2/- doz; 4-way, 2/6 doz.; 5-way, 3/- doz.; 7-way 4/- doz.; 28-way 10/- doz.

ASSORTED PILOT LAMP HOLDERS .... 4/- „

FUSES 1¼in. Most values from 750 mA. to 10 amp. .... 2/- „

POINTER KNOBS. Small black, with line, ¼in. hole .... 7/6 „

STANDARD ROUND KNOBS: Small, ¼in. hole, 6/- ; Large, ¼in. hole, 7/6 ; with spring clip, ¼in. hole .... 4/6 „

CLIX WANDER PLUGS, Type MP2. Red, black, blue .... 2/- „

PHILIPS TRIMMER TOOLS. 1/- each .... 9/- „

BELLING & LEE. P/M FUSE HOLDERS, Type L356 .... 2/6 each

WEARITE COILS: Types PA4, PO4, PA5, PO5. 1/3 each .... 12/- doz.

VALVE HOLDERS: Moulded. B9A, 7/6 ; B7G, 6/- ; EF50, 6/- ; **ENGLISH OCTAL,** 3/- per doz. **SCREEN CANS** for B9A, B7G, 6/- doz. ; **PAXOLIN**—B7G, MAZDA 4-pin UX .... 3/- „

BELLING & LEE. PLUGS AND SOCKETS. Ex-Govt. BRAND NEW 5-pin, Chassis and Cable, 7-pin .... 1/6 pair

BULGIN. P.73, Plug and Socket, 2/9 each; P74, Plug and Socket, 2/6 ; P200, Plug and Socket, 2/- ; Rotary Switches, S.255, 2/- ; Dolly Switches, S.267, 2/- ; Dolly Switches, S.259, 1/6 ; Standard Switches, Ex-Govt., On-off .... 1/6 each

POST OFFICE LAMP JACKS, No. 10 1/- each .... 9/- doz.
Lamp Covers for same .... 3/- „

L.F. CHOKES. 300 w., 60 mA. CH5 .... 4/6 each

OUTPUT TRANSFORMERS. Multi Ratio, 5/- ; Pentode or Power .... 4/- „

VALVE SCREEN CANS for Standard Valves. 1/- each ... 10/6 doz.

DRUM DRIVES. 4½in. .... 1/- each

WESTECTORS. WX6, WX12, W1, W12, W4. 1/- each .... 9/- doz.

ARCOLECTRIC (Whitney Lamps). Red, green, clear. 1/6 each .... 15/- „

SIGNAL LAMP HOLDERS P/M, complete with adjusting lamp holders. 1/9 each .... 18/- „

AIR SPACE TRIMMERS. Preset and spindle types, 5PL, 10PF, 15PF, 20PF, 25PF, 50PF, 75PF, 15/- ; 100PF Preset. 1/6 each .... 15/- „

JONES PLUG AND SOCKETS. 4-pin, 2/6 ; 6-pin, 3/- ; 8-pin, 3/6 ; 10-pin, 4/- ; 12-pin .... 6/- pair

NUTS. 8BA, 3/- ; 6BA, 2/6 ; 4BA, 3/- ; 2BA .... 4/- gross

SOLDER TAGS 1/6 gross. **SHAKEPROOF WASHERS**... 2/- „

WASHERS, 2, 4 and 6BA .... 1/- „

SHAKEPROOF SOLDER TAGS, 4BA and 6BA, 2/- ; 2BA... 2/3 „

PAXOLIN SHEET, 36in. x 4½in. x $\frac{1}{16}$in. .... 2/- each

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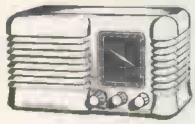
We can supply all the parts (including valves, 5in. moving coil speaker, cabinet, chassis, and everything down to the last nut and bolt, to enable YOU to build a professional-looking radio. The chassis is punched and drilled ready to mount the components. There is a choice of any of three attractive cabinets 12in. long 5in. wide by 6in. high, as follows; either ivory or brown bakelite, or wooden, finished in walnut. Complete and easy-to-follow point-to-point and circuit wiring diagrams supplied.



MODEL 1 T.R.F. RECEIVER

This is a 3-valve plus metal rectifier T.R.F. receiver with a valve line-up as follows: 6K7 (HF), 6J7 (Det) and 6V6 (Output). The dial is illuminated and when assembled the receiver presents a very attractive appearance. Coverage is for the Medium and Long Wave bands. Operates on 200/250 volts AC Mains.

Plus 2/6 Packing, Carriage, Insur. **£5 · 10 · 0**

MODEL 2. SUPERHET RECEIVER

This is a powerful midget 4 valve plus metal rectifier Superhet Receiver with a valve line-up as follows: 6K8, 6K7, 6Q7, 6V6. The dial is illuminated and coverage is for the Short Wave bands between 16-50 metres, the Medium Wave bands between 190-540 metres, and the Long Wave bands between 1,000-2,000 metres. Operates on 200/250 volts AC mains.

Plus 2/6 Packing, Carriage and Insur. **£7 · 19 · 6**

T.R.F. RECEIVER We can supply this Receiver ready built at £6/15/6 plus 3/6 p.c.

ALL COMPONENTS SUPPLIED ARE GUARANTEED FOR ONE YEAR

NOTE: *We would respectfully suggest to those interested in building this receiver that they send for OUR Instruction Booklet. Intending constructors can then judge for THEMSELVES how comprehensive this Booklet is.*
Instruction Booklet and priced Parts List, for either of the above, available separately at 1/-. This money will be refunded if circuit diagram is returned as NEW within 7 days. *When ordering please state Model No.*

The increasing popularity of our

T.R.F. RECEIVER

and the tremendous demand for the component parts to build it, have enabled us to purchase the components in larger quantities than ever before. Due to this bulk buying we have bought at keener prices. Therefore, in accordance with our advertised policy of a "New Deal for Mail Order Shoppers," and as evidence that we are determined to maintain the reputation we have gained for fair and honest trading, we are passing this advantage on to our customers.

All the parts to build the receiver illustrated can now be supplied at

£5 · 10 · 0
Plus 2/6 Carr & Ins.

CONSTRUCTOR'S PARCEL

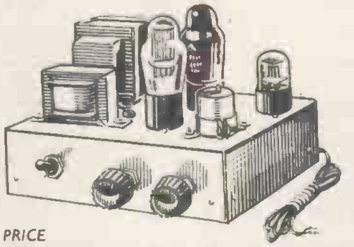
We can supply the basic parts to help you construct the radio illustrated above. Most radio enthusiasts have stocks of small components such as condensers, resistors, valves, etc. around their workroom. For those people we supply a special constructor's parcel of the main components to enable them to build a set to their own circuit. This parcel consists of: Cabinet (Bakelite) in Ivory or Brown. Or wooden (as above), 17/6, plus p. & c. 2/6. Punched chassis, 3 valves T.R.F., 3/9. Dial front plate, 2/6. Dial M. and L. with station names, 1/6. Drum, 1/6. Driving head, 1/6. Double pointer, 4d. Spring, 3d. Chassis fixing bracket, 9d. pr. T.R.F. coils, 180-550, and 800-2,000 metres, 5/6 pr. The above items may be purchased separately or as a complete parcel at 31/-, plus p. & c. 2/6.

4 watt AMPLIFIER KIT

This is a 3 valve 3 stage Amplifier for use with Gramophone, Microphone or Radio. Valve line-up is as follows: 6SL7, 6V6, 5Z4. Negative feed-back. Tone control. Voltage adjustment panel incorporated. 4 watts output. For operation on A.C. Mains 200/250 volts.

The complete Kit, includes every item down to the last nut and bolt, drilled and punched chassis, and comprehensive point-to-point wiring circuit diagram. Chassis dimensions: 8in. × 6in. × 2½in.

ALL COMPONENTS SUPPLIED ARE GUARANTEED FOR ONE YEAR



PRICE **£4 . 19 . 6** *Plus 2/6 PACKING CARRIAGE & INSUR.*

The Output Transformer supplied is for use with a loudspeaker of 3 ohms impedance and we would suggest that the output of the completed amplifier justifies the use of one of the latest W.B. H.F. Speakers which can be supplied as follows: 8in., 60/6; 9in., 67/-; 10in., 73/6. All plus 2/6 pkg. carr., ins.

Circuit Diagram only, available separately at 1/-.
To those who require this Amplifier ready-built we can supply it at £5/19/6, plus 3/6 pkg., carr., ins.

ACCUMULATORS—*BRAND NEW!*

2 v. 10 amp. Non spillable. Made by famous manufacturer. Dimensions: 1¾ in. sq. x 6¾ in. high, from base to top of terminal. 4/11 plus 9d. post/pkg.

SPECIAL ANNOUNCEMENT

Our *NEW GRAMOPHONE RECORD Dept.* is now open for both personal and mail order shoppers. Your order for records will receive the careful attention and prompt despatch for which we are noted. When ordering please state record numbers.

TERMS OF BUSINESS:
Cash with order. Under £1 please add 1/6 pkg. and post. Over £1 post free.

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Incorporates metal rectifier. Transformer is suitable for A.C. mains 200/250 volts. Charges either 12, 6 or 2 volt accumulator at 1 amp. Complete with circuit diagram. Price 22 6, plus 1/6 post and packing.

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Primaries tapped 200/250 v.
Type MT5B. To charge 12, 6, and 2v. at 2½ amps. 18/-.
Type MT5. To charge 12, 6 and 2v. at 4 amps. 22/-.
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METAL RECTIFIERS (FULL WAVE)

12 v. 1 amp. (Bridge Type), 7/6; 12 v. 2 amp., 11/3; 12 v. 3 amp., 12/-; 12 v. 4 amp., 15/-.
Suitable for use with the above transformers.

S.T.C. METAL RECTIFIERS

R.M.1.	125 v. 60 mA.	4/6
R.M.2.	125 v. 100 mA.	5/-
R.M.3.	125 v. 125 mA.	6/-
R.M.4.	250 v. 250 mA.	18/-
E.H.T. PENCIL RECTIFIERS—		
K3/50.	4 kV.	8/8
K3/100.	8.5 Kv.	14/8

METAL RECTIFIERS—*BRAND NEW!*

May be used in series or voltage doubling to give any required voltage, 300 v. 75 mA., 7/11. Also 250 v. 40 mA., 4/9. *Plus 6d. post/pkg.*

MAINS NOISE SUPPRESSOR KIT

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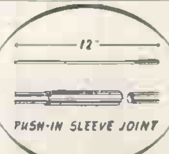

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All Steel coppered rods measuring 12in long ¼in. O.D. PRICE 1/9 per dozen, *plus 9d. post*; 18/- per gross, *plus 3/6 post.*

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Model B6.—Six Wavebands. Med. Long, 4 Short. (3 Band spread). 5 valves. Output 3½ watts	£15 15 0
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For A.C. Mains 100/120 and 200/250 volts.
The Double Feature chassis are supplied with separate Power Packs.

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PLESSEY 3-SPEED AUTO-CHANGER UNIT

This famous unit incorporates these special features:
Will play 10in. and 12in. Records intermixed. Latest turn-over pick-up head with separate sapphire stylus for L.P. and Standard Recordings. Either head can be brought into use by simply turning a switch. Height above Base Board 5¼in. Below Base Board 2½in. Overall dimensions of Board required 16in. × 12½in. BRAND NEW in manufacturer's carton, complete with instructions Limited quantity only available at £11/19/6 (normal List Price £23). Plus 5/- pkg., carr., ins.

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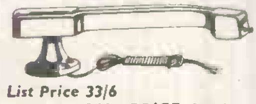

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COMMUNICATION RECEIVER R1155 for world-wide reception Can be heard at any time during shop hours. Air tested prior to despatch. Brand new at £11/19/6. A few slightly used at £7/19/6.
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TYPE C, with an 8in. R. & A. speaker in specially designed beautiful black crackle cabinet to match the receiver. Size 11½in. x 10½in. x 6in. A de Luxe job. Price £6/10/-, plus 3/6 carr.
SAVE £££££££'s. Deduct 10/- when purchasing any R1155 and power pack together.
POLICE, FIRE, WROTHAM. Special offer of R1132A receiver, covering 100-124 Mc/s., complete with 11 valves, circuit diagram, brand new condition and in original transit case and standard 19in. rack mounted power pack No. 3 for A.C. mains 200/250 volt operation together with inter-connecting lead, all tested and ready for immediate use, ONLY £7/5/-, plus 12/6 carr.
INDICATOR UNIT 182A. Contains 3—EF50, 1—5U4G, 4—SP61 and 6½in. C.R.T. type VCR517. This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a more pleasant tube colour. Contains in addition a very large assortment of pots, resistors condensers, etc. Tubes demonstrated. Supplied brand new (less relay) for only 67/6, plus 7/6 carr., in original transic case. Original circuit supplied free with each order, or 1/6 separately.
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SPECIAL BARGAIN of 3,500 moving coil 3½in. projection type meter for ONLY 15/-.
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EDDYSTONE "680" RECEIVER. Perfect. £28.
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- **ULTRA MODERN DESIGN RADIOGRAM,** complete with latest MODEL "COLLARO" 3-speed autochange unit, £31/10/-net trade and CHANGERS, LOUDSPEAKERS, MAGNETIC TAPE RECORDING EQUIPMENT, MICROPHONES, RESISTORS, CONDENSERS AND TUNING COILS, ETC.

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R.1. A 5-valve 3 W/B Superhet Receiver. A.C. mains 200/250 volt. Latest Mullard miniature valves; ECH42, EL41, EBL41, EF41 and EZ40 rectifier. Large edge-lit scale with printed English and Continental Station names. 4 controls, Volume off—on, Tone, Wavechange and Tuning. Chassis size 13½in. × 6in. × 2½in. vertical or horizontal, dial size 10 × 4½in. PRICE £9/19/6. **R.2.** A 5-valve 3W/B Superhet Receiver. Specification as for R.1 but size of chassis 11in. × 7in. × 2½in., scale 8in. square. Price £9/19/6.

TRADE ONLY SUPPLIED. EXPORT ENQUIRIES WELCOMED.

V.E.S. WHOLESALE SERVICES LTD.

11 GUNNERSBURY LANE, ACTON, W.3. *Telephone: ACOrn 5027*

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)

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.

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!!

THE NEW R.C. HIGH-FIDELITY AMPLIFIER. P.P. 6V6 output. Freq. 25—18,000 cps.—60 db at 6½ watts. Treble boost and cut—Brass boost—L.P. correction. Provision for Feeder Unit. Max. UNDISTORTED OUTPUT 8½ watts. Price 16 gns., plus 7/6.

NOW AVAILABLE. Kit of Parts, complete with fully illustrated instructions, 13 gns., plus 5/- carriage. Illustrated booklet available separately at 2/6.

THE NEW R.C. "UNIVERSAL" AMPLIFIER. A small 3-watt gramophone amplifier for 110-250 v. A.C./D.C. operation. Negative feed-back, low hum-level, chassis isolated. Suitable for either crystal or magnetic pick-up, and carbon or moving coil microphone. Two controls; Volume/on/off and variable tone control. Chassis size 8in. × 6in. × 2½in. Only £4/19/6, absolutely complete, plus 5/- packing and carriage.

ELPICO 4-WATT AMPLIFIER. AC/34. A small 3-valve 3-stage audio amplifier. A.C. 200/250 v. Output 4 watts. 2/3 ohm. Suitable for Radio, Microphone or Gramophone input. Volume and Tone Controls—Valve line-up: 6SL7, 6V6, 5Y3—Engraved front panel. Size of chassis only—7in. × 5in. × 2in. Overall height, 5½in. Price £7/10/. Each amplifier guaranteed for 12 months.

DECCA LIGHTWEIGHT PICK-UP. Complete with standard crystal insert, 32/6 only! Spare inserts for either Standard or LP 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 LP and Standard, £9/9/6 only!

METER RECTIFIERS. 1 mA. by G.E.C., at 11/6, also 5 mA. by Westinghouse at 8/6.

I.F. TRANSFORMERS. SPECIAL OFFER. All iron-cored 465 Kc/s. By Weymouth. Size 3½in. × 1½in. × 1½in., 8/6, or Phillips, size 2¾in. × 1½in. diameter (cylindrical), 7/6 pair. By Invicta—Cylindrical, 2½in. × 1½in. diameter, 8/6 pr. Also, our own special ultra-midget, size 1½in. × 13/16in. × 13/16in. Only 9/9 per pair. By Wearite, Type 501 and 502, 12/6 per pair.

THE "SUPERIOR" FOUR KIT. Our new four-valve receiver. A.C. mains. 200/250 v. M and Long Waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size: 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!

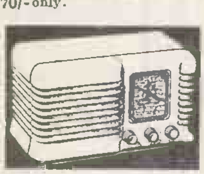
METERS

F.S.D.	Size		Type	Fitting	Price
250 microamp	D.C.	2¾in.	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.	Desk Type	27/6
5 mA.	D.C.	2in.	M.C.	F.Sq.	7/6
10 mA.	D.C.	2½in.	M.C.	R.P.	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
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.	7/6
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
15-0-15 volt	D.C.	2½in.	M.C.	F.R.	17/6
150 volt	D.C.	2in.	M.C.	F.R.	15/-

R.P. = Round projection. Thermo = Thermo-couple.
F.Sq. = Flush Square. M.C. = Moving Coil.
F.R. = Flush Round. M.I. = Moving Ion.

PORTABLE RECORD PLAYER CABINETS. Manufacturer's surplus, brand new. External dimensions 15in. × 16½in. × 8½in. deep. Finished attractively in dark brown rexine. Motor board cut for B.S.R. Monarch Changer, but will take any standard single player, also room for amplifier. Front view shows attractive grill for speaker. Leather carrying handle, two snap locks. Price 45/- only, plus 2/6 packing and carriage. Also available to take any standard single player—brown leatherette covered. Complete with lock and carrying handle. Size 15in. × 13½in. × 5½in., 22/6 only, plus 2/6 packing and carriage. We can now supply a modern style portable cabinet in brown lizard effect, uncut motor board, made to take any Collaro, Garrard, Plessey autochanger, etc. Price 69/6, plus 5/- packing and carriage. Also, in very handsome two-tone blue finish, a portable cabinet to take autochanger, with ample room for amplifier and 8in. speaker—Ultra-modern appearance. Price 82/6, plus 5/- P. & P.

45 Mc/s PYE STRIP—Brand new complete with 6 valves type EF50 and one EA50, 70/- only.



THE "ECONOMY FOUR" T.R.F. KIT. A three valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up, 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/15/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free—This is allowed if kit is purchased later—Please, 2/6 packing and carriage for complete kit.

CABINETS. We can supply a cabinet for every requirement, Table Model, Extension Speaker, Portable Player, Console, even for Projection T/V! Why not call and see us?

COLLARO RECORD CHANGERS, TYPE RC3/521. Complete with two CP27 crystal plug-in heads—one for standard and one for long-playing records. Brand new in sealed cartons at very low price of £9/19/6. Very few left! But we can also offer a few only later type RC3/531, with turn-over head, at £10/19/6.

VERY SPECIAL HIGH-QUALITY RADIOGRAM CHASSIS. We have purchased a limited quantity of these chassis by Britain's leading manufacturers of quality radiograms. Circuit is a 3-waveband five-valve superhet with A.V.C. Valves 6K8G frequency-changer, 6B8G I.F. amplifier, detector and A.V.C. 6SL7GT. Combined pick-up amplifier and A.F. Amplifier on Radio and Gram. 6V6G, beam-power output tetrode; 5Z4G full-wave rectifier, employing a special circuit for gramophone pre-amplification. A continuously variable tone-control provides ample treble correction without accentuating the bass. Large glass dial, horizontal tuning measuring 11in. × 3½in. Chassis measurement: 14½in. × 9in. × 8in. This is a superior chassis designed to sell originally in a radiogram costing £79. Our price is £13/19/6 only, tax paid, plus 5/- packing and carriage. We will gladly demonstrate this chassis or any other working item from our stocks to personal callers.

CONSOLE RADIOGRAM CABINETS. This is an attractive figured walnut cabinet, originally intended for the above superhet chassis.

It is constructed to take the chassis in the top part, dial being permanently visible through sloping front. Underneath the gramophone unit is housed in a drawer which slides forward on steel runners—when required for use. Total cabinet measurement is 36in. high by 20in. wide by 16in. deep. Our price for the cabinet only is £9/17/6, plus 10/- packing and carriage.

● The Collaro changer listed above fits neatly in drawer of this cabinet! ●

We can supply the three units—cabinet, chassis and changer, if purchased together at one time—at a price of £32/10/-, plus 20/- packing and carriage. May we suggest an 8in. Elac P.M. Speaker at 17/6? Fully assembled model being demonstrated at our shop premises.

G.E.C. RECORDING TAPE. 1,200ft. on metal spool, at bargain price of 17/6 per spool.

INTRODUCING L.T. RECTIFIERS TYPE R.K. A newly manufactured range, fully guaranteed for 12 months, 6 v. 1 a. Centre tapped, 5/- each.

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.

LATEST PLESSEY 3-SPEED AUTO-CHANGER. We have just purchased a very limited quantity only of these small A.C. changers. Requires only 5in. above and 2½in. below motor board. Complete with turnover crystal head, £9/19/6 only, tax paid. Our portable cabinet at 45/- can very simply be adapted to take this changer!

LIGHTWEIGHT CRYSTAL HEADPHONES. Brand new, by Rothermel. List price 70/-. Our Price 25/-!! Limited supply.

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.

ACOS CRYSTAL MICROPHONE INSERTS. Brand new, no transformer required, 8/6 ea. Also we have a few of these taken out of units in good condition at 4/6 only.

TWO GANG .0005 mfd. Absolutely standard, with feet by Wingrove & Rogers. Long spindle, 6/6 ea.

THREE GANG DITTO, less mounting feet. 6/6 only!

22 SET POWER UNIT NO. 4MKI ZA10478—Complete with 4 metal rectifiers each 250 v. 60 m/A. Two 12 v. 4 pin Mallory Vibrators, transformers, condensers, resistors, signal 1 amp. indicator, etc., etc., in good condition. Complete in metal box size 10½in. × 6in. × 8in. Weight 19lb. 27/6 plus 5/- P. & P.

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 1.30 p.m. on Saturday.

Wireless World Classified Advertisements

Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies : Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day : May 1954 issue, Monday, March 29th. 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.

FOR SALE AND WANTED ADVERTISEMENT FORM

TURN TO PAGE NO. 163

NEW RECEIVERS AND AMPLIFIERS

ALL types of audio equipment designed and built to order.—Bernard J. Brown, 33, Goldhawk Rd., London, W.12. [0024

QUALITY amplifiers, bass and treble controls; s.a.e. list.—Parker, 22, Tybenham Rd., Merton Park, S.W.19. [2478

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

F.M. Unit, Amos and Johnstone; £5.—Box 3496. [2535

SOUND SALES.—DX Plus One tuner, £10 o.n.o.—Houlsom, 6, Penmere Rd., Penzance. [2621

QUAD amplifier with control unit, radio tuner, and Acoustical Corner Ribbon speaker, cost £154/10, sell £60 or offer.—Box 3835. [2612

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

HALLICRAFTER SX28 Super Skyrider 230/115v, in grey cabinet with unmounted 8inch LS; good working order except ANL; £25; London area.—Box 3595. [2550

PHILCO Mystery Control Receiver 116RX chassis, radio control transmitter, auto trans., complete and full working order; will automatically change stations and alter volume level from controller in another room; no wires, 15 valves, push-pull, 12in concert speaker; offers.—Box 3890. [2620

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND WANTED

DENCO coil turret CT4 and Denco communication receiver DCR19 required.—Box 3320. [2495

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 400VA alt. or rotary converters, by return post; state which required; terms c.w.o., pro forma invoice c.o.d. (post goods only).

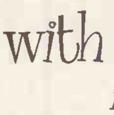
T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

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

Michael Faraday (1791-1867)
The founder of modern electrical science

Tradition moves with the times....

It is traditional that a new science must be born in a small back room, and the phrase once conjured up visions of a burning faith, beset by the snags of crude apparatus, and a succession of failures crowned by ultimate — and sometimes accidental — success. The research worker today backs his theory with only the finest equipment; and at the birth of the science of electronics, Partridge Transformers were not only in on the ground floor, but right there, in the small back room.



P 3064—the latest development in Audio Transformers, Technical data sheet No. 5 on request.

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PARTRIDGE TRANSFORMERS LTD
TOLWORTH SURREY

NEW DYNAMOS, MOTORS, ETC.

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.

DEISEL electric plants, special offer.—Diesel electric generating plants, comprising a Petter type AV2 twin cylinder engine, direct coupled to a 6kva 230v, single phase alternator with push-button remote control starting and stopping; limited number only owing to frustrated export order; price £280 each delivered anywhere in United Kingdom.

CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

E.D.C. rotary converter, fitted radio filter, input 110 A.C., output 220 A.C., 1 amp.; guaranteed condition; £20, nearest.—Nicholls, Dolwen, Llandewy, Radnorshire. [2447

ROTARY converters (3) for sale, 200-230 volts input, 200v output, D.C. to A.C.; also number of sundry starters and transformers; available for inspection Marylebone.—Box 3694. [2575

ROTARY converter by Electro-Dynamic, 200v d.c. to 230v a.c., 50 cycles, with smoother for radio, mounted on rubber, in box, in perfect order, 6 months' use since complete overhaul by makers, bill available; £15.—H. H. Salisbury, 5, Hatfield Rd., Northallerton. [2515

TEST EQUIPMENT—SURPLUS AND SECONDHAND

VOLTMETER, electrostatic, 6kV; £5.—Below.

OSCILLATOR, AVO all-wave model; £15.—Below.

VALVE tester, Taylor model 45; £12.—Below.

ALL in working order.

H. S. CAWSEY, Station Approach, West Byfleet, Surrey. Tel. Byfleet 557. [2480

AS new B.C.221; best offers.—Hawkins, 55, Tonbridge Rd., Maidstone, Kent. [2528

DUMONT Model 241 5in laboratory oscilloscope; offers over £30.—Box 3891. [2626

B.P.L. signal generator, 100kc/s to 30mc/s, dummy aerial and leads, as new.—Offers Wood, 86, Bargate, Grimsby. [2593

AVO valve tester, oscillator, bridge, Taylor 88A, G.E.C. miniscope and wobbulator, Roberts analizer; s.a.e.—Bond, 40, Newdigate Rd., Coventry. [2618

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0056

NEW Advance E.2 sig/gen. with maker's guarantee, £20; Taylor 47A valve-tester including multi-range meter, 3 adaptors, valve manual, perfect, £15; new Morphy-Richards pyrometer (for thermostat setting of irons) £6.—32, Borough St., Brighton. [2636

70CM enthusiasts! A must that you have been waiting for a long time, ex A.M. test sets, comprising complete Antenna kit with adjustable elements and Parabolic reflector (scanners) covering 300-450mc/s, mounted on the top of black crackle case containing RL 18 oscillator unit tunable from 300-450mc/s, fully calibrated and fitted in heavy silvered screening box, with variable output, metering jack, etc., etc., a really beautiful piece of equipment, our special price, £5; despatched per rail in special transit case to any address in England or Wales 7/6 extra.—Walton's Wireless Stores, 48, Stafford St. Wolverhampton. [0101

NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder, models 2A and 2B now available, from 76gns.

WEARITE tape decks and component parts.

DISC recording machines and blank discs.

MAGNETIC tape—Ferrograph, Scotch-boy, etc.

RESLO ribbon microphones and stands.

EVERYTHING for the professional recording studio.

SOUND DISCS (SUPPLIES), Ltd., 178, Bispham Rd., Southport, Lancs Tel. 88153. [2314

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., manufacturers of high quality portable and console magnetic tape recorders for professional and amateur use; full details on application.

BICKFORD Rd., Witton, Birmingham, 6. East 0822. [2056

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. [2638

NEW GRAMOPHONE AND SOUND EQUIPMENT

HIGH fidelity tuner units, a new sensitive 6-valve self-powered model, with A.F. stage, covers both Wrotham F.M. senders, now modulated with Third and Home; the only answer to background noise and with full frequency range output and contrast expansion; price £17/10; note display advert. also; trade supplied.—Bel Sound Products, Co., Mfg. Electronic Engrs., Marlborough Yard, N.19. [0185

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

PRACTICALLY new Grundig tape recording machine; to clear £60.—Box 3754. [2579

EXCEL. tape recorder (1950), two-speed; £40. —Spivey, Healey Cottage, Batley, Yorks. [2600

2 B.S.R. disc recorders, 15ohm, reasonable.—31, Peel St., Eccles, Manchester. Eccles 1624. [0122

COMPLETE 3-speed tape recorder, with moving coil microphone; £30; London.—Box 3917. [2643

MASSIVE experimental bronze turntable, cheap.—Details from Cluff, 2, Beech Walk, N.W.7. [2615

TAPE recorders, shop soiled, Emicorda 90gns reduced to 70gns; Sound Mirror, 70gs reduced to 50gns.—Tel. Ley. 1362. [2402

FOR sale, 2 Wirek wire recorders model B2, with accessories, in excellent condition; will accept reasonable offer.—R. H., 109, Borough Rd., S.E.1. [2476

R.C.A. portable disc recorder complete with playback, ball microphone, spares and blanks; £25.—57, Broomleaf Rd., Farnham, Surrey. [2517

DISC recording apparatus for sale, 2 Presto portables and 1 studio model, accessories, etc.—Details on request John King (Films), Ltd., East St., Brighton. [2487

3 G.E.C., 42in horns, as new, £7 each; Truvox tape deck, £15; Elpico AC54 tape amplifier, £10; Trusound PR7 tape deck, £13 or offers for quick sale, all unused.—Box 3916. [2642

4 PARALLEL tracking groove locators with B.T.H. pick-up heads, as used by the B.B.C., in first-class condition; £20 for the 4.—Visual Education, Ltd., 9, Upper Berkeley St., London, W.1. [2651

RIM drive disc recording motor, £6/10; packet 12 stellite cutters, 9/-; 15Ω output/2.500Ω cutterhead matching transformer, 50/-; E.M.I. cutterhead, £4/10; C.J.R. tape recorder (prof. model), £85; tape and gram motors, discs, etc.; s.a.e. please. Wanted, disc recorder.—Box 3293. [2489

M.S.S. P.R.A. disc recorder with speaker, Vitavox microphone, sapphires, discs, etc.; perfect order, ready to operate; ideal for direct recording or dubbing permanent discs from tape, can also function as P.A. amplifier; apparatus recently passed by makers; private sale, £65.—Box 3759. [2581

ANY of you tape types building your own? Although we deal primarily in sub-standard cine equipment, it's quite possible that our "Bits and Pieces" list might be useful: s.a.e. please. We also wish to buy tape desks, recorder components, etc.—Burgess Lane & Co., Block J, Sunleigh Works Sunleigh Rd., Wembley. Tel. Wem 2378 [0253

MSS disc recorder, £19/10; MSS amplifier, £12/10; E.M.I. cutter head, £4/15; 100 stellite cutters, 50/-; 200w Valradio D.C./A.C. converter, 170/-; disc recording motor, 135/-; T.R.F. tuner, 95/-; leadscrew assembly, turntable, record player, tape recorder, gram motor (3-speed shaft), speakers, mikes, infinitely variable, reversible leadscrew gear box (cost £25), 110/-; Bull capacitator start induction motor, 117/6; 7w A.C./D.C. amplifier, 99/6; pneumatic dashpot, 8/9; infra-red lamp, 72/-; etc.; s.a.e. please.—Box 3888. [2614

TRANSMITTERS

SHORTWAVE C.W. transmitter 3.5-16 Mc/s, 1 kW; £350 only; HRO receivers unused.—Avinash Electronic, Ltd., 27, Oldham Rd., London, W.10. Tel. Ladbroke 2688. [2518

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TELEVISION.—New ¾in sq canned cored formers, ea. 2/3; parts for the 70cm converter, 45 mc/s output, e.g., coilsets, 25/-; transistors, junction, 52/6, Mullard; also crystals with whiskers, per set of 6, £4.—Bel, Marlborough Yard, N.19. Arc. 5078. [0187

NEW COMPONENTS

FLUORESCENT 80 watt 230v complete ballast unit, 39/6; 80w brick choke and starter lamp, 14/6; 40 watt complete ballast 230v, 28/9; complete fluorescent fittings from 45/-; metal rectifiers, 12v 4amp f/w bridge, 13/9; suitable charger transformer, 16/6; 0-4 ampmeter, 8/6; brand new small radio cabinets, 16/6; multi-ratio output transformers, Goodmans, 7/6; Diamond H switches, 4/6; 4-pole cooker switches, 5/-; charge your dry cell batteries with our special charger from mains, complete unit, 14/9; new G.E.C. ½hp electric motors, 230v S/p, £4/16.—Malden Transformer Supplies, Rear of 5, Coombe Rd., New Malden, Surrey. Mal. 2655 (Longside of Malden S.R. Station). [0038

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

FOR really good results you can do no better than use Osmor coils and coilpacks, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new coil-data leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, all Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1.
OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9. [0046

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; 32+32, 275v+50mf 25v, 1×3, lug, 3/6; 60+100, 275v, 1⅜×3, lug, 4/6; 100, 275/350v, 1⅛×3, clip, 3/6; 32+12, 350v, 1⅜×2, clip, 4/-; 16+16+16, 350v, 1⅜×2, clip, 1⅜×2 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, 450, ⅞×2, tag, 2/9; 20, 450v, 1×2, lug, 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, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 50, 12v, ¾×1⅝, 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, 1⅛×2, clip, 4/-; 40+40, 275v, 1⅜×2, clip, 3/3; 24+24+16, 350/425v, 1⅜×2, clip, 4/9; 60+200, 275/350v, 1¾×4½, clip, 6/6; 4, 150v, ⅝×1¾, clip, 1/1; 500, 12v, 1⅜×2¾, clip, 2/-; 8, 350v, ¾×2, clip, 1/9; 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, ¾×1¾, tag, 1/6; 2, 350v, ¾×1¾, tag, 1/3; 1,000, 6v, 1×2¾, clip, 2/9; 8, 450v, ¾×2, clip, 1/9; 6,000, 6v, 1⅜×3, clip, 4/9; 32+32 450/525v, 1⅛in×3in, wire ended, 5/6; all ali cans, some with sleeves all voltages, WKG. surge where marked new stock, guaranteed.
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PERSONAL receivers, 3 valve T.R.F. using IT4s, 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-contained 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.
5 mA meters, moving coil, Bakelite case, 2in square, flush mounting, new, boxed; 8/- post paid.
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RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 155. [0016

CONDENSERS, 1st grade, new surplus silver mica, 350v, 45, 50, 58, 60, 70, 140, 200, 1,900, 4,000 p.f., 12/6 per 100, £5 per 1,000 (values as reqd.)
CONDENSERS, 2nd grade, slightly marked, mixed values, 5-4,000 p.f. (our choice), 7/6 per 100, £3 per 1,000; mail orders only.—J. Duck, 97, Belgrave Rd., Ilford, Essex. [2572

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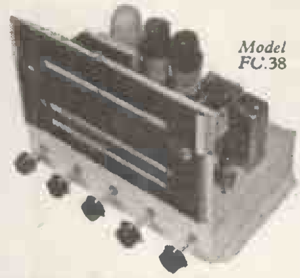

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MODEL FC.38 An 8 valve Superheterodyne chassis giving 8 watts push-pull output with negative feedback and separate BASS and TREBLE lift controls. Flywheel tuning and a magic eye. Three wavebands covering 16-50 metres, 190-550 metres and 1,000-2,000 metres.
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WANTED, Wilcox Gay V.F.O. units in new or modified condition.
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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

COIL winding machines, Douglas No. 3 or similiar preferred.—Walinst, Derwent 4421. [2592

WANTED, R.C.A. transmitters, all types or any R.C.A components, including chassis and metal work.
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WANTED, American microphone assemblies type ANB-M-CI.—Epta Engineering Co., 100, Chamberlayne Rd., Kensal Rise, N.W.10. Tel. Ladbroke 4089. [2617

NO. 10 headsets or No. 13 microphones, large or small quantities required top prices paid.—Industrial Suppliers (Cambridge), Ltd., 15a-17, Brecknock Rd., London, N.7. Gulliver 5891. [2018

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WANTED, BC-610 Hallicrafters, RCA-4336 transmitters SX-28, AR-88, S-27, HRO receivers and spare parts for above; best prices. —P.C.A. Radio, Office and Works, Beavor Lane, Hammersmith W.6. Tel. Riv. 8006. [0080

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

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VALVES wanted, Marconi/Osram MSP4/VMP4/VMS4B.—24, Mill Rd.; Haverhill. [2589

ALL types of valves required for cash; state quantity and condition.—Bentley, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [2610

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WALNUT radiogram cabinets; details.—Cabinetware, 1a, Heyes St., Blackburn.

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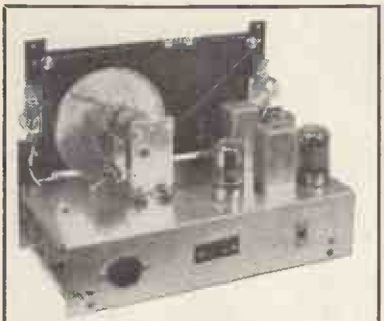

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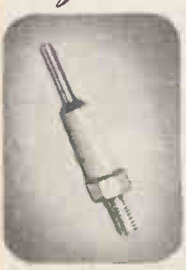

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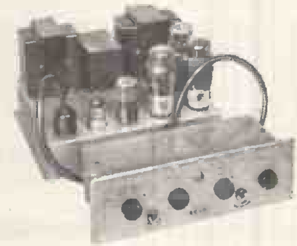

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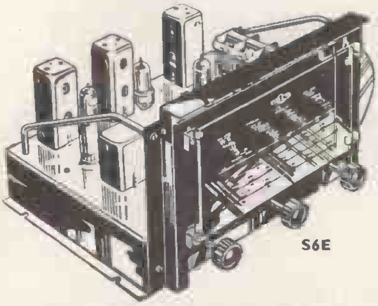

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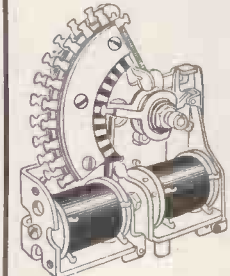

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SITUATIONS VACANT

ROTHAMSTED Experimental Station.

DEPARTMENT of Statistics.
APPLICATIONS are invited for the post of Technician with experience of electronic equipment to assist in the maintenance and servicing of electronic computer. Experience with this type of equipment desirable but not essential. Salary, according to age and experience, in the range £595×£25—£738.
APPLICANTS should write to the Secretary, Rothamsted Experimental Station, Harpenden, Herts, giving full details of age, education, qualifications and experience, and the names of two referees. [2563

MITCHAM WORKS, Ltd., require a

TECHNICAL Assistant with ability to carry out without close supervision measurements on broadcast and/or television receivers and associated components. Commencing salary in accordance with age, qualifications and experience, but not less than £530 p.a. Applicants, who should be aged 25 to 35 and educated in radio to Grad. I.E.E. standard, should write to the Personnel Officer, Mitcham Works, Ltd., New Rd., Mitcham Junction, Surrey, quoting Ref. G.1. [2481

DE HAVILLAND PROPELLERS, Ltd.

INSTALLATION engineers are urgently required for work on the following projects:—
REF. General propeller development on
B.1 Hydraulic and mechanical engineering.
B.2 Scanner development.
B.3 Cold air units—knowledge of thermodynamics required.
APPLICANTS must have had previous experience in engineering but specialised training for these positions will be given to otherwise suitable candidates.
WRITE in detail or send a postcard for Application Form, quoting reference number of position sought, to The Personnel Dept. (Technical Employment), De Havilland Propellers, Ltd., Hatfield, Herts. [2383

NORTHAMPTON POLYTECHNIC, E.C.1.

INSTRUMENT DEPARTMENT.
INSTRUMENT workshop Technicians required; one with experience of electronic chassis wiring and assembly; permanent; 44-hour week; varied interesting work; 5 weeks paid holidays; scale £300 p.a. at 21 to £393 at 26; write with full particulars to Secretary. [2605

SENIOR Wireless Officer required by the

WESTERN Pacific High Commission for one tour of 30 months in the first instance. Salary, etc., in scale equivalent to £855 rising to £945 a year. Free passages, liberal leave on full salary, quarters available at moderate rental. Candidates, preferably holding first-class P.M.G. Certificate should be expert telegraphists, capable of operating a commercial network and of carrying out routine maintenance.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1 State age, name in block letters, full qualifications and experience and quote M2C/30399/WF. [2544

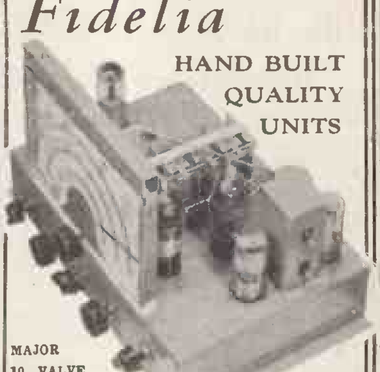
THE Royal Technical College, Glasgow.

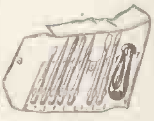
NATURAL Philosophy Department.
TECHNICIAN, on salary scale £420 to £510, for duties involving construction and maintenance of electronic equipment. National Certificate or equivalent qualification required. Applications by letter to Professor of Natural Philosophy. [2559

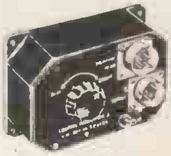
COMMISSIONERS of Northern Lighthouses.

APPLICATIONS are invited for a post as an assistant on the Radio Engineer's staff for duties in connection with erection, maintenance and development of radio navigational aids and communications. Applicants should be fully conversant with all classes of radio, radar and electronic aids, and must have passed the graduate examination of the Institute of Electrical Engineers, or hold City and Guild groups Certificates, or equivalent. Salary scale £635 to £980 per annum, linked to age at entry between 25 and 34 years, maximum starting pay is at age 34: i.e., £880 per annum. Superannuation conditions are similar to those in the Civil Service.—Applicants should apply in writing to the Secretary, Northern Lighthouse Board, 84, George St., Edinburgh, 2, stating age, qualifications, experience and enclosing copies of testimonials. [2543

UNIVERSITY of London. Post-Graduate Medical School.
ELECTRONIC Engineer required in the Biophysics laboratories to assist in development of instruments for medical research. Field covered includes electrocardiography, servo-operated resuscitators, optical methods of following blood conditions, strain gauge methods of pressure recording and other applications of electromechano transducers and recording devices for studying conditions in the human subject. The candidate should have a knowledge of D.C. amplifier circuits. The selected candidate, who must be under 33 years of age, will be a member of a small group, in well-equipped laboratories, with good workshop facilities, and must be capable of independent work under limited supervision and guidance. Permanent position for the right person. Salary £460-£540, or up to £625 if the candidate holds a Higher National Certificate or its equivalent. Superannuation under the University of London Pension Scheme after six months' probation.
APPLICATION forms from The Dean, Post-Graduate Medical School, Ducane Road, W.12. [2649







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SITUATIONS VACANT

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WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/30305/WF. [2641

TELECOMMUNICATIONS Installers required by the NIGERIA Government Posts and Telegraphs Department for one tour of 12-24 months in the first instance. Salary, etc., £1,270 a year. Gratuity £150 a year. Outfit allowance £60. Free passage for officer and wife. Assistance towards cost of children's passages or grant of up to £150 annually for maintenance in U.K. Liberal leave on full salary.
(a) VERY high frequency radio (M2C/30360/WF). Candidates must have a sound knowledge of radio principles with particular knowledge of V.H.F. radio and preferably some knowledge of telephone terminal equipment. They should have had experience of commercial radio installation work and must be prepared to travel extensively in Nigeria.
(b) HIGH frequency radio (M2C/30364/WF). Candidates must have a sound knowledge of radio principles and of modern H.F. radio. They should have had considerable experience of radio installation work, including the installation of transmitters up to 5KW output, receivers, radio telephone terminals, frequency shift keying and teleprinter equipment.
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WIRELESS Station Superintendent required by the NIGERIA Government Posts and Telegraphs Department for one tour of 18 to 24 months in the first instance. Option of appointment (a) on temporary terms with salary, etc., according to experience in scale £864 rising to £1,392 a year and gratuity of up to £150 a year, or (b) with prospect of pensionable employment with salary, etc., in scale £750 rising to £1,175 a year. Outfit allowance £60. Free passages for officer and wife. Assistance towards cost of children's passages or grant of up to £150 annually for their maintenance in the U.K. Liberal leave on full salary. Candidates must have had wide practical experience of modern radio techniques and equipment, in particular V.H.F. equipment, and preferably also V.H.F. multi-channel equipment.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/28927/WF. [2556

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BRITISH OVERSEAS AIRWAYS CORPORATION urgently require:—
RADIO mechanics in their radio maintenance unit at London Airport, experienced in overhaul and maintenance of airborne radio and radar equipment; rates of pay 3/6 p.hr., plus 3d p.hr. bonus, attracting proficiency pay up to 3d p.hr.; 44-hr. week; possibly shift work; generous pension, sickness and holiday entitlement schemes; canteen facilities.—Call or write Staff Supt. (Recruitment), London Airport, Bath Rd., Hounslow, Middx. [2533

DEVELOPMENT engineer required, design experience of HF and VHF transmitters essential.
GOOD theoretical background and knowledge of production methods desirable.
APPLY with full details to—Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [2343

TELEVISION Radio Engineer, addition to staff; £10 per week.—K & B Radio Services, Ltd., S.E.20. Syd. 8119. [2352

RADIO & television service engineers for city factory; 5-day week; canteen.—Apply A. J. Balcombe, Ltd., 47, Tabernacle St., E.C.2. [2645

MURPHY RADIO, Ltd., wish to appoint senior design engineers to lead teams in their radio and television laboratories.
SUCCESSFUL applicants must possess good academic qualifications with some research experience and several years' service in an industrial organization engaged in television or allied fields.
THE posts are pensionable and the salaries paid will be commensurate with the high standard of qualification required.
APPLICATIONS, which will be treated in strict confidence, should be addressed to the Chief Designer, Murphy Radio, Ltd., Welwyn Garden City, Herts. [2614

TV/Radio service engineer, old established business, seaside holiday resort; finest test equipment, initiative encouraged; salary £500-£600 p.a.—Gerry 36, Bank St., Newquay. [2609

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6 or 12 VOLT RECTIFIERS at 4 amps output, complete with suitable transformer, 200/230 volts input, 45/- each, post 1/6.

12/24 VOLT RECTIFIERS, at 4 amps, with suitable Mains Transformer, 200/230 volts input, 55/- each.

MAINS TRANSFORMERS (NEW), input 200/250 volts in steps of 10 volts, output 350/0/350 volts, 180 m/amps, 4 volts 4 amps, 5 volts 3 amps, 6.3 volts 4 amps, 45/- each, post 1/6; another 350/0/350 volts 180 m/amps, 6.3 volts 8 amps, 0/4/5 volts 4 amps, 45/- each, post 1/6; another 500/0/500 volts 150 amps, 4 volts 4 amps C.T., 6.3 volts 4 amps, C.T., 5 volts 3 amps, 47/6 each, post 1/6; another 425/0/425 volts 160 m/amps, 6.3 volts 4 amps, C.T. twice 5 volts 3 amps, 47/6 each, post 1/6.

MAINS TRANSFORMERS (NEW), suitable for spot welding, input 200/250 volts, in steps of 10 volts, output suitably tapped for a combination of either 2/4/6/8/10 or 12 volts 50/70 amps, 95/- each, carr. 7/6.

MAINS TRANSFORMERS, 200/250 volts input, output a combination of 6, 12, 18, 24, 30 and 36 volts at 6 amps, 45/- each, post 1/6.

MAINS TRANSFORMERS, Input 180/250 volts, output 435/0/435 volts, 250 m/amps, 6.3 volts 10 amps 6.3 volts 8 amps, 6.3 volts 8 amps, 5 volts 6 amps, 65/- each.

MAINS TRANSFORMERS, 200-250 volts input, output 400/0/400 volts, 280 m/amps, 6.3 v. 8 a., 2 v. 3 a., 5 v. 3 a., 4 v. 2 a., 4 v. 2 a., the last two heaters insulated at 8,000 volts, 85/- each; another 200/230 volts input, output tapped 0, 9, 18 volts at 4 amps, 25/- each, post 1/-.

MAINS TRANSFORMERS, input 200/250 volts, output 45/50 volts, 70 amps, suitable for arc welding, £15 each; another 70 volts, 50 amps, £15 each.

MAINS TRANSFORMERS (NEW), 200/250 volts input in steps of 10 volts, output 0, 6, 12, 24 volts 6 amps, 42/6 each, post 1/6. Another, as above but 10-12 amps, 55/- each, post 1/6; another as above but 25/30 amps, 75/- each, carriage 3/6; another, input as above, output 0/18/30/36 volts 6 amps, 47/6 each, post 1/6.

Ex-U.S.A. ROTARY CONVERTERS, 12 volts D.C. input, outputs 500 volts 50 m/a., 275 v. 100 m/a. Complete with smoothing, 22/6 each, carriage 2/6, as new.

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W. T. SELLEY, *Chief Education Officer.*

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(a) DESIGNER draughtsman with several years' experience of electronic equipment and light electro mechanical assemblies.

(b) DRAUGHTSMAN-CHECKER with good knowledge of modern workshop practice and several years' drawing office experience preferably in light mechanical engineering with electrical bias.

(c) JUNIOR draughtsmen for work on design and detail of light engineering products associated with electronics; O.N.C. desirable.

(d) DRAUGHTSMAN with good workshop knowledge to carry out modifications to production drawings.

(e) DRAUGHTSMAN or woman for preparation of electronic circuit diagrams; good circuitry and components knowledge essential and preferably knowledge of "Blue Book."

ALL these positions offer excellent opportunities to active men who are looking for experience and promotion in a new and expanding industry.—Applications to Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. 1119A. [2540

ENGINEER or physicist with degree or equivalent qualification reqd. for interesting development work; two vacancies exist calling for the following experience:—
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(B) AUDIO frequency design involving feedback amplifiers and filters.
PLEASE write with full details to Personnel Dept. (ED/145), E.M.I., Eng. Dev., Ltd., Hayes, Middx. [2597

A TELECOMMUNICATIONS firm in the north dealing with multi-channel carrier equipment for use on lines has a number of vacancies in the following fields:
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(2) LABORATORY development engineers of senior grade.
(3) EQUIPMENT design engineers.
(4) TECHNICAL writer for preparation of handbooks; services experience an advantage; age of secondary importance.
THE positions are on the established staff of the company, with contributory pension scheme, the usual staff conditions.
APPLICANTS are invited to write, giving full particulars of experience, qualifications and age to—Box 532, Dorland Advertising, Ltd., 18-20, Regent St., London, S.W.1. [2347

ELECTRONIC engineers are required by the G.E.C. Stanmore Laboratories, Brown's Lane Division, for work in their Development Laboratories in the following fields:—
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2. Microwave circuits.
3. Pulse circuits.
4. General radar circuits and C.R.T. radar presentation.
5. Preparation of G.W. equipments for trials.
6. Stabilised radar aerials.
APPLICANTS should be experienced in at least one of the above fields, and also for preference should have a minimum of two years' experience in the development of equipment for the Services. Degree or equivalent desirable but not essential. The situations vacant are for permanent staff with good salaries for the right men.—Reply to the Personnel Manager (Ref. WW/MW), The Grove, Stanmore Common, Stanmore, Middlesex, stating age, qualifications and experience. [2564

EXPERIENCED technician required for installation test and servicing of industrial electronic equip.; good salary offered; pension scheme.—Full details to Box 3471. [2529

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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

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SALARY according to qualifications and experience; modern factory, sports, social and canteen facilities; single board available.
PLEASE apply, stating age, qualifications and experience to the Personnel Manager. [2342

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WRITE full details of education, experience and expected commencing salary to—Box 2676. [2332

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

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BUSH RADIO, Ltd., have a number of vacancies in their expanding laboratories at Plymouth. Applicants for posts (a) and (b) should preferably hold a B.Sc. or equivalent qualification in Physics or Engineering.
(a) A RESEARCH and development engineer and a junior development engineer for work in new television and circuit fields.
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(a) A DEVELOPMENT Engineer to initiate design and engineering layout of domestic radio receivers for the export market. Five years' experience of design of domestic receivers, and familiarity with working with drawing office and production departments, are required.
PLEASANT laboratory, good prospects, pension scheme. Interviews in London or Plymouth. Write giving full details and salary required to the Chief Engineer, **Bush Radio, Ltd.**, Power Rd., Chiswick, W.4. [2483

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DRAUGHTSMAN.—Experienced electronics circuit draughtsman required for new Crawley factory; house available; apply in writing.—Redifon, Ltd., 59, Webber St., London, S.E.1. [2498

AN engineer (H.N.C.) is required in London for training as test engineer on special oscillators and amplifiers; minimum starting salary £600 p.a.; write giving age and full experience to—Box 3312. [2494

DEVELOPMENT engineer required for electronic instruments; written applications invited containing details of age, education, training and experience to—Multitone Electric Co., Ltd., 223/7, St. John St., E.C.1. [2492

RADIO/TELEVISION engineer, qualified, required by West End Murphy dealers, able to drive. permanent situation with top wages to suitable applicant; pension scheme; half-day Saturday.—Larg & Sons, Ltd., 77, High Holborn, W.C.1. [2475

DESIGNER/Draughtsman with experience of electronic equipment required by London radio manufacturers; progressive post to applicant with experience and initiative; applications treated confidentially.—Box 3415. [2510

EXPERIENCED television receiver development engineers required; London Laboratory; progressive positions offered to suitable applicants; vacancies also for TV service engineers.
APPLY, Masteradio, Ltd, Fitzroy Place, N.W.1. [2511

TECHNICAL author (male), aged 21-25, reqd. on production of handbooks for domestic radio, T.V. and other electronic equipment; West Middx.—Write giving full details to Box 3450. [2525

TELEVISION Radio Service Engineer required, fully experienced all makes, able to drive; good wages, permanent position.—A. G. Allen & Co., Ltd., 3-4, Bridge Rd., Wembley Park, Tel. Arn. 2261. [2631

QUALIFIED Radio Engineer, also capable of installing and maintaining V.H.F. and television equipment, required by Bermuda firm on 3-year contract; £18 weekly wage; no income tax; passage paid according to contract; please address all replies to—Box 3907. [2632

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

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

JUNIOR draughtsman wanted with about 3 years experience preferably in light engineering and electronics; some workshop experience advantageous.—Applications in writing invited by Multitone Electric Co., Ltd., 223/7, St. John St., E.C.1. [2493

RADIO engineers required to work in test department, preference given to applicants with experience of laboratory instruments; opportunity for ex-service radio and radar mechanics.—Apply Personnel Officer, Airmec, Ltd., High Wycombe, Bucks. [2504

A LARGE engineering organization in S.W. Lancs in the light electrical field has several vacancies for development engineers for work on circuit design in telecommunications utilizing the properties and potentialities of semi-conducting materials.
APPLICANTS are invited to write to Box No. 606, Dorland Advertising, Ltd., 18/20, Regent St., London, S.W.1, giving details of age, qualifications, experience and approximate salary sought; experience in these fields is desirable, but consideration will be given to applicants who are interested in the scope offered by such materials.
POSITIONS will be on established staff status with contributory pension fund and usual staff conditions. [2585

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SITUATIONS VACANT

DRAWING OFFICE TRAINING, MARCONI'S WIRELESS TELEGRAPH CO, have a limited number of vacancies at their Drawing Office School as from February, 1954, onwards. A SIX months' concentrated course, with fixed salary, at the Drawing Office School, Chelmsford.
AFTER successful completion, permanent posts will be available in the Company's Drawing Offices at Chelmsford or Acton, London.
QUALIFICATIONS, age limit 28, must have workshop experience; preferably have O.N.C., must have drawing ability; write giving full details to—Dept. C.P.S., 336/7, Strand, W.C.2, quoting ref. 171B. [2514

TECHNICAL representative required by well-known radio and television component manufacturers to maintain existing connections with set makers, etc.; previous experience in this field preferred.—Write, giving full details. to Box 3794. [2596

DRAUGHTSMAN.—We have a vacancy for an electronic draughtsman with experience of radio and radar circuitry or an electro-mechanical draughtsman interested in light engineering.—Apply in writing to R. Y. Pickering & Co., Ltd., Wishaw, Lanarkshire. [2538

X-RAY service technician required for London and the Home Counties; practical experience with X-ray apparatus essential.—Write, giving details of age, experience and salary required, to Watson & Sons (Electro-Medical), Ltd., East Lane, North Wembley. [2586

GLASSBLOWER, aged 20-25, required for Research Laboratories; all-round experience in hard glass essential; some knowledge of lathe work advantageous; good opening for keen young man.—Apply in person or write to Personnel Dept., E.M.I., Ltd., Hayes, Middx. [2613

ELECTRONIC engineer, H.N.C., with design experience, including radio communication work, required for small organisation on South Coast; first-class opportunity for keen young engineer for project development; state age, qualifications and salary required.—Box 3834. [2608

RADIO and television field service and bench service engineers required, with first-class experience; excellent opportunities in new service factory with good working conditions and good salary.—Write or telephone Leytonia Radio, Ltd., 784/786, High Rd., Leyton, E.10. Tel. Leytonstone 3003. [2459

DRAUGHTSMAN with some experience of electro-mechanical instrument work and preferably electronic drawing required for Research Department, Unilever, Ltd., located at Port Sunlight.—Applications in writing to Employment Manager, Lever Bros., Port Sunlight, Ltd., Port Sunlight, Cheshire. [2599

YOUNG man required as assistant in press office to deal with routine and assist with the preparation of material, some radio technical knowledge essential; salary about £500 p.a.—Write giving details of age and experience to Publicity Manager, Marconi's Wireless Telegraph Co., Ltd., Chelmsford, Essex. [2551

RADIO/RADAR mechanic for small flying unit in Edinburgh; practical experience in servicing of aircraft airborne radar equipment essential.—Apply, quoting Ref. RM/TID, giving details of training, qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2562

OPPORTUNITY offered to an electronic engineer capable of holding a responsible post as an instrument designer; an engineering degree and experience covering a wide range of frequencies are advantages which will be reflected in the salary offered.—Apply Box 3284. [2484

A SENIOR transformer designer with specialist knowledge of all types of small transformers used in electronics is required with a view to taking charge of a design section; practical as well as academic knowledge essential; pension scheme available; West London.—Box 3474. [2531

QUALIFIED Radio and Television Service Engineers required by progressive North-west London retailers; drivers preferred; congenial conditions for work with good wages; please apply by telephone for appointment to—Northern Lights (Cricklewood), Ltd., Speedwell 7477/4262. [2634

NELSON RESEARCH LABORATORIES, The English Electric Co., Ltd., Stafford, have vacancies in the test section for young men with electronic workshop testing experience; the work which is in connection with prototype devices is of a non-repetitive nature; preference will be given to applicants who hold a City and Guilds Telecommunications Engineering 4th year certificate or Ordinary National certificate.—Apply to Dept. C.P.S., 336/7, Strand, W.C.2, quoting ref. 944B. [2539

WEST Africa.—British company established in Nigeria, Gold Coast, Sierra Leone, require the services of qualified radio sales/service engineers, experience of refrigeration desirable; selected men will be given a preliminary training in radio and other sections of the service department before leaving for West Africa; excellent prospects for the right type; good salary; first-class air/sea passage; free furnished quarters; full pay on leave after tours of approximately 18 months; pension scheme; apply in confidence stating age (21 to 27 preferred), married or single, full details education, business experience, National Service; references not required until a definite position is offered.—Apply T.S.D., Box 3436. [2520

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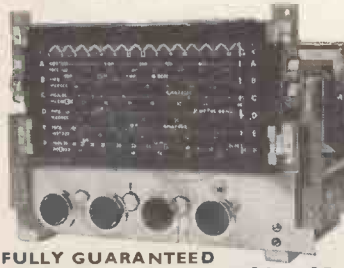

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DRAUGHTSMAN.—A vacancy exists for an experienced draughtsman for the design and development of domestic radio, television and allied equipment; applicant must be experienced and capable of working on own initiative; write giving full details.—Regentone Products, Ltd., Eastern Ave., Romford, Essex. [2546

DEVELOPMENT engineers and technical assistants required by the precision engineering division of Short Brothers & Harland, Ltd., Belfast. for work on guided weapons and other interesting projects; ideal conditions in new laboratories for men with good practical experience in one of the following fields:—
(1) PRECISION mechanical engineering: including hydraulics or pneumatic servos; medium/Light Mechanisms or Instruments.
(2) SMALL electro-mechanical devices, servos or instruments.
(3) ELECTRONICS: preferably D.C. amplifiers, electronic computation, pulse technique or miniature equipment.
MINIMUM qualifications: Development engineers, University degree or equivalent; technical assistants, H.N.C., or C. & G. Finals; good salaries and prospects for men with initiative; pension scheme; assistance with housing.
SEND full particulars of age, qualifications and experience, with salary required, to Short Brothers & Harland, Ltd. Castlereagh Factory, Belfast, quoting Ref. No. E.4. [2648

TECHNICIAN required with knowledge electronics for cm radar and to assist in research lab.; salary according to age and qualifications in range £315—£450, plus London Weighting £20-£30; good conditions of service.—Apply own handwriting to Dept. Meteorology, Imperial College, London, S.W.7. [2569

DEVELOPMENT engineer, aged 25-30 required by manufacturing company in S.E. London area, applicant should be interested in the development of radio communication equipment, particularly as applied to merchant ships, preferably holding Higher National Certificate or equivalent; state age, qualifications, experience and salary required to—Box 3906. [2633

THE advertisers, an established firm manufacturing quartz crystals, N.W. area, require the services of a crystal engineer to take charge of pre-production department; experience of development and production essential; permanent post, excellent contributory pension fund; write giving full details, in confidence, to—Box 83518. [2542

ASSISTANT (scientific).—The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to December 31, 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 January 1, 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. [2560

TECHNICAL writer required to assist in the preparation of operating instructions and technical bulletins on facsimile equipment, measuring instruments, magslip and servo components. Degree or H.N.C. desirable with an aptitude for this specialised form of writing.—Apply in writing to Muirhead & Co., Ltd., Beckenham, Kent. [2568

UNIVERSITY COLLEGE, London (Gower St., W.C.1), has vacancy for Technician in Dept. of Phonetics; knowledge of electronics essential and interest in acoustics preferred; wage scale £315—£15—£450 p.a., plus London weighting; initial wage according to qualifications.—Application forms from Secretary, quoting Phonetics/2. [2624

RADIO service engineers.—Selfridges, Ltd., have vacancies for radio service engineers; applicants must have experience of all makes of radio and television sets, and must able to drive a car; good starting salary and generous increases to men who show ability; posts are permanent and pensionable to men under 43 yrs.; apply between 9 a.m. and 11.30 a.m. Monday to Friday, to—Personnel Manager, Provision Building, Somerset St., W.1. [2554

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MULLARD EQUIPMENT, Ltd., have vacancies in their engineering dept. for electronic and electro-mechanical engineers with experience in the development and engineering of communications and other electrical equipment; permanent position, good salary, and pension scheme.—Apply in writing to Personnel Dept., 51/55, Garratt Lane, S.W.18. [2570

TELEVISION receiver engineers are required for development work on monochromatic and colour television for home and export markets with excellent opportunities for advancement and travel in rapidly expanding field.—Applications, stating experience and salary required, to Chief Television Engineer, Pye, Ltd., Radio Works, Cambridge. [2502

THE ENGLISH ELECTRIC COMPANY, Ltd., require a television service engineer for their workshop in London, N.W.3; applicants must be fully experienced, fit and possess a current driving licence; staff appointment pensionable after qualifying period; full details in own handwriting to—Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 468J. [2505

UNUSUAL opportunity occurs for junior electronic engineer to join rapidly expanding organisation; interesting work concerned with the development of electronic instruments and allied equipment, with excellent prospects of rapid advancement for person of real ability. —Rivlin Instruments, Ltd., 7a, Maitland Park Villas, N.W.3. [2532

RADIO component manufacturers require chief inspector to take charge of mechanical inspection of piece parts and final electrical testing; knowledge of loudspeakers an advantage.—Write, giving details of past experience and salary required, to Electro Acoustic Industries, Ltd., Stamford Works, Broad Lane, Tottenham, N.15 [2653

WRIGHT & WEAIRE, Ltd. have vacancies for senior and junior engineers for research and development work on components, electronic circuitry and small electro/mechanical assemblies with particular reference to magnetic recording. Write in the first instance to the Technical Director, Simonside Works, South Shields, Co. Durham. [2577

THE ENGLISH ELECTRIC Co., Ltd., require a Television Service Engineer for their workshop in London, N.W.3. Applicants must be fully experienced, fit and possess a current driving licence. Staff appointment pensionable after qualifying period. Full details in own handwriting to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 468K. [2576

ELECTRONIC engineers required, preferably with production experience but ex-service radio/radar mechanics and radio service engineers considered; permanent, progressive positions available with expanding company in Shrewsbury; housing assistance provided; applicants must state full details of previous experience and salary required.—Box 3322. [2500

SENIOR mechanical designers, over 30, with creative ideas and experience in mass-production design of either domestic equipment or radio/television, required by Vidor-Burndept, Ltd., to meet expansion at their Erith Works; permanent progressive positions with good salary; staff pension scheme; please write or call on Personnel Manager, West St., Erith, Kent. [2601

DRAUGHTSMEN experienced in broadcast radio and television are offered exceptional opportunities with a firm of repute in the London area; experience in production drawing or mechanical design would qualify for a very attractive starting salary.—Applications, which will be treated in strict confidence, should give full details of experience and should be addressed to Box 3930. [2646

TEDDINGTON CONTROLS, Ltd., Merthyr Tydfil, S. Wales, have a vacancy for an electronics engineer to work on the development of magnetic amplifiers and transistors; applicants should preferably be graduates who have a degree in electrical engineering; salary will be according to age and experience.—Apply in writing to the Assistant Chief Engineer Electronics. [2537

CHIEF of test required by Airmec to take charge of the electronic test department, must be able to organise, and to control staff; experience of A.I.D. procedure desirable; monthly appointment, with pension scheme; accommodation may be available.—Write giving full details of qualifications and experience Personnel Officer, Airmec, Ltd., High Wycombe, Bucks. [2552

TEST engineers required for interesting work in connection with radar and other electronic equipment. Applicants must have sound theoretical knowledge of radar backed by some practical experience gained in H.M. Forces or industry. Good wages and excellent conditions. Single lodging accommodation available. Apply, giving full details to Personnel Dept. (CE/4), E.M.I., Ltd., Hayes, Middx. [2567

MINISTRY OF TRANSPORT AND CIVIL AVIATION.—Radio technicians (men only) required at aerodromes and radio stations in various parts of U.K.; special training courses for keen technicians with basic quals.; interesting work in progress providing electronic aids to navigation; prospect of permanent pensionable posts; rates of pay (London) from £335 p.a. at age of 19, to £445 at 25, rising, subject to qualifying test, to £540; rates slightly lower for provinces.—Candidates age 19 or over with practical experience in maintenance of radio or radar equipment should apply to any Employment Exchange, quoting Order No. Westminster 6627. [2530

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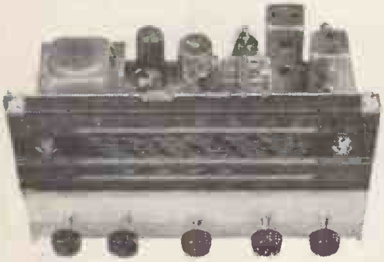

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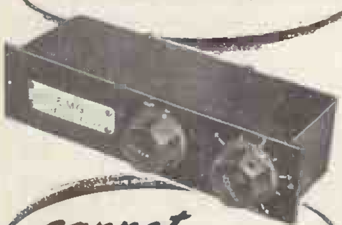

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SITUATIONS VACANT

ENGINEER required to undertake the design of electronic instruments; the successful candidate will be required to accept responsibility for development to the production stage; degree or equivalent preferred; the salary will be commensurate with qualifications and experience.—Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., London, E.17. [2485

DRAUGHTSMEN, senior and intermediate, are required at Chelmsford and Acton by Marconi's Wireless Telegraph Co., Ltd., experience in the design of radar, radio or similar apparatus preferred; these are permanent positions in expanding development groups; applicants should write, giving full details and quoting ref. 142J, to—Dept. C.P.S., 336/7, Strand, W.C.2. [2513

DRAUGHTSMAN required with experience in layout of automatic moulding press electrical equipment, involving mechanical drawings, sub-assemblies, circuits, and parts schedules; suitable for prototype and batch production; apply, in writing, to—Works Supt., The Streetly Mfg. Co., Ltd., Aldridge Rd., Streetly, stating age, experience and salary required. [2521

ENGINEERS, mathematicians or physicists required for design and development work on new projects in the telecommunication field; experience in this type of work desirable, but not essential.—Apply, giving full details of age, qualifications, experience and salary required, to the Personnel Manager, Standard Telephones and Cables, Corporation Rd., Newport, Mon. [2652

ENGINEER, aged 26 to 34, required to take charge of engineering department of factory manufacturing quartz crystals; university degree and experience of industrial or service electronic equipment essential; rudimentary knowledge of chemistry an advantage; house could be made available to successful applicant. —Write Box WC.9139, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [2584

PRODUCTION manager required for radio factory in Southern Rhodesia, applicants, preferably single, must have several years' experience in the radio industry in similar capacity, and be capable of production lay-out, time study and overall technical supervision; commencing salary £120 per month. air passage will be provided.—Apply in writing to 31, Burlington Ave., Kew Gdns., Richmond, Surrey. [2598

FIRST-CLASS openings for experienced radio and television engineers will shortly become available with a firm of repute in the London area; engineers able to undertake immediately, development work on broadcast radio and television apparatus would be offered an attractive salary; the successful candidates will be eligible for company superannuation and insurance schemes.—Please reply, giving full details of experience, to Box 3933. [2647

WAR Department requires lecturer at R.E.M.E. Training Centre, Arborfield. Qualifications: Degree in Electrical Engineering or equivalent; experience in light current, radio or radar engineering essential. Salary in accordance with Burnham Technical Scale for Assistant B, with allowances for degree, other special qualifications and for extra working time compared with Technical Colleges. Normal Teacher's Superannuation.
APPLICATION forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting Ref. D.2/54A. Closing date 12 April, 1954. [2629

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; salary according to qualifications and experience.—Write stating qualifications and experience to Personnel Manager, Standard Telephones & Cables, Ltd., North Woolwich, E.16. [2491

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; junior posts also available for electronic engineers, aged 23 upwards, having H.N.C. or equivalent qualification. [2650

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

ASSISTANT electronic engineers and technical assistants are required to take part in an extensive design and development programme ranging from precision audio oscillator to microwave equipment; present developments include encapsulated sub-miniature techniques involving the use of transitor circuits; there are excellent opportunities for junior engineers to gain valuable experience so that they may in due course occupy positions of technical responsibility within the company; applicants should either possess a degree or be studying to that end.—Write to The Wayne Kerr Laboratories, Ltd., Sycamore Grove, New Malden, Surrey. [2583

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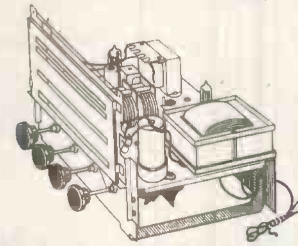

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TRANSFORMER Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply stating age, qualifications and experience, to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [0260

THE BRITISH TABULATING MACHINE Co., Ltd., manufacturers of "Hollerith" accounting machines, will shortly open a new research laboratory at Stevenage, Herts; men interested in the development of electronic digital computing techniques for business accounting machines, and who are seeking employment of this nature in congenial surroundings, are invited to contact the company with a view to a staff appointment. Experience in photo-cell circuitry and counting techniques desirable but not essential. In particular, the company would like to interview:—
(i) UNIVERSITY graduates with an Honours Degree in Physics or Electrical Engineering, some previous experience in the electronic research and development field being an advantage.
(ii) ENGINEERS holding a Pass Degree or Higher National Certificate, or equivalent qualifications; practical experience of electronic equipment an advantage.
SALARY will be commensurate with experience and qualifications; a pensions scheme is in operation.—Applications giving full particulars of candidate should be addressed to Personnel Officer, British Tabulating Machine Co., Ltd., Letchworth, Herts. [2524

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

SENIOR television development engineer required by well-known radio and television manufacturer in London area; applicants must have a wide experience in development for mass production of modern commercial radio and television receivers; a good salary will be paid to a person possessing drive and organising ability and capable of carrying through projects from development to production stages, under the supervision of the chief engineer; kindly state full particulars of technical education and experience to Box 3358. [2506

SENIOR Electronic Engineer required to lead a group working on advanced valve applications; the 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; apply in writing to—Personnel Dept., M.O. Valve Co., Brook Green, Hammersmith, W.6, stating age, qualifications and details of experience. [2522

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. [2390

THE National Physical Laboratory, Teddington, Middlesex, has vacancies for junior staff to assist in laboratory or drawing office, in work on electronic computers and other electronic equipment; age 16-26; salary £215 to £410, according to age, with regular increments (lower maximum for women); minimum qualification General Certificate of Education at ordinary level in four subjects, including English Language and a scientific subject or mathematics; posts unestablished with opportunities of established (pensionable) posts, and of promotion to higher grades. [2587

ADMIRALTY, Royal Naval Scientific Service. —Engineers and Physicists (particularly with electronics) required for appointments in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire Areas and Scotland. Candidates, British Subjects, must possess one of the following qualifications: University degree in Science, Engineering or Maths., Graduate Membership of appropriate professional institute, Higher National Certificate, Final Certificate of five-year grouped course in relevant subjects at City and Guilds of London Institute or comparable institution, Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels). London salary inclusive of pay addition (men) E.O.s £681—£838, A.E.O.s (according to age) £274—£607. All appointments unestablished, but with some opportunities to compete for established posts. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting A 247/52/A. [2503

SITUATIONS VACANT

ASSISTANT Lecturer, mainly in radio and television servicing, is required immediately for our London headquarters; applicants should have had some years' practical experience in servicing and should possess theoretical qualifications up to the standard of Grad. Brit. I.R.E.; salary is £550-£750 per annum depending upon qualifications and experience.—Applications to the Principal, E.M.I. Institutes, 10, Pembridge Sq., London, W.2. [2625

HIVAC, Ltd., manufacturers of specialised thermionic and electronic devices offer interesting posts for scientists, engineers and technicians in their expanding organization on research and development projects in valves, cold cathode tubes and transistors; previous experience in these fields, although an advantage, is not essential, but a sound education and an active and enquiring mind are; encouragement will be given, wherever possible, to the publication of original work.
THE Company is a member of a major communications group and the posts, which are available for both senior and junior applicants, are pensionable and offer scope for advancement; there is a 5-day working week.
APPLICATIONS in writing, which will be treated in strict confidence, stating age, education, qualifications and salary expected, should be addressed to—The Engineer-in-Chief, Hivac, Ltd., Greenhill Crescent, Harrow, Middlesex. [2452

APPLICATIONS are invited for posts of senior and junior television development engineers; applicants should have sound technical educations and be fully conversant with modern techniques of television design, and capable of progressing designs through to production stages. Staff pension scheme; five-day week.—Applications, giving full details of qualifications and experience, and salary expected, to be addressed to The Personnel Manager, Vidor-Burndept, Ltd., West St., Erith, Kent. [2561

CABLE AND WIRELESS, LTD., invite applications from telecommunications engineers who are interested in a career in this company's overseas service ashore; applicants must have had practical experience of maintenance and operation of wireless telegraph apparatus and possess C. & G. Radio II Certificate or equivalent; desirable age limit 29; basic commencing salary £324 (age 22) to £456 (age 29) per annum; free accommodation or allowance in lieu; foreign service and expatriate allowances (up to £240 and £550 per annum respectively) additional; tax paid; permanent and pensionable positions for suitable candidates.—Apply in writing, giving experience and qualifications, to Managing Director, Cable and Wireless Ltd., Electra House, Victoria Embankment, London, W.C.2. [0008

A JUNIOR development engineer is required to assist in the development of precision electronic laboratory instruments. The successful applicant will be engaged on interesting long-term projects concerned with the development of a wide range of equipment. The appointment is of a permanent nature, it carries considerable technical responsibility and offers scope for the exercise of individual initiative. Applicants should have had previous development experience preferably in the instruments field. Academic qualifications ranging from O.N.C. (or an equivalent standard) to a University degree in Communications Engineering or Physics are acceptable. Salary will be dependent upon age, qualifications and experience.—Apply stating full details to: The Chief Engineer, Furzehill Laboratories, Ltd., Shenley Rd., Boreham Wood, Herts. [0030

THE PLESSEY COMPANY have vacancies at their Ilford works for engineers and draughtsmen of senior and intermediate grades for development work on components and mechanisms for radio, television and communications equipment. These vacancies occur as a result of the enlargement of the laboratories to permit a substantially increased interest in the design of circuits and components for specific applications. All positions are permanent and pensionable and the expansion now in progress offers good prospects of advancement. Salaries are progressive and attractive initial salaries are offered to men who are qualified by reason of educational attainment or practical experience. All applications will be dealt with in confidence and should be addressed, in the first instance, for the attention of the Personnel Manager, The Plessey Co., Ltd., Vicarage Lane, Ilford, Essex. [2578

ELECTRONICS Engineer and Physicists required by Ministry of Supply Experimental Establishment at Farnborough, Hants; Malvern, Worcs.; Sevenoaks, Kent, and elsewhere, mainly in Southern England. Duties include research, development or design of telecommunications and radar equipment; guidance and control systems; instrumentation for variety of research problems. Experience of V.H.F., pulse techniques, display systems, etc., desirable for some posts. Appointments according to qualifications and experience as Scientific Officer (1st or 2nd class honours degree or equivalent), £417-£781; Assistant Experimental Officer (Higher School Cert. (science) or equivalent, degree or H.N.C. may be an advantage and technical experience in Forces or industry desirable), £264 (age 18) to £576; Experimental Officer (H.S.C., etc., but min. age 26), £649-£799. Women somewhat less. Appointments unestablished. F.S.S.U. benefits may be available for S.O. class.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D480/53A. Closing date April 13. 1954. [2623

SITUATIONS VACANT

TECHNICIANS required for laboratory and inspection duties in connection with design of quartz and synthetic crystals and associated circuits; applicants should be between 24 and 35 years of age and preferably have had some industrial or services experience in radio techniques; salary £500 to £700 per annum dependent upon qualifications and experience; the position is tenable in South West Lancashire and is on the established staff status with contributory pension fund and usual staff conditions.—Applicants are invited to write to Box 530, Dorland Advertising, Ltd., 18-20, Regent St., London, S.W.1, giving full particulars of their qualifications, experience and age. [2338

DEPUTY chief mechanical inspector required by world-famous manufacturer of radio and radar equipments in the Home Counties; this is a responsible appointment and applications can only be considered from first-class men of good education and technical qualifications, possessing a sound knowledge of light engineering as applied to the manufacture of electronic equipment; familiarity with machine shop practice, tools and jigs is essential and applicants must be capable of controlling a large A.I.D. approved inspection organisation; this appointment is permanent and pensionable with good prospects.—Applications, which will be treated in confidence, should be addressed to Box 3550, quoting ref. IAA. [2547

ELECTRON microscopes. Engineer required, preferably graduate in physics or engineering, to operate from London headquarters on installation and regular periodical servicing of electron microscopes in United Kingdom and Western Europe. Applicants must have skilled practical aptitude for electronic and vacuum physics maintenance work and ability to deal with technical enquiries and sales matters in correspondence, and personal contact with microscope users. Experience in electron microscopy an asset, but not essential if scientific education and practical electronic background otherwise suitable. State age, and give complete details education, experience, languages, and salary required.—Box 3790. [2590

WAR Office require Assistant Mechanical Engineering Officer (Recruitment Grade Professional) at Donnington, Salop, to organise, control and supervise a workshop sector employing 30 to 40 civilians engaged on repair and calibration of electrical and electronic test equipment. Inclusive salary range £645 to £960 (Provincial). Applicants must be British of British parentage and be Corporate members of the Institution of Electrical engineers or have passed or be exempt from Sections A and B of their membership examination, or possess a University Engineering degree. Starting salary fixed according to age, qualifications and experience. Annual increments subject to satisfactory service. Posts temporary but long term possibilities. Application forms quoting reference D423/53A from M.L.N.S., Technical and Scientific Register (K), Almack House, 26, King St., London, S.W.1. [2628

AN Electronic Engineer is required by a nationally known manufacturer of accounting machines to undertake specialised duties in training service engineers who are already employed by the Company. The successful applicant would be required to live in Hertfordshire as he would normally be based at the Training School which is established in that county. Applicants should have served a recognised apprenticeship in electrical or electronic engineering and should preferably have the Higher National Certificate (Electrical) and have worked for some years on the development or the servicing of electronic control equipment, age limit 24/30 years. The commencing salary will be according to experience and qualifications held but not less than £500 per annum; full staff conditions apply with sick pay scheme and contributory pension scheme. Write in strict confidence stating age, qualifications and experience to Box 3755. [2580

SITUATIONS WANTED

ENGINEER, 40 years, experienced installations, transmitters/navigational aids, buildings; five years tropical applications/deterioration, survey land and marine, seeks change, home/abroad.—Box 3321. [2496

CHIEF mech. eng. executive, 44 leading mfrs. radio, T.V., domestics; all projects, design, development, D.O. Prod. Eng., tools, methods, production, inspection, planning.—Box 3629. [2566

SENIOR Sales Executive, M.S.M.A., with wide background in radio industry, seeks change to tougher assignment, and would undertake to rescue moribund business, or develop new one; age 35; efficient administrator, practiced in modern methods.—Write Box 3887. [2613

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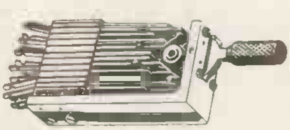

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On the left is part of the manufacturers' section; on the right are some of our retail lines.

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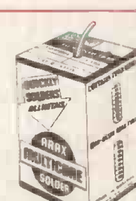

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