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.
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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 Vosc range from 2 volts to 5 volts, therefore a Vosc 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 Vosc, 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

<table>
<thead>
<tr>
<th>Ih</th>
<th>0.3 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vh</td>
<td>9.0 V</td>
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#### CHARACTERISTICS

**Pentode Section**

<table>
<thead>
<tr>
<th>Va</th>
<th>170 V</th>
</tr>
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<tbody>
<tr>
<td>Vg2</td>
<td>170 V</td>
</tr>
<tr>
<td>Ia</td>
<td>10 mA</td>
</tr>
<tr>
<td>Ig2</td>
<td>2.8 mA</td>
</tr>
<tr>
<td>Vg</td>
<td>-2.0 V</td>
</tr>
<tr>
<td>k</td>
<td>6.2 mA/V</td>
</tr>
<tr>
<td>rs</td>
<td>400 k Ω</td>
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**Triode Section**

<table>
<thead>
<tr>
<th>Va</th>
<th>100 V</th>
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<tr>
<td>Ia</td>
<td>14 mA</td>
</tr>
<tr>
<td>Vg</td>
<td>-2.0 V</td>
</tr>
<tr>
<td>k</td>
<td>5.0 mA/V</td>
</tr>
<tr>
<td>μ (approx.)</td>
<td>20</td>
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#### TYPICAL OPERATING CONDITIONS

As a frequency changer

<table>
<thead>
<tr>
<th>V52</th>
<th>170</th>
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<tbody>
<tr>
<td>Vg2</td>
<td>170</td>
</tr>
<tr>
<td>Rg1</td>
<td>100</td>
</tr>
<tr>
<td>Rk</td>
<td>820</td>
</tr>
<tr>
<td>Ig1</td>
<td>5.2</td>
</tr>
<tr>
<td>Ig2</td>
<td>1.5</td>
</tr>
<tr>
<td>Vosc (r.m.s.)</td>
<td>3.5</td>
</tr>
<tr>
<td>Vg</td>
<td>0</td>
</tr>
<tr>
<td>Ig2</td>
<td>53</td>
</tr>
<tr>
<td>Rs</td>
<td>2.1</td>
</tr>
<tr>
<td>Rs</td>
<td>2.05 mA/V</td>
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#### BASE B9A

#### LIMITING VALUES

**Pentode Section**

<table>
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<tr>
<th>V52 max.</th>
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<tbody>
<tr>
<td>p52 max.</td>
<td>1.7 W</td>
</tr>
<tr>
<td>Vg2 max. (Ig2=14 mA)</td>
<td>175 V</td>
</tr>
<tr>
<td>Vg2 max. (Ig2=10 mA)</td>
<td>200 V</td>
</tr>
<tr>
<td>p52 max.</td>
<td>0.5 W</td>
</tr>
<tr>
<td>Ig2 max.</td>
<td>14 mA</td>
</tr>
<tr>
<td>Vb-k max. (heater negative)</td>
<td>150 V</td>
</tr>
<tr>
<td>Vb-k max. (heater positive)</td>
<td>90 V</td>
</tr>
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**Triode Section**

<table>
<thead>
<tr>
<th>V5 max.</th>
<th>250 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>p5 max.</td>
<td>1.5 W</td>
</tr>
<tr>
<td>Ig2 max.</td>
<td>14 mA</td>
</tr>
<tr>
<td>Vb-k max.</td>
<td>±90 V</td>
</tr>
</tbody>
</table>

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
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-acoustic 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 minutiae 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.
RENE 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.

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 Department).
P.O. Station Extensions • Set Makers’ Problems

V.H.F. Stations • International Conferences

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.V. 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 representative of the various participating countries at Cannes during 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 Computers (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 10.00 on April 28th. Admission to the show, which closes at 8.00 on the first day and at 6.00 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, Resound, 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, Industrial Institute Road, London, S.W.7, on April 8th for five days. It opens daily at 10.00 and will close at 8.00 on the 8th, 9th and 12th, and at 5.00 on the 10th and 13th. Admission is by ticket, valid for a specific afternoon 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 Service of the British Joint 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 £20,000 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 Ferrari 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 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 by the radio and television department of the 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 Ministry, on leaving Exeter in 1936, worked on proximity fuzes under N. Coles and G. A. Whitefield, 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 protective equipment issue of September, 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, Richardon de Gruchy, Herts—is the protected moving-coil microammeter described in the September issue.


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 years, and a half year ago he 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 Corps should 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 units in the United Kingdom. The subscription is £15 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 received for a total of 156 from the Radio and Television Societies. It 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.

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 (F. K. Balcombe); Bush (G. J. Eagles); C.B. Electronics (C. M. Benham, vice-chairman); RAF (G. S. Tomlin); English Electric (D. H. Vocken); G.E.C. (M. M. Macqueen, chairman); Gramophone Co. (F. W. Perks); Kolster-Brandes (P. H. Spagnolo); Philips (A. L. Sutherland); Pilot (H. L. Levy) and Ultra (E. F. 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 (E. R. Hill); British Moulded Plastics (J. H. Bridge); Garrard (Hector V. Slade); Hunt (S. H. Brewell); Multicore (R. Arbib); Smiths (K. Graham); T.T. (G. W. Godfrey); Cosser (J. S. Clark); English Electric (D. C. Spinck); Ferguson (L. Bentley-Jones); G.E.C. (M. M. Macqueen, chairman); Gramophone Co. (F. W. Perks); Kolster-Brandes (P. H. Spagnolo); Philips (A. L. Sutherland); Pilot (H. L. Levy) and Ultra (E. F. Rosen).

Seminars.—An international conference on semiconductors is to be held in Amsterdam from June 29th to July 3rd by the Netherlands Physical Society. A number of papers and discussions on the theoretical aspects of semiconductors, and the applications of these materials in transistors, will be read during the conference, which will be supported by U.N.E.S.C.O. and the International Union of Pure and Applied Physics. A pre-press announcement of the conference was published in the Journal of Physics, February 1954, pages 142-144.

Semiconductors.—An international conference on semiconductors is to be held in Amsterdam from June 29th to July 3rd by the Netherlands Physical Society. A number of papers and discussions on the theoretical aspects of semiconductors, and the applications of these materials in transistors, will be read during the conference, which will be supported by U.N.E.S.C.O. and the International Union of Pure and Applied Physics. A pre-press announcement of the conference was published in the Journal of Physics, February 1954, pages 142-144.

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 30 minutes and can be borrowed free of charge by engineering societies, technical colleges, etc., from Philips Research Laboratories, 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 fixed wing aircraft, with 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 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 15s 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.

**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.

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, Lilie 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.

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 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, are 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.

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, 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, 2mA with a particular transistor, it will be found that the collector current will vary from about 1.4 to 4mA 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-

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*Cosmecord, 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.

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 \( R_2 \). 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. \( R_1 \) 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 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.e. means by 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-collector potential when the base was fed through a 0.5 mH saturation; 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 maximum 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  

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impedance against load impedance of this network, the effects of R1 and R2 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 m\(\Omega\) 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 \(\Omega\).

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 \(R_5, R_6, R_{11}\), and \(R_{12}\). 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 \(\Omega\) (R of Fig. 5) and fed into a 1,000-\(\Omega\) insert telephone receiver. Curve C used the same input conditions as A, but with a 10-henry choke (d.c.\(R=300 \Omega\)) shunted with a 1,000 \(\Omega\) 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, and extra bass cut can be obtained by reducing the values of \(C_{11}\) and \(C_{12}\). 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

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**Fig. 4.** Experimental four-stage transistor hearing aid with RC coupling throughout. \(C_1-C_6\) inclusive are miniature 8 \(\mu\)F, 6-V d.c. working capacitors.

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

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

_Wireless World, April 1954_
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 1 in. 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.

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 $C_{as}$ and $C_{pk}$ (supplemented by the adjustable $C_3$) form two bridge arms and $C$, and $C_1$ form the other two. The switched coil $L_s$ 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 $L_s$ is the only one in circuit. It actually is a coil, for it has 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 $L_s$ 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! $L_{sc}$ 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 $R_s$ is the d.c. grid-return path of the valve and $R_s$ 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 $L_1$ and $L_2$. The physical arrangement of this circuit is basically the same as in the case of $L_s$. 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 coupling capacitance is brought in for Band I and certain individual sections of inductance are short-circuited to prevent unwanted absorption.

The mixer $V_s$ is the pentode section of a triode-pentode PCF80, the oscillator voltage being fed to the grid through $C_{3a}$. 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 $V_3$, operating above the signal frequency. The same basic switching arrangement is used for $L_{3a}$, but the basic inductance $L_{4a}$ 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 $L_{3a}$, 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 $L_{3a}$ 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-fre-
quency 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 4½ in. deep x 3 in. high x 2½ in. wide. Overall, the behind panel space need not exceed 5 in. deep x 6 in. high x 2½ 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 8.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 ear-piece 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 3½in x 2½in x 3½in. The weight including battery is 4½oz.
This article describes a small 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

\[ A = g_mR_d \]  

in which \( g_m \) 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 \( g_m \) and \( R_d \), the maximum gain available without instability at 1 Mc/s is given by

\[ 2 \frac{1}{V^2} \times 10^{-4} \times 0·01 \times 10^{-12} \times 300 \times 10^3 = 100 \text{ times approximately.} \]

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 \( g_m \) 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

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**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 1/4 W. Alternative valves to the 6F12 are 6AM6, Z77, EF91 and BD3.

*Wireless World, April 1954*
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 C9 and R3 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 (3.5 mA/V) permitting high stage gain. The operating conditions for the valve must be chosen with care to avoid exceeding the maximum permitted d.c. dissipation (0.7 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 automatically taking 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 C10, 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.

L1 and L2 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 Me 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 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 L3 and L4 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 L4 to maintain adequate selectivity. At first a 1-M Ω load resistance was used in parallel with C10 but this was later omitted because it was found that the reverse resistance of the crystal provides an adequate discharge path for C10 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 C10 and the gain control R8 but C10 is connected in the low-potential end of R8. 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 bias 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 experi-
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 Rg has a value of approximately 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 R6. 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 R5, R6 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 1/2 ohms (approximately 250 ohms), but V2 screen is fed from a 10-kΩ potentiometer R9, connected in the cathode circuit and thus the screen resistance for V2 screen varies somewhat with the setting of R9, rising to a maximum of approximately 2.5 kΩ when R9 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 R9 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 R6 is returned via C10 not to earth but to a fixed potential divider R12, R13 across the secondary winding of the output transformer. When the gain setting is low, the slider of R6 is near the junction with C10 and nearly the whole of the voltage developed across R13 is applied to V2 grid to give feedback. On the other hand, when the slider of R6 is near the junction with the crystal, a.f. gain is high and very little of the voltage across R13 reaches V2 grid, implying very little feedback.

Feedback Adjustment

The degree of feedback which remains when R6 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 R6 (1 MΩ), and very little feedback remains when the gain control is at maximum. This can easily be demonstrated by short-circuiting R13 (to remove feedback entirely) when a weak signal is tuned in and R6 is at maximum; there is practically no change in audible output. The values of R12 and R11 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 resistors used by the author were 470 ohms (R12) and 37 ohms (R11), but these depend on the constants of the output transformer.

The transformer used by the author was a Goodmans Type 74243. The values of R14 and R15 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 R14 and R6 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 C11 and C12. C11 presents V2 with a very small load at r.f. frequencies (only 160 Ω at 1 Mc/s) and C12 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 1l.

![Fig 3. Winding details of coupling transformers (L1, L2).](image-url)
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.
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.

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 A1, has its gain reduced to A/(1 + Aβ) by feeding back a fraction β 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 d0, in the output. With feedback connected we shall find a new value of distortion, say d′0, in the output. We feed back Aβd0 to the amplifier input, where it is then amplified, and appears as a term Aβd′0. Then d′0 is equal to d0 (the actual distortion) = d0 (the intrinsic distortion) + Aβd0 (the distortion returned round the loop) and so d′0 = d0/(1 + Aβ).

The factor (1 + Aβ) 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 + Aβ) 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 to 20 db of feedback.

**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 muddv 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 $g_m - e_o$ characteristic, and for the curve shown the level of second harmonic below the fundamental will be

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

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

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

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

$$\frac{1}{R_e} \left( g'_m + \frac{1}{g_m} \right)$$

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

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

third harmonic

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

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 $e'_m$ which

![Fig. 2. Mutual conductance of 6AG7 valve as a function of grid bias. $E_o = 330V$. $E_i = 150V$.](image)

![Fig. 3. Effective mutual conductance $g'_m$ with 20 db gain reduction due to feedback.](image)
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, transgressed 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 wouldn'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 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 needless 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 $d_p = d_0/(1 + A\beta)$. 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

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

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

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*Wireless World, April 1954*
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 conclusion of an effective muting network is that a 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, I. Sec.: R. H. Huggett, 13, 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 the 21st Mr. 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 managing a similar, the World and Country, Exhibition which is being held at the Drill Hall, Wellingborough from April 20th to 23rd. Sec.: R. J. Henty, 4B, Silver Street, Wellingborough.

Wolverhampton Amateur Radio Society has moved to its 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**


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 effectiveness of suppressing the B.S.833 level of tolerable interference. Pp. 7; Figs. 4. Price 6s. The Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.


**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 5-4 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 Jam & Raikes, 123, Hampshire Street, Quincy, Illinois, U.S.A.


Solenoids for industrial use with maximum strokes from 1 in to 11 in 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.


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.c./D.c. 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 30db/decade.

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


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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.

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 anticyclical 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
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 \( h_T \) and \( h_R \) each at least a few wavelengths above the ground, and spaced a distance \( d \) apart over a smooth earth surface such that \( d > (h_T + h_R) \), the field strength at the receiving point is given by the expression:

\[
E = \frac{90\sqrt{W}}{\lambda d^2} \quad \text{F volts/metre} \quad (1)
\]

where all lengths are in metres, \( \lambda \) 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 \( E \propto \text{frequency} (f) \). 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 \( h_T \) and \( h_R \)—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 multi-path 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.

<table>
<thead>
<tr>
<th>Frequency (Mc/s)</th>
<th>Minimum Range of Field Strength Variation (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>10% of sites</td>
</tr>
<tr>
<td>600</td>
<td>50% of sites</td>
</tr>
<tr>
<td></td>
<td>90% of sites</td>
</tr>
<tr>
<td>100</td>
<td>8</td>
</tr>
<tr>
<td>600</td>
<td>17</td>
</tr>
</tbody>
</table>

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 of the same order at all distances, at least up to 40 or 50 miles. Thus in Band III the discrepancy is substantial.

![Fig. 1. Transmission over smooth earth. One reflected ray only is shown and aerial heights are exaggerated.](www.americanradiohistory.com)
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 \( \lambda/2 \pi \), 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.p.s 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

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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 twisting 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 shifter or 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."

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 reveling 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-simplification 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 half-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 100 ft) 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 broad-banding 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

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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.)


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:

\[
\begin{array}{c}
\text{(EMITTER)} \\
\text{(base)} \\
\text{(COLLECTOR)}
\end{array}
\quad 
\begin{array}{c}
\text{(EMITTER)} \\
\text{base} \\
\text{(COLLECTOR)}
\end{array}
\]

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.”

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, thermostat 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 interference problems (including automobile ignition).

Some of our interference can be traced to poor receiver design. We have some excellent receivers, but a few 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 come from a source other than the one we wish to view.

West Hartford, BYRON GOODMAN, WIDX.

Conn. U.S.A. 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 recent survey, in the report on the facilities of the various TV stations that 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 Rayovac!* 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 gratefully should you decide to pass them on to your readers.

Montreal, Canada.

C. M. WELLS.


**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 being 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, since it is announced by 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 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 21 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 \( C_{bb} \) is obviously of vital importance in determining high frequency response. To make \( C_{bb} \) 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 \( I_e = -0.06mA, V_e = -0.5V \), the figures for the RCA transistor are quoted at \( I_e = -1mA, V_e = -6V \), so that we should expect to see a factor of 16 to the advantage of Philco so far as \( C_{bb} \) is concerned. On the other hand, the RCA unit will have a lower value of \( r_{bb} \), which will offset this to some extent.

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

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

www.americanradiohistory.com
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 10 Mc/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 $s > 0.95$ and $f_a > 10$ Mc/s opens up new possibilities.

Acknowledgments. Fig. 1 is based on Fig. 4, and Fig. 2 to Fig. 3 of "A $p$-$n$-$p$ Triode 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.Ins.E.

**Mutual Inductance and Coupling Coefficient on the Slide Rule**

EVALUATION of the well-known formula $M = k \sqrt{L_1 L_2}$ 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 $\mu$H 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 $10^1$ (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:

$$\log L_1 - \log k - \log M = \log L_2$$

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

$$\log L_1 + \log L_2 - \log k = \log M$$

$$\log \sqrt{L_1 L_2} + \log k = \log M$$

$$\log L_1 L_2 - \log k = \log M$$

$$\log k \sqrt{L_1 L_2} = \log M$$

$$k \sqrt{L_1 L_2} = M.$$
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 developed e.m.f.s may 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 angel, 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:

\[ E = 0.01 \sqrt{W h_T h_R f} \text{ microvolts/metre} \]  

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
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 \(\mu\)V} \quad (5) \]
\[ e_3 = \frac{0.0016 \sqrt{W h_T h_R f_3 \lambda_3}}{d^2} \quad \text{Band III \(\mu\)V} \quad (6) \]

Beyond the horizon:
\[ e'_1 = \frac{0.0016 \sqrt{W h_T h_R f_1 \lambda_1 D_h}}{d^4} \quad \text{Band I \(\mu\)V} \quad (7) \]
\[ e'_3 = \frac{0.0016 \sqrt{W h_T h_R f_3 \lambda_3 D_h}}{d^4} \quad \text{Band III \(\mu\)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 \(.625 \text{ ft}\)
- **Height** \((r)\) of receiving aerial \(.30 \text{ ft}\)
- **Band I frequency** \((f_1)\) \(.55 \text{ Mc/s}\)
- **Band III frequency** \((f_3)\) \(.190 \text{ Mc/s}\)

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.\(^2\) their Band IV 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\(^\circ\), 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.
The simplest multi-element arrays for TV reception are based upon the Yagi system named after its discoverer 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 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

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

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

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.

**REFERENCES**


**Wireless World, April 1954**
"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 3/8 square by 7/16 inch 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.

Wireless World, April 1954
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 \( \frac{1}{2} \) in square and \( \frac{1}{50} \) in thick. Capacitances may be varied from 7 pF to 0.0111 F 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 75 ft 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 \( \pm 10 \) per cent up to temperatures of about 200 F, and are capable of dissipating \( \frac{1}{2} \) 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 t'at 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.](image-url)
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 150 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.
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 "depreciated" 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 "=; officially it denotes the "amplification factor" of a valve, but some authorities very regretfully 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 more easily related to the harmonic content. On the question of distortion, this Standard seems to fall between two stools, neither boldly tackling the problem of differing objectionability 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.

Wireless World, April 1954
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 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. 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. 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.

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**TABLE 1**

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

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3 Gazzetta Ufficiale della Republica Italiana, (Part I), 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, 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.

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

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from $2f_0 \pm \text{i.f.}$, the more important of these being $2f_0 - \text{i.f.}$, 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 $2f_0 + \text{i.f.}$ 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 $2f_0 + \text{i.f.}$ 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...
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 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

### Table 2

Table of Interference Possibilities

<table>
<thead>
<tr>
<th>Frequencies affected (Mc/s)</th>
<th>Interference source (Mc/s)</th>
<th>Cause</th>
<th>Frequencies affected (Mc/s)</th>
<th>Interference source (Mc/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41-55.6</td>
<td>186.5-216</td>
<td>2f₀ + i.f.</td>
<td>51.4-54.5</td>
<td>144-146</td>
</tr>
<tr>
<td>54-56.9</td>
<td>144-146</td>
<td>2f₀ - i.f.</td>
<td>52.3-68</td>
<td>146-174</td>
</tr>
<tr>
<td>55-68</td>
<td>146-172</td>
<td>2f₀ - i.f.</td>
<td>60.3-66.5</td>
<td>144-146</td>
</tr>
<tr>
<td>63-68</td>
<td>235-245</td>
<td>2nd Ch.</td>
<td>62.5-68</td>
<td>146-151.5</td>
</tr>
<tr>
<td>174-182.8</td>
<td>452.5-470</td>
<td>2nd Ch.</td>
<td>56-68</td>
<td>235-259</td>
</tr>
<tr>
<td>174-193.7</td>
<td>381-420</td>
<td>2fᵣ † i.f.</td>
<td>66.5-68</td>
<td>174-177</td>
</tr>
<tr>
<td>174-216</td>
<td>243.5-289.5</td>
<td>2fᵣ - i.f.</td>
<td>174-175.2</td>
<td>467.5-470</td>
</tr>
<tr>
<td>180.8-216</td>
<td>470-540.5</td>
<td>2fᵣ - i.f.</td>
<td>174-191.4</td>
<td>386-420</td>
</tr>
<tr>
<td>191.9-216</td>
<td>420-468</td>
<td>2nd Ch.</td>
<td>174-216</td>
<td>253.5-299.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2fᵣ † i.f.</td>
<td>174-216</td>
<td>470-555.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2fᵣ - i.f.</td>
<td>189.5-216</td>
<td>420-470</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2fᵣ - i.f.</td>
<td>214.7-216</td>
<td>470-472.5</td>
</tr>
</tbody>
</table>

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 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.

### 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.

Wireless World, April 1954
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 squegers). 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

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

Fig. 2. Electrical analogy of the punctured tyre.

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...
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 V1 (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 I1, and the voltage V1-V = I is dropped in the resistance, leaving V1 between anode and cathode of the valve; and the current through the valve when voltage V1 is applied to it certainly is I1. 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 R = R1R2/(R1 + R2) to find the resistance when R1 is, say, -15 kΩ and R2 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 I₁ and V₁. 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 ceases 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, Vₕ, 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 I₁ or I₂? Well, it all depends on what was done at the start. If the voltage Vₕ were switched on after the cathode had warmed up, the anode current would probably be found to correspond to point S. But if now the resistance were reduced (indicated on the diagram by raising the slope of the load line attached to Vₕ 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 I₁, 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.

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*Wireless World, April 1954*

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$\ddagger$ 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 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...
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.

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**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 C2, diode load R1, and grid leak R3, is, of course, to keep the d.c. voltage developed across R1 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 R1—it depends on the way round the crystal diode, D, is connected—and were C2 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 R1. Under such conditions the grid bias on the following valve could be anything from zero to several times the optimum. The resistor R2 and capacitor C1, give additional r.f. filtering, should it be required.

H. B. D.

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*“A Modern Crystal Set,” Wireless World, September, 1951.*

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**Circuit arrangement for connecting crystal set to amplifier**

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*Wireless World, April 1954*
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 

±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 70Ω 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., Centuray 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 quality 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, Ltd., 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 mains 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 of the RF/716 three-waveband superhet, with low distortion detector.

The tape mechanism is by Truvox and gives speeds of 3½ and 7½ in/sec with interlocking push-button controls.

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 spoons 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 3½ in/sec. An automatic stop function 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 50-10,000 c/s ± 3 db and a tone control is provided for playback. A "magic 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 £7 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

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

Grundig Type TK9 tape recorder.
supply unit of comparable size, only about 100 lb. Positive or negative prints on paper or film up to 10" x 10" 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 13 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 26 db 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.

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 so use as 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 μcoulombs 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 B.S.1,004:42.

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. B.S.1,004 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.


COPILED 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


Informal discussion on "Safety Measures for Radio and Television Equipment" opened by E. P. Wech, on April 12th.

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


"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.

Mercy 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 9th 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. Spanner, B.Sc.(Eng.), and T. Worswick, M.Sc., at 6.15 on April 13th at the Presbyterian Hostel, Howard Street, Belfast.

South Midlands Radio Group.—"The Theory and Application of Transistors" by P. 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 Training and Education for the Electrical Industry" by H. L. Haslgrave, M.A., Ph.D., M.Sc.(Eng.), at 7.30 on April 5th at the Technical College, Stafford.

London Students' Section.—Address by the president, H. Bishoff, C.B.E., B.Sc.(Eng.), at 6.30 on April 15th at Savoy Place, London, W.C.2.

British Institution of Radio Engineers

London Section.—"Crystal Valves in Radio and Electronics" by B. R. Ber-ttridge (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.—"Crystal Valves in Radio and Electronics" by B. R. Ber-tridge (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.

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

North-Eastern Section.—"Electronic Microscopy" by F. Proctor, 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 6.30 on April 1st at the Electricity Service Centre, Whitechapel, Liverpool.

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


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.

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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, the counterpart 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 wobblateur” and “un oscilateur 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 oscilateur 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: “un oscillateur backward” is the name by which it is known in France, the carciontron. I can’t help thinking that EDNO (onde backwa) would have been nearer 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 unpressed) 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.”

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ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.
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.

WASHINGTON, APRIL 1954

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OF CRITICS

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ENGINEERS should investigate the present multiple switching arrangements on their apparatus, and see if "PolyMicro" cannot do the job better. Small and compact, with a high current carrying capacity, this revolutionary new design in Micro-Switches incorporates the Bulgin Miniature "M" type Micro-Sensitive switches, ganged together in a highly-placed metal frame in any number, up to 12 units.

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NEAT GROPPING OF
SOLDER-TAGS

To facilitate soldering operations the silver-plated tags are mounted at one end of assembly. The illustration also shows the operating leaves that are actuated by the cams.

UNIT ONE DEPRESSED

Clearly shows in the switch assembly with unit 1 in on or off position with unit 2 set to make contact, and so on. This is only one of the dozens of permutations.

SEND FOR COMPLETE DETAILS (Ref. PM/WW)

BALL-BEARING INDEX LOCATOR

Illustration (above) shows the end view of the "PolyMicro" switch. Cam location is by 6 holes arranged through 360° and ball-engage. This ensures accurate and positive positioning.

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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 the 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 up to the manufac-

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 semiote 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 manufac-

By FREE GRID

turer did make such a device once—in fact I believe there was more than one—but, like the pale hands beside the Shalimar 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 un silenced 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.

Wireless World, April 1954

Reprisals
Produced in response to a demand for a high sensitivity version of the world-famous Universal AvoMeter, this model incorporates the traditional design features of its predecessors, so highly valued for simplicity of operation and compact portability.

It has a sensitivity of 20,000 ohms per volt on all D.C. voltage ranges and 1,000 ohms per volt on A.C. ranges from 100V. upwards. A decibel scale is provided for audio frequency tests. In addition, a press button has been incorporated which reverses the direction of current through the moving coil, and thus obviates the inconvenience of changing over test leads when the current direction reverses. It also simplifies the testing of potentials, both positive and negative, about a common reference point. A wide range of resistance measurements can be made using internal batteries, separate zero adjustment being provided for each range.

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

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<tr>
<th>D.C. VOLTAGE</th>
<th>D.C. CURRENT</th>
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£23 : 10s.

Size 8½" × 7½" × 4½"
Weight 6½lbs. (including leads)

For your Valve Characteristic Meter or Valve Tester

Owing to the very large number of valves which have been issued within the last two years, no further amendments will be issued for the original "AVO" Valve Testing Manual. A new, completely revised and fully up-to-date Valve Data Manual is now available from the Company at 15/- post free.

RESISTANCE

First indication 0.51.
Maximum indication 20MΩ.

-0—2,000Ω using internal batteries
-0—200,000Ω external batteries
-0—20MΩ using internal batteries
-0—200MΩ using internal batteries

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON S.W.1
Telephone VICToria 3404-9
"The word possesses" possesses more S's than any other word possesses except possibly "dispossesses" . . . .

How the Z33 lives up to this test

NOT such a silly sentence as it seems—those sibilant "S"s produce a hissing sound that form an important part of normal speech. Spoken into a microphone that has any "peaks" in its response, or has upper register emphasis, those sibilants become distorted, and unnatural reproduction results. Apply this "S-test" to the Z33! Because of its flat response and its freedom from "peaking" those "S"s will be fed to the equipment just as spoken—no coloration, no emphasis—just natural reproduction.

Full details in Folder WJM gladly sent on request.

See it on
STAND No. 12
R.E.C.M.F. EXHIBITION—April 6th-8th.

SPECIFICATION

OUTPUT IMPEDANCE
Standard Model .................................................. 20 ohms

SENSITIVITY
(20 ohms imp.) — 87 db with respect to 1 v/microbar; (Hi-Z) — 55 db ditto.

FREQUENCY RESPONSE .............................. 50-10,000 c/s, ± 5 db.

DIMENSIONS ............................................. Overall length 3 lin., Max. dia. 3 in.

WEIGHT .............................................. (incl. 10 ft. screened cable) 14 ozs., with transformer 16 ozs.

FINISH ............................................ Polychromatic Old Gold, Front cover and base anodised, dyed gold. Or grey crackle and chromium. Incorporating recessed "ON/OFF" switch.

With built-in matching transformer providing 200 ohms, 600 ohms or Hi-Z impedances 30/- extra

GOODMANS INDUSTRIES LTD.
Axiom Works, Wembley, Middx. Telephone: Wembley 1200 (8 lines)
Exhaustive tests on samples selected at random from every production batch of Mullard Special Quality Valves ensure that the exceptional care and skill exercised throughout manufacture have achieved their object.

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.

The first five of a comprehensive range of Special Quality Valves are now available from Mullard. Your enquiries on their employment and the availability of types at present under advanced development are invited at the address below.

**Mullard**

**SPECIAL QUALITY VALVES**

**TESTED TO SPECIFIED EXTREMES**

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2
**Portable Frequency Meter**

**TF 1026 (Series)**

*Direct-reading from 250 Mc/s to 4,000 Mc/s*

The Marconi Instruments TF 1026 (Series) directly-calibrated absorption wave-meters provide an easy means of checking the frequency of sources of power and together cover the range 250-4,000 Mc/s. Features include: excellent screening due to the type of fully enclosed construction employed; effective scale length of 9 inches; light weight (3 lbs. approx. each instrument); no power supply required.

The degree of coupling between input and resonant circuits is such that the accuracy of the calibration is substantially independent of changes in the type of input circuit, whether by stub aerial or direct by feeder.

Tuning is accomplished by means of a variable lumped capacitance across the line input. The effective Q is extremely high, due to the very low series resistance.

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. x 7½ ins. x 8½ ins.

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<th>Temp. Coeff. per deg. C.</th>
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**MARCONI INSTRUMENTS**

*SIGNAL GENERATORS • BRIDGES • VALVE VOLTMETERS • FREQUENCY STANDARDS WAVE METERS • WAVE ANALYSES • BEAT FREQUENCY OSCILLATORS • Q METERS*

**MARCONI INSTRUMENTS LTD • ST. ALBANS • HERTS • TELEPHONE: ST. ALBANS 6161/7**

THE range of Wearite/OAK vibrators for car radios and mobile telecommunications equipment has been especially designed for long and dependable service, whatever the extremes of climate.

The main structure is of steel and mica, so that expansion at varying temperatures is uniform, the base being sealed by the special Wearite process. The main contacts are ground to extreme limits of flatness and certain starting at the lightest of pressures and voltages is obtained by the use of non-tarnishable precious metal driving contacts. The vibrator is acoustically and electrically shielded by its sponge-rubber lined metal can.

A complete range—synchronous, non-synchronous and split-reed synchronous types—is available for all makes of car radio and other mobile equipment.

Vibrapower Units are completely self-contained assemblies for providing H.T. power from a 6 or 12 volt D.C. source. They include a tapped transformer for the selection of output voltage, buffer capacitors and basic R.F. filtering, and a Wearite/OAK vibrator of a type depending on input voltage. Provision is made for the earthed input pole to be connected to positive or negative as required.

H.T. smoothing is not included and must be externally connected, the value depending on the efficiency desired. An input filter must also be used.

The units are completely screened and are mounted on four rubber buffers to prevent possible transmission of vibration to other equipment. Full details of Wearite/OAK Vibrators and Vibrapower Units are available on request.

* Wearite vibrators are manufactured under license of the Oak Manufacturing Co. of Chicago and are covered by various patents.
It's a "5 STAR AERIAL"

The entirely new and patented "SNAPACITOR" principle, exclusive to Antiference, provides an aerial that is:

- **CORROSION PROOF**
  There are no metal-to-metal connections prone to corrosion. The capacitor couplings guarantee long life, 100 per cent electrical efficiency.

- **PRE-ASSEMBLED AND ALIGNED**
  Rods and insulator are factory-assembled and aligned as a complete aerial tuned for peak performance.

- **QUICKER TO INSTALL**
  Factory-built as a unit, packed complete in one carton, is instantly ready for mounting—no loose parts to go astray, streamlines installation time and cost.

- **LIGHTER IN WEIGHT**
  Construction is of highest-grade aluminium tubing of aircraft specification which provides maximum strength with minimum weight and widest safety margin to withstand the severest of weather conditions.

- **TRULY COMPETITIVE IN PRICE**

**MODEL X4L 'ANTEX'** with 6ft. mast and chimney lashing equipment. **LIST PRICE** £7 5/-

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

Other models for Vertical Mounting: X₄M with 10ft. x 1¾ in. dia. mast; X₄P with mast cap for mast top mounting; Horizontal mounting models include XH₄W with swan neck arm for wall mounting and XH₄L for chimney lashing, also XHE₄W and XHE₄L with 6ft. angled mast.

Full details of the complete 'Antex' range available on request.

**ANTIFERENCE LIMITED, BICESTER ROAD, AYLESBURY, BUCKS.**
Designed for Continuous Service

ATE/TMC transmission equipment is designed to offer an operating administration the maximum facility in installation and in subsequent maintenance routines. A bayside can be unpacked, carried, erected and equipped by one man if necessary. Panel frames, fitted with quickly detachable functional units, are of the “jack-in” type, an arrangement which ensures the most rapid form of servicing yet devised. Further information is contained in the brochure “Unit Construction Practice” a copy of which will be forwarded on request.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.
from 10 to 310 mc/s

Within the small compass of 14½" × 12¾" × 8", this generator provides facilities as are normally available only in instruments of much greater size and weight—and with an accuracy which suggests something far more costly. Outstanding features include: Frequency calibration ± 1% • Max. attenuation error at 300 Mc/s., ± 4 db. • Modulation (a) 30% sine wave at 1,000 c/s., (b) approximately 50/50 square wave at 1,000 c/s. • Negligible stray field • Weight 34 lb.

Fuller details contained in leaflet W-6 sent on request
Sealed
with 'Araldite'

Outstanding adhesion to metals and excellent electrical and mechanical properties combine to make 'Araldite' "the resin of choice" for sealing electrical components. Exceptionally low shrinkage on setting plus resistance to high temperatures, humidity and corrosive agents contribute further to the success of this new epoxy resin for potting or casting applications. 'Araldite' complies with the requirements stipulated for the sealing of Service equipment. Our illustration of a transformer potted in 'Araldite' is published by courtesy of the makers, Messrs. Evershed & Vignoles Ltd., who also use the same resin for sealing resistances and valve assemblies.

'Araldite' epoxies are simplifying production in many industries. Nowhere, however, is their contribution more important than in the potting and sealing of components for radio, electronics and electrical engineering generally.

THESE ARE THE NEW EPOXIES!
'Araldite' (regd.) epoxy resins are obtainable in the following forms:—
Hot and Cold setting adhesives for metals, and most other materials in common use.
Casting Resins for the electrical, mechanical and chemical engineering industries.
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Aero Research Limited
A Ciba Company
DUXFORD, CAMBRIDGE. Telephone: Sawston 187
254 644
Valve Voltmeters

Millivoltmeter Type 784

(Wide-band Amplifier and Oscilloscope Pre-Amplifier)

- Frequency range from 30 c/s to 10 Mc/s.
- Voltage ranges 0-10, 0-100, 0-1,000 millivolts.
- Excellent Stability.
- Can be used as an amplifier up to 15 Mc/s.
- Immediate delivery.

Valve Voltmeter Type 712

- Frequency range from 30 c/s to 200 Mc/s.
- Balanced, unbalanced and differential inputs.
- Measures both positive and negative D.C. voltages.
- Six resistance ranges reading up to 100 megohms.
- Balanced circuitry ensures exceptional stability.
- Very low probe input capacity.
- Immediate delivery.

Full details of these or any other Airmec instruments will be forwarded gladly upon request.
V.H.F. and TUNERS demand
... exacting quality in capacitors and resistors

ERIE High Voltage Capacitors
There is a wide selection of disc and moulded Ceramicons* for various applications, covering voltages up to a maximum of 30 kV.

ERIE High Stability Resistors
The only resistor of this class in which the supersensitive carbon film is ceramic encased. Available in ratings of ½ watt, ⅛ watt and ⅛ watt, in values ranging from 10 ohms to 10 megohms, and in tolerances down to ±1%.

ERIE Solid Moulded Carbon Resistors
Available in ratings of ¼ watt, ½ watt and ⅛ watt, either phenolic or ceramic insulated, in values ranging from 10 ohms to 10 megohms, and in tolerances down to ±5%.

ERIE Disc Ceramicons*
Available in values ranging from 2.5 PF to 30,000 PF in working voltages from 500 to 8 kV, and in tolerances down to ±10%. Capacity variations with temperature, age, and voltage are exceptionally small. A truly outstanding range.

ERIE Trimmer Capacitors
The largest and most versatile range of plastic and ceramic temperature compensating trimmer capacitors. Available in values ranging from 0.5 PF minimum to 30 PF maximum.

ERIE By-pass and Compensating Ceramicons*
For by-pass requirements, there are three types available in values ranging from 220 to 18,500 PF. For compensating, there are nine types in temperature coefficients ranging from ±100 to ±750, available in values up to ±450 PF.

ERIE Stand-off and Feed-thru Ceramicons*
Specially designed to overcome radiation and critical by-passing problems. Available in values up to ±500 PF.

*Registered Trade Marks

The frequency response of any item in a high fidelity system indicates that range of frequencies or musical pitch which is within certain clearly defined limits. These limits, in the case of high grade equipment, are usually ±2dB for Amplifiers, ±2dB for gramophone pick-ups, but ±4dB for Loudspeakers.

The balance of frequency response is most important. If only a limited bass response is available it is often desirable to impose similar limits upon the extreme treble response. When examining specifications of loudspeakers indication of the variation of response on and off axis is essential while with amplifiers it is important to know the amount of power which can be delivered at the upper and lower extremities of the range.

It is interesting to note that a number of high-quality commercial reproducers have a frequency range of up to six or seven octaves, and many so called high fidelity systems do not exceed this. A complete Tannoy home music system, however, has a range in excess of ten octaves.
“Cyldon” Capacitors have a world-wide reputation for efficiency and dependability. We welcome enquiries for types not covered by our standard range. Our resources and experience are at your service.

Equipment Manufacturers and Wholesalers are invited to write for literature covering Cyldon “Teletuners” (Ref. T.V. 1953) and Cyldon Trimmers (Ref. T. 1951), together with details of our complete range of Variable Capacitors and list of Agents for Home and Overseas.

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Contractors to Ministry of Supply, Post Office, and other H.M. Government Depts.

CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX.

Phone: Enfield 2071-2. Telegrams: “Capacity, Enfield.”
To start you talking
—and listening

Those who have followed the growth of high quality reproduction in recent years may wonder how it is possible to improve still further the amplifier part of the system. Yet, like its predecessor, the QUAD II introduces entirely new features of importance to the final objective—features anticipating trends in design of both amplifier and associated equipment.

Engineers will readily appreciate among the many salient points of design of this amplifier, the complete stability under all load conditions. They will delight too in the unique low noise pickup matching system and in the new wide range filter developments.

The gramophone enthusiast will be pleased to find that his moving coil pickup no longer requires a transformer; that each of the seven playback characteristics is accurately provided at the touch of a button; that the logical system of filter control gives him low distortion without the sacrifice of correct musical balance.

Above all, the musician will find that the QUAD II gives the closest approach to the original sound. . . . The QUAD II booklet will tell you why.
For SPECIAL PURPOSES

Complete details and prices of Ediswan Mazda photo-multipliers will be supplied on request.

* These valves are plug-in replacements for the American type 931A.
MAGNETIC MATERIALS  Extensive research and manufacturing facilities have established Mullard as the leading producers of magnetic materials. They were the first, for example, to introduce Ferroxcube, the world’s most efficient magnetic ferrite; ‘Ticonal’ anisotropic permanent magnets, renowned for their high stability and high energy output; and Magnadur, an entirely new type of permanent magnet with the insulating properties of a ceramic.

The wealth of experience gained from these developments is available to all users of magnetic materials through the Mullard advisory service. An enquiry to the address below will put a team of specialised engineers at your disposal.

Mullard

‘TICONAL’ PERMANENT MAGNETS  MAGNADUR (Formerly Ferroxdure)
PERMANENT MAGNETS  FERROXcube MAGNETIC CORE MATERIAL

MULLARD LTD., COMPONENT DIVISION, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2.
Industrial Television

The Pye company is known throughout the world for its research and development work on television. Notable advances have been the introduction of the first transformerless receiver, Pye Black Screen, Pye Automatic Picture Control, and the Pye Sequential Colour System. The demand from the great broadcasting networks of America for television cameras and transmission equipment produced by Pye continues to increase week by week.

Intensive research into every aspect of television has enabled Pye to lead in all these fields and similar foresight has now resulted in the introduction of a special camera for industrial use. The new camera is small and will transmit an extremely bright picture without special lighting. Large numbers of trainees can thus study the detail of a demonstration from screens in an adjacent lecture room, and harmful or potentially dangerous processes may be viewed by research scientists without risk.
The Pye Company has always been in the forefront of the search for ever greater realism in the reproduction of sound. The recent sensational improvements in recording technique, in particular the introduction and development of the Long Playing microgroove record, have not hitherto been matched by improvements in the quality of reproduction from the ordinary domestic radiogram or record player, which are incapable of delivering the full sound frequency spectrum and give a muffled and distorted rendering. The Pye Black Box, the first High Fidelity equipment of its kind, gives a performance of concert hall reality and allows the superb quality of the new records to be enjoyed for the first time.
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.
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.

A police patrolman singled out by Selective Calling stops to receive instructions from H.Q. over the V.H.F. radio-telephone.
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.
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.
A miniature range of Hunts Electrolytics approved to Inter-Service standards RCS 134 Issue 3 and RCL 134 Addendum Issue 2.

Temperature range: 
-30°C to +70°C max.

Please write for leaflet giving details of complete range.

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<tr>
<td>32+32</td>
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<tr>
<td>60+100</td>
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</table>

All units are insulated by a Suflex sleeve and dimensions must be increased by ½" on the length and ¼" on the diameter to allow for this sleeve.

A. H. HUNT (Capacitors) LIMITED
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No-one would believe us if we said we did—anyway, “best” in this context can mean different things to different people.

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Cables: INTAERIO, London
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For the television home constructor with his eye on professional standards

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BRITISH MADE LONG LIFE 16-INCH METAL C.R. TUBE

The tube around which the 'Tele-King,' 'Magnaview' and 'Super-Visor' circuits and 'View Master' conversion circuits were designed. * The T901A is a suitable replacement for 16in. wide angle metal C.R. tubes used in A.C. and D.C. sets, without modification.

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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.

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- 156.6 Mc/s Marine Port Control
- 156.8 Mc/s Marine Safety & Calling

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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

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WE RECOMMEND
10 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 11 in. x 6 in. Wavebands 16-50; 190-550; 1,000-2,000 metres. Bass and treble controls for cut and lift. Magic eye tuning indicator. Precision Bywheel tuning. Chassis size 12in. x 7in. Overall height 9in. Chassis height 21in. 8 Mazda valves 6C9, 6F15, 6L1, 6LD20, 6U7, 6MJ and 2 x 6P25. Speech coil impedance 3 or 15 ohms. Extension speaker sockets. Smoother 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...

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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 SUITCASE TAPE RECORDER

is the smallest

lightweight portable fully automatic tape recorder, it weighs only 33 lb., it costs only 45 GNS

COMPLETE WITH MICROPHONE & TAPE

HIRE PURCHASE
£15/15/- Deposit, 12 monthly instalments of 42/-., or 18 monthly instalments of 21/-.

CREDIT TERMS
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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 7½ in. 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. Positive servo braking on all functions. Compact size for ease of handling, only 16½in. x 12in. x 5½in. (7in. with lid). Magic eye recording indicator. Weight only approx. 33 lb. 200-250 v. A.C. Mains. Radio/Gram and Microphone Inputs.

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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.

<table>
<thead>
<tr>
<th>AMPLIFIERS AND ACCESSORIES</th>
<th>CREDIT SALE OR HIRE PURCHASE</th>
<th>DEPOSIT</th>
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<td>CASH PRICE</td>
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<td>Leak Point One TL/12</td>
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<td>Leak Varioscope</td>
<td>£12 0 0</td>
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<td>Rogers Bririo de Luxe</td>
<td>£10 10 0</td>
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<td>Burgessy AT Pre-Amplifier</td>
<td>£3 0 0</td>
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<td>CABINETS</td>
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<td>TALLON VIEWMASTER</td>
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<td>9in. Tube</td>
<td>£8 6 0</td>
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<tr>
<td>9in. Console</td>
<td>£13 15 0</td>
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<td>Burgessy Non-Auto Record Player</td>
<td>Fit Guu</td>
<td>£3 0 10</td>
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<td>Burgessy Auto Changer Record Player (Fit Monarch)</td>
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<td>CATHODE RAY TUBES, ETC.</td>
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<td>MULLARD</td>
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<td>17in.</td>
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<td>English Electric 16in.</td>
<td>£22 4 10</td>
<td>57/1</td>
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<tr>
<td>E.M.I. 10in.</td>
<td>£14 16 11</td>
<td>38/6</td>
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| GRAMOPHONE UNITS            |              |      |        |        |
| B.S.R.                      |              |      |        |        |
| Regent (GU4/TOH)            | £9 4 11 | 24/9 | £3 1 | 13/3 |
| GU/DEWI/with 2 Deca XMS      | £12 18 0 | 38/3 | £4 6 | 17/8 |
| Connoisseur 3-speed         | £23 8 11 | 59/11 | £17 6 | 3/29 |

| LOUDSPEAKERS                |              |      |        |        |
| W/COCS (B)                  |              |      |        |        |
| Golden 10                   | £7 12 0 | 21/8 | £2 11 | 12/0 |
| Bronze 10                   | £16 13 0 | 43/6 | £6 10 | 3/8 |
| Super 8CSA                  | £6 13 0 | 19/5 | £2 4 | 5/6 |
| Super 8                     | £6 18 0 | 19/8 | £2 4 | 5/6 |
| Bronze 8                    | £3 3 11 | 13/5 | £1 4 | 6/6 |
| Super 5                     | £2 0 0 | 8/6 | £1 6 | 5/6 |
| W.B.                       |              |      |        |        |
| 12in. Concentric Duplex (less transformer) | £22 11 0 | 57/11 | £7 10 | 29/6 |
| Ditto (with transformer)    | £23 16 0 | 60/0 | £7 19 | 0/30/9 |
| 10in. Concentric Duplex (less transformer) | £9 7 6 | 24/11 | £3 13 | 15/3 |
| Ditto (with transformer)    | £10 15 0 | 28/6 | £3 12 | 0/13/4 |
| Tweeter Unit                | £3 15 6 | 12/2 | £1 5 | 7/6 |
| HFP10 High Fidelity         | £2 0 11 | 12/6 | £1 9 | 6/6 |
| HFP9 High Fidelity          | £3 0 6 | 10/1 | £1 0 | 2/6/6 |
| HFP11 High Fidelity         | £3 0 11 | 12/6 | £1 0 | 6/7/3 |

| GOODMANS                    |              |      |        |        |
| Axiom 22                    | £14 11 0 | 37/6/5 | £6 4 | 0/19/2 |
| Axiom 101                   | £6 12 1 | 19/2 | £2 4 | 0/10/7 |
| Axiom 102                   | £9 16 0 | 26/5 | £3 6 | 0/14/0 |
| Axiom 150                   | £10 5 0 | 27/6 | £3 8 | 0/14/0 |
| Audion 60                   | £16 12 8 | 23/6 | £2 17 | 6/12/11 |

| RECORD PLAYERS            |              |      |        |        |
| E.A.R.                     |              |      |        |        |
| Music Maker Non-Auto       | £19 15 0 | 49/6 | £6 11 | 8/25/4 |
| Music Maker Auto           | £24 17 6 | 62/2 | £8 5 | 10/31/6 |

| PICK-UPS                   |              |      |        |        |
| Aco GP20                   | £3 6 0 | 11/1 | £1 2 | 0/6/ |
| Connoisseur Super Lightweight (2 heads) | £5 9 5 | 23/6 | £3 1 10/3/6 |
| Deco XMS (2 heads)         | £6 9 3 | 19/0 | £2 3 | 1/10 |
| RONETTE                    | £3 9 6 | 11/1 | £1 3 | 2/7/4 |
| Miniweight (14,000 c/s) (2 heads) | £16 3 | 12/10 | £1 5 | 5/7/4 |

| RECORD PLAYERS             |              |      |        |        |
| BURGOYNE                   |              |      |        |        |
| Auto 3-speed               | £16 10 0 | 42/5 | £5 10 | 20/1/8 |
| Auto 3-speed               | £9 5 0 | 25/3 | £2 1 | 8/6/4 |

| RADIO RECEIVERS and CHASSIS |              |      |        |        |
| BURGOYNE                   |              |      |        |        |
| RG1 Superhet 8 valve       | £23 2 0 | 59/8 | £7 14 | 0/29/ |
| RPI Feeder Unit            | £3 12 1 | 11/4 | £2 7 | 2/6/4 |
| Leak Tuner                 | £35 0 0 | 89/0 | £11 13 | 4/4/6/6 |

| TEST EQUIPMENT              |              |      |        |        |
| AVO                         |              |      |        |        |
| heavy Duty Meter            | £15 0 0 | 38/5 | £5 0 | 2/0/0 |
| Model 7 of 40 Meter         | £19 10 0 | 49/9 | £6 10 | 2/6/6 |
| Universal Minor             | £10 10 0 | 27/6 | £3 10 | 0/15/0 |
| Signal Generator, Mains or Battery | £30 0 0 | 74/10 | £0 0 | 0/39/ |
| Universal Bridge            | £34 0 0 | 86/2 | £1 12 | 0/42/ |
| Electronic Test Meter       | £40 0 0 | 102/3 | £13 6 | 8/30/9 |
| Valve Characteristic Meter  | £60 0 0 | 153/0 | £20 0 | 7/5/2 |
| D.C. Minor                  | £5 5 0 | 16/1 | £1 15 | 9/0/2 |
| Model 8 Meter               | £23 10 0 | 60/0 | £7 16 | 3/30/4 |
| Leather cases for 7, 8, 40 and heavy duty meters | £3 0 0 | 9/6 | £1 0 | 0/5/ |

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(As illustrated.)
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(As illustrated.)
A 1261 30 Watts Portable AC Mains.
A 1262 12 Volt Power unit for A 1261.
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Special Amplifiers, Transformers, Chokes and Laboratory Apparatus. A full range of Microphones and Loudspeakers available. For superb reproduction of gramophone records use the Monarch or Regent and A 1254. Obtain details from your local retailer or wholesaler. In case of difficulty and all overseas enquiries, write to "Dept. AB" at the address below.

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ALONG WITH
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✓ LIGHT WEIGHT

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FOR ANY OF YOUR STANDARD
OR SPECIAL APPLICATIONS

A few of the very low capacitance types are:

<table>
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<tr>
<th>Type No.</th>
<th>Capacit. μm F/ft</th>
<th>Impedance ohms</th>
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<td>7.3</td>
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<td>0.36&quot;</td>
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MICRO VOLTS DOWN TO 10
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Improved single and double beam 'scopes with D.C. amplifiers—Now available in twelve standard models with most useful aids for the unusual problem plus versatility in daily laboratory use.

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High Fidelity Microcell pick-up heads are designed for high standard of tonal balance, optimum tracking, negligible record wear, freedom from surface noise, cantilever suspension of the stylus, standard 3-pin fitting, interchangeability, and stylus replaceability by the user. Correction is only required with high-gain amplification. Bass-boost is available. These heads are suitable for use with leading record makers.

Hudson Radio-Telephones

**MODELS**

**AM 250/M** 5 watt Mobile 60 to 100 Mc/s
**AM 250/M** MK2 as above but with P.A.
**AM 150/M** 5 watt Mobile 100 to 185 Mc/s
**AM 250/F** 6 watt Fixed Station 60 to 100 Mc/s
**AM 150/F** 5 watt Fixed Station 100 to 185 Mc/s
**HED 102** Walkie-Talkie 60 to 132 Mc/s
**FM 101** 10 watt FM Fixed Station 60 to 185 Mc/s
**FM 102** 10 watt FM Mobile Station 60 to 185 Mc/s

Supplied to the G.P.O. and the Home Office

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Mr. J. G. G. 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

EGEN ELECTRIC LTD
CHARFLEET INDUSTRIAL ESTATE - CANVEY ISLAND - ESSEX

'R.E.C.M.F. STAND 20 APRIL 6th-8th
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 waveform. 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.

GOODMANS INDUSTRIES LIMITED, Axiom Works - Wembley - Middx - Wembley 1200 (8 lines) GD
Telcon Multicore Cables

for electronic and radio engineering

Whilst Telcon Multicore Cables are designed primarily for aircraft wiring, they are also eminently suitable for the varying needs of the electronic and radio engineer.

Available in a range of from 2 to 25 cores, with alternative finishes, Telcon Multicore Cables are colour-coded for easy reference. Fully illustrated and detailed publication, ref MC/1, is available free on request.

THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO. LTD
Works: Telcon Works, Greenwich, S.E.10. Tel: GREenwich 3291
Branch Office: 43 Fountain St., Manchester, 2. Tel: Central 0758
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.

<table>
<thead>
<tr>
<th>Junction transistor type</th>
<th>OC10</th>
<th>OC11</th>
<th>OC12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. D.C. negative collector-to-emitter voltage (V)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Typical D.C. collector voltage (V)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Typical collector current (mA)</td>
<td>-0.5</td>
<td>-0.5</td>
<td>-2</td>
</tr>
<tr>
<td>Current amplification factor ($\alpha'$) with grounded emitter</td>
<td>17</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Output resistance with infinite A.C. source impedance (grounded base) (KΩ)</td>
<td>700</td>
<td>700</td>
<td>500</td>
</tr>
<tr>
<td>Special low-noise characteristics</td>
<td>★</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
AERFRINGE—For long-distance reception this range has the high electrical performance which is essential. The robust construction ensures long service even in the most exposed conditions. The range is available with 10ft. or 14ft. alloy mast and double chimney lashings or arrays only. Prices from £12/15/- complete (Model 63).

DUBLEX—Special folded dipole construction plus driven array connections make the Dublex the highest gain aerial in this price bracket. The Dublex (as supplied to the B.B.C.) is available with 7ft., 10ft. or 14ft. mast versions or as an array only. The Dublex 77S (7ft. mast single lashing bracket) is £4/8/- complete. (Mast and array is only 3.2 lbs.)

UNEX—Light in weight, high in performance, the Unex combines excellent forward gain with robust construction at a low price. The cross-connected elements give a driven array which is extremely easy to erect. The Unex 83S (with 6ft. alloy mast, single lashing chimney bracket) is only £3/19/6 complete.

AERFOLD—Where conditions do not allow an outdoor aerial to be fitted, the Aerfold provides a high gain aerial which has excellent directivity. It is easy to fit and by rotation will eliminate or substantially reduce interference. Price £1/5/-.

Model 63A
Forward Gain 8 dB
Front/back Ratio 21.6 dB
Acceptance Angle 55°

Model 77
Forward Gain 6 dB
Max/min Ratio 25 dB
Acceptance Angle 96°

Model 83
Forward Gain 3 dB
Front/back Ratio 25 dB
Acceptance Angle 176°

Model 71
Forward Gain 3.75 dB
Max/min Ratio 40 dB
Acceptance Angle 120°

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Designed to measure the inductance of iron cored chokes with d.c. flowing. Inductance range 0 to 1000 H. Superimposed d.c. continuously variable from 0 to 1 amp.

AUTOMATIC FREQUENCY MONITOR (20 Mc/s.)
An extension of the well known range of 'Cintel' monitors, this new instrument will measure any frequency in the range 10 c/s to 20 Mc/s and present the answer in decimal notation on 8 panel mounted meters.

These new instruments together with the redesigned Flying-Spot Microscope MK II will be on view for the first time on STAND 38 at the PHYSICAL SOCIETY EXHIBITION, 8th-13th April Inc.

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A Company within the J. Arthur Rank Organisation

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enhancing those, we have
already met!

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The complete range of control knobs you’ve been waiting for! 16 special GOLD FILLED inscriptions that will meet the demand of every radio, T/V, tape recorder or amplifier enthusiast—beautifully made and designed to enhance the appearance of every commercial or amateur constructed set.

Sizes: Type "A" 1½" dia. Type "B" 1¾" dia. Both types are ½" deep.

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"Brilliance/On-Off.

AMPLIFIER: "Bass," "Treble" (plus any of above).

TAPE RECORDER: "Record-Play" (plus any of above).

AVAILABLE IN WALNUT OR IVORY, ALSO BLACK TO SPECIAL ORDER.

PRICES: Type "A," 1/6 each; Type "B," 1/2 each.
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GRAMOPHONE EQUIPMENT

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Turnover Crystal head (for TA/AC)

- TA/AC or TB. 3-sp. (less heads)
- Honed stator tunnel giving true electrical
- Thrust ball for spindle bearing.

GARRARD Min.

DECCA XMS-Std. or "H" LP

Turnover Magnetic head (for TA/AC)

- GARRARD
- THE " COLLARD " 3-speed Studio TRAN
- eight ranges.
- Completely built General Purpose amplifier suitable for most desks
- R/P or Erase Heads
- Also Complete "SOUNDMASTER" Kit.

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Main plate (Drilled—16-jin. x 14-jin.)... 52/6
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- (Send S.A.E. for detailed list)
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- Truvox 22 gns.
- Lane £17/10

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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.

Tracking weight—8 grammes.

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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

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Works—West Drayton
NEGLIGIBLE BACKGROUND NOISE
M.S.S. disks permit of a dynamic range greater than 60 db. at 78 r.p.m. (max. stylus vel. 8 cm/sec., r.m.s.) and greater than 54 db. at 33 r.p.m.

WIDE FREQUENCY RESPONSE
The quality of the equipment used is the only likely limitation of the recording range of M.S.S. disks.

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The anti-static properties of M.S.S. disks ensure that with a correctly designed cutter the swarf is thrown towards the centre of the disk in a manner allowing of easy removal.

HIGH RESISTANCE TO WEAR
The groove walls of all M.S.S. disks will stand up to constant playback without diminishing the level of the higher frequencies.

SUITABILITY FOR PROCESSING
M.S.S. disks fulfill all processing needs; a special feature is the absence of the 'horn' or 'hangnail' at the groove edges even at high stylus velocities—a valuable advantage in microgroove recording.

RESISTANCE TO AGEING AND CLIMATE
M.S.S disks can be stored, blank or recorded, for indefinite periods under extremes of climate without loss of quality or performance.

FOUR GRADES SAVE YOU COST
A grading system based on selection enables you to choose the right priced disk for the job. For example, top grade disks must be beyond reproach in appearance as well as performance, and are, therefore, selected to conform to extra stringent standards of quality.

You can be certain of a perfect recording with M.S.S. disks. That is why so many leading recording and broadcasting companies throughout the world always use them. Let us send you further information on the four grades of M.S.S. disks available.

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Manufacturers of Sound Recording Equipment
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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**: 3/16in./7/16in. per sec.
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- **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.

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**DISTORTIONLESS SUPERHET 3-WAVE RADIO TUNER UNIT**

May be fitted in a few minutes.

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Hand unit in rubber grip...3 gns.

Studio Floor-stand Pattern...6 gns.

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**TEST RESULTS AND OPERATING RECOMMENDATIONS INCLUDED WITH EACH CELL**

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OF ELLIPTICAL
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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.

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Ever Ready Plastic 4 pin battery plug has been specially designed to ensure correct and easy battery connections. Plugs are fitted with four staggered metal pins, also four coloured wires 18" in length. List Price 2/- complete. Suitable for use with BSS 1766-1951.

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A balanced service life of 300 hours is obtained when the high tension current is 10.5 mA at 90 volts and the low tension current 125 mA at 1.4 volts; the respective cut-off voltages being 40v and 1.0v on load. The maximum battery dimensions are 71/8" x 3 3/8" x 4" and the weight is 5 lbs. 10 oz. Price 16/—.
Output Level Stabilised to $\pm \frac{1}{2}\text{db}$

OVER THE FULL FREQUENCY RANGE OF 10 Kc/s — 10 Mc/s.

An outstanding feature of the Wayne Kerr Video Oscillator Type 0.222A is a thermistor bridge circuit stabilising the amplitude. Once set the output level will remain constant within 0.5 db while the oscillator frequency is varied over its full range of 10 Kc/s to 10 Mc/s. Another advantage is its special facility for indicating the modulus of the load impedance to which the instrument is connected.

SPECIFICATION

| Frequency Range | 10 Kc/s — 10 Mc/s in 6 ranges |
| Frequency Stability | better than 1 in $10^6$ in 1 hour |
| Frequency Accuracy | 1% |
| Output Range | $+10\text{db to } -50\text{db on 1V p-p.}$ |
| Output Level | Constant to $\pm 0.5\text{db at any frequency}$ |
| Output Impedance | 75 ohms (setting less than 1% |
| Total Harmonic Content | THE WAYNE KERR LABORATORIES LTD · NEW MALDEN · SURREY |
WILLIAMSON AMPLIFIER KITS

With PARTRIDGE output transformer, mains transformer and chokes. Fully drilled and enamelled chassis, T.C.C. condensers, Marconi-Osram-Cossor valves, sundries by Belling & Lee, Erie, Bulgin, Welwyn, etc., complete to the last nut and bolt, with wiring instructions and layout drawings.

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A simple inexpensive pre-amplifier for use with Tele-Radio Williamson kits. Specification includes full control of bass and treble, radio input and switched compensation for 78 r.p.m. and L.P. records. Recommended for use with Acos GP20 and HGP39, Decca "C" and "D" and Connoisseur heads. With wiring instructions and layout drawings.

KIT OF PARTS 6½ GNS. READY BUILT 8½ GNS.
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RAINHAM, ESSEX. Telephone: Rainham Essex 3322

London Sales Office: CENTRAL HOUSE, UPPER WOBURN PLACE, W.C.I. Telephone: EUSton 8265
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

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MODEL 2
A 3 watt high fidelity amplifier for outstanding reproduction of all types of gramophone records.
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A 15 watt high fidelity amplifier giving superlative reproduction from records or radio. Less than 0.1% distortion at 10 watts.
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S.L.8 SPIN WHEEL DRIVE. A precision slide rule drive complete with 3 band glass scale. The spin wheel drive gives perfect control through ratio 24:1. Fitted with constant velocity coupling, eliminating strain on condenser and providing mechanical and electrical isolation from vibration and noise.

M.G. GANG CONDENSER. Available as 1, 2 or 3 gang, 490 p.F. nominal capacity, matched and standardised to close limits. Cadmium plated steel frame. Aluminium Vanes. Low loss non-hygroscopic insulation. Length excluding spindle: 1 gang—1 1/4 in. to 3 gang—3 1/4 in.

Price 1 gang, 9/3, 2 gang, 14/-, 3 gang, 18/6.

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Our large number of satisfied customers to date is the finest possible testimonial to the efficiency of Leak models—and that is why we confidently recommend the new TL/10 as one of the best "value for money" amplifiers available. We look forward to your early post enquiries or a personal visit at our showrooms.

Demonstrations Daily at 90/94, Fleet Street.

Our stock of Leak models, loudspeakers, record players, Tuners, Gram Units, etc. is there for your inspection.

Easy Payment Terms on the new Leak TL/10 are £10/7/- deposit, and the balance 12 monthly payments of 33/4 or 18 of 23/4.

Why not PART EXCHANGE your present equipment for the latest type?

Write with details.
Discouraging 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 102 £9 18.2 (Inc. Tax)
AXIOM 150 MK. II £10 5.6 (Tax free) AXIOM 101 £6 12.1 (Inc. Tax)
Radio Mechanics

AND

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GARRAD 3-SPEED GRAM UNIT MODEL "T."

With turnover Magnetic Pick-up Head or Turnover Astatic Crystal Head, £10, post and pack 2/6.

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as above, but fitted with the latest High-Fidelity Aco HGF35 Pick-up Heads (one for Std.


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30in. high, consists of fully-cut jin. thick, heavy, inert, non-resonant patent acoustic board, deflector piece, felt, all screws, etc., and full instructions. £15 10/6. £10 10/6. Carryage according to area. The 10in. model is ideal for the WB HF 1012 (see "The Gramophone" review March).

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APRIL 6th TO 8th, 1954

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The NEW ACOUSTICAL "QUAD. II" Amplifier

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The NEW LEAK AMPLIFIER "TL/10"

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Before buying a tape recorder we earnestly advise you to hear the "REFLECTOGRAPH." The "HOME" model costs £87/0/0 and gives outstandingly good reproduction. Other models are available for industrial, scientific and educational use.

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5 - 18 kV D.C. and
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Please write for illustrated leaflet.

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**ABRIDGED DATA**

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**METERS**

**LARGE AND VARIED STOCKS AVAILABLE FOR IMMEDIATE DELIVERY**

**EXAMPLES FROM OUR RANGE OF 2¼ inch FLUSH PATTERN (as illustrated)**

<table>
<thead>
<tr>
<th>Range</th>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-0-50</td>
<td>Microamps</td>
<td></td>
</tr>
<tr>
<td>100-0-100</td>
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<tr>
<td>250-0-250</td>
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<td>500-0-500</td>
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<tr>
<td>1-0-1</td>
<td>Milliamps</td>
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<tr>
<td>0-100</td>
<td>Microamps</td>
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<tr>
<td>0-10</td>
<td>Milliamps</td>
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<tr>
<td>0-15</td>
<td>Millivolts</td>
<td></td>
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<tr>
<td>0-25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We can supply meters with NON-STANDARD, CURRENT and VOLTAGE RANGES to any specification. DELIVERY 7-14 days.

**ANDERS ELECTRONICS LTD.**

91, HAMPSTEAD ROAD, LONDON, N.W.1.

Telephone: EUSTON 1639

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---

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---

**CLASSIC CABINET** £27 10 0

**QUAD RADIO UNIT** £24 0 0

**QUAD MARK II AMPLIFIER** £42 0 0

**CONNOISSEUR MOTOR WITH TWO PICK-UPS** £27 10 0

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**CLASSIC CABINET** £27 10 0

**LEAK RADIO UNIT** £34 19 0

**LEAK POINT-ONE AMPLIFIER** £40 9 0

(With Vari-slope pre-amp.)

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---

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2 LOWTHER PICK-UPS £21 10 0

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**ROGERS JUNIOR PRE-AMP** £9 0 0

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A series of Application Reports under the general title given above is in course of preparation by The General Electric Co. Ltd. The first report of the series, entitled "Principles and Design of Small Signal Amplifiers", will be distributed to subscribers to our Technical Data Service. Additional copies may be obtained, without charge, on application to the address below. These Application Reports are the first fruits of an intensive transistor application programme initiated by the G.E.C. Research Laboratories prior to the release of the GET1 point-contact transistor a year ago. It is believed that they will prove a notable addition to the rather sparse literature on the subject at present available in this country. Some thousands of GET1 transistors have already been supplied to many manufacturers' Research Depts., and much valuable information has been gained on the application and circuitry of this new and revolutionary device. The release of junction type transistors is anticipated shortly. Manufacturers and others interested are invited to write to:

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1 Chassis Brackets 1 6
1 Drive Spindle (Rear Drive) 1 6
1 Drive Drum 1 3
1 Drive Spring 1 3
1 Defe Pointer 1 3
1 Dial 1 6
1 Front Plate 2 6
2 Dial Clips L.H. 5 6
2 Dial Clips R.H. 5 6
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SPECIAL PRICE FOR COMPLETE SECTION £1/5/6 plus packing and postage 2/6.

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- 1 Wave-change Switch 2 6
- 2-gang Variable Condenser with Trimmers 8 6

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SECTION 2

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2 Amps Tapped at 5 volts 5 6
1 Output Transformer Ratio 45/1 6 6
1 Volume Control 10 K ohm with Switch 4 6

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- The NEW PREMIER T.R.F. RECEIVER design
- You can build the Receivers illustrated for £5.15.0
- The circuit is the latest type TRF using 3 Valves and Metal Rectifiers for operation on 200/250 volt A.C. mains. Waveband coverage is 180/350 metres on medium wave and 800/2,000 metres on long wave. The Dial is illuminated and the Valve line up is: 6K7-H.P. Pentode, 6L7-Detector and 6V6-Output. The attractive Cabinets to house the Receiver; size 12ln. long 6in. high, 51/2 in. deep, can be supplied in either WALNET or IVORY BAKELITE or WOOD.

- INSTRUCTIONAL BOOKLET
- 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

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

Brief Specification: VALVE LINE-UP: EP7A First Stage, 6L7 Second Stage and Tone Control; 9V1 Output (2 X R.F. Receiver; VT911A Bias and Iron Oscillator; 7193 Record Level Amplifier; 6G5 Single Eye Record Level Indicator. OUTPUT: 4 Watts. FREQUENCY RANGE: 30 p.s. to 10,000 p.s. CONTROLS: Volume; Record/Playback Switch; Treble Boost; Bass Boost on/off; 7193 Record Level Amplifier; 6U6 Magic Eye Record Level Indicator. OUTPUT: 600/2,000 metres on long wave. The circuit is the latest type TRF using 3 Valves and Metal Rectifiers for operation on 200/250 volt A.C. mains. Waveband coverage is 180/350 metres on medium wave and 800/2,000 metres on long wave. The Dial is illuminated and the Valve line up is: 6K7-H.P. Pentode, 6L7-Detector and 6V6-Output. The attractive Cabinets to house the Receiver; size 12ln. long 6in. high, 51/2 in. deep, can be supplied in either WALNET or IVORY BAKELITE or WOOD.

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* INSTRUCTIONAL BOOKLET 2/6

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Supplied completely assembled 39 GNS. Plus 1/- pkg. & Carr.
MAY BE BUILT FOR

£31.19.7
including all valves.
(plus cost of CRT)

The COMPLETE TELEVISOR IS SAFE TO HANDLE, BEING
COMPLETELY ISOLATED FROM THE MAINS BY A
DOUBLE WOUND MAINS TRANSFORMER. ALL PRESET
CONTROLS CAN BE ADJUSTED FROM THE FRONT.
MAKING SETTING UP VERY SIMPLE.

The Televisor may be constructed in 5 easy stages: (1) Vision, (2) Time Base, (3) Sound, (4) Power Pack, (5) Final Assembly. Each stage is fully covered in the Instruction Book, which includes layout, circuit diagrams and point-to-point wiring instructions.

PRICE £13.10.0
plus 21/- packing & carriage.

Three years ago we gave you the 6in., 9in. and 12in. Televisors which achieved tremendous popularity. Now, after a considerable period of research our Technical Staff have designed a very worthy successor to these original Models.

Brief Technical Details are as follows:
20 valves (plus tube) Superhet Receiver, tunable from 40-68 Mc/s, without coil or core changing. Wide Angle scanning Flyback EHT giving 14 kV, Duomag Focaliser permanent magnet focussing with simple picture centering adjustments, suitable for any 17in. or 14in. wide angle Tube, may also be used with a 12in. Tube with very minor modifications.

VISION CIRCUIT. Common RF Amplifier, single valve frequency changer, two IF stages, Video Detector and Noise Limiter followed by special type of Video Output Valve. ALL COILS PRE-TUNED ASSURING ACCURATE ALIGNMENT AND EXCELLENT BANDWIDTH.

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LINE TIME BASE. Blocking Oscillator using a pentode driving a high efficiency output stage comprising Ferroxcube Cored Output Transformer with Booster Diode.

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POWER PACK. Double wound Mains Transformer supplying all L.T. and H.T. using two full-wave Rectifiers.

The Instruction Book also includes full details for converting existing Premier Magnetic Televisors for use with modern wide angle tubes. All components are individually priced.

Instruction book 3/-, Post Free.

A handsome Walnut Cabinet that will be a fitting housing for a first-class Telegraph
Primarily designed for our own Televisor, they are quite suitable for most designs published in the various Radio Periodicals. Folding doors are fitted to cover the Cathode Ray Tube when not in use. A flap is provided which gives access to any preset controls on the front edge of the Chassis. A baffle board suitable for a 10in. Loudspeaker and all the necessary Tube and Chassis bearers are included. The overall dimensions of both Cabinets are the same: Height 38½in. Width 19in. Depth Top 19in. Depth Bottom 21in.

TUBE ESCUTCHEONS

<table>
<thead>
<tr>
<th>Tube Size</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>17in.</td>
<td>White Moulded</td>
<td>21/- (packaging and postage 1/-)</td>
</tr>
<tr>
<td>17in.</td>
<td>Bronze Moulded, Complete with Protective Glass</td>
<td>48/- (packaging and postage 2/-)</td>
</tr>
<tr>
<td>14in.</td>
<td>Black Moulded</td>
<td>7/- (packaging and postage 1/2)</td>
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<td></td>
<td>Dark Screen Filter suitable for 14in. or 17in. Tubes</td>
<td>19/- (plus 1/- packaging and postage)</td>
</tr>
</tbody>
</table>

PREMIER TELEVISOR

CONSOLE CABINETS

For 14" and 17" Televisors
**PREMIER RADIO COMPANY**

**ONLY A FEW LEFT!**

THE FAMOUS "SOBBEL" 4-VALVE SUPERHET TABLE RECEIVER

M. & L. WAVEBANDS

Valve line-up: 12AT7, 35L6, 12AX7, 35Q6.


£8.5.0

Fully covered by Manufacturer's Guarantee

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**1124 RECEIVER UNITS**

In original cases complete with 10 valves. Frequencies covered 10.5 Mc/s to 30.5 Mc/s. Height 11.5/6, width 9.5/6, depth 3.6/6. Price £28.10.0.

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**1155 RECEIVER UNIT**

As a special offer, power supply unit including transformer, 2 gang .0005 raid. with trimmers for bass and treble. The ideal short-wave converter for T.V., variable tuning. Suitable for circuits in manufacturer's surplus stock. 12J7, 12Q7, 35L13, 12Q6. Price £25.15.0.

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**At last!**

A 4-watt AMPLIFIER KIT with everything for £4-10-0

Plus 2/6 Postage & Pack.

**METERS**

Valve line-up 6SL7, 6V6 and 6X5. For A.M. Mains 75/100 250 Volts. The twin-tube 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 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 feedback is applied from the secondary of the output transformer across the output transformer 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.

**SPEAKERS**

Contains 7 tweeter and 2 woofer. The ideal speaker for the 1124 receiver. Price 15/-.

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**MATERIALS**

LOUDSPEAKERS

ELAC-20 units, Moving Coil, 3 ohms imp. 15/6. Plus 7/6 post, pkg. & Ins.

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**WEYMOUTH MINIATURE COIL PACK**

Covering Metal Knob/Short Waveband. For iron cored, planar converters only, diam. 15/6, length 5/6, width 5/6. Price 15/6.

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**ACCESSORIES**

**PREMIER VARIABLE IMPEDANCE AMPLIFIER KIT**

Suitable for circuits in manufacturer's surplus stock. 12J7, 12Q7, 35L13. Price £25.15.0.

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**VARIABLE RESISTORS**


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**ELECTRICAL WIRE**

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Covering Metal Knob/Short Waveband. For iron cored, planar converters only, diam. 15/6, length 5/6, width 5/6. Price 15/6.

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**MINIATURE MICROPHONES**

3 gang 15/6 with trimmers. Price £2.10.0.

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**FILAMENT TRANSFORMERS**


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**BATTERY CHARGERS**

Suitable for all types of radio. Price 2/6.

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**MICROPHONES**

**CRYSTAL MICROPHONE**

An extremely sensitive crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance, no background noise, really natural tone. Price £10.10.0.

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**CABLES**

**BATTERY CHARGER KITS**

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**FLATHEADS**

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**BATTERY CHARGERS**

3 gang 15/6 with trimmers. Price £2.10.0.

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**MICROPHONES**

**CRYSTAL MICROPHONE**


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**CRYSTAL MICROPHONE**

An extremely sensitive crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance, no background noise, really natural tone. Price £10.10.0.

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**BATTERY CHARGERS**

Suitable for all types of radio. Price 2/6.

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**MICROPHONES**

**CRYSTAL MICROPHONE**


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**CRYSTAL MICROPHONE**

An extremely sensitive crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance, no background noise, really natural tone. Price £10.10.0.
SPECIAL OFFER
THE FAMOUS "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP—TYPE GPX for Standard and Long Playing

The Chancery Light Weight, GPX Pick-up which has a Sapphire stylus which is precision ground and will not wear. With two cartridges L.P. and 1 Standard Price £5. Additional L.P. or Standard ground and semi-permanent. With two cartridges 1 L.P.

TYPE GPX for Standard and Long Playing

For use on 200/230 v. A.C. mains 60 cycles.
The Motor, Tone arm, and Magnetic Pick-up is in one

SPECIAL OFFER—at Almost

FIDELITY MICROCELL PICK-UP—THE FAMOUS "CHANCERY"

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UNITS

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★ The control—so simple—so handy.

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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 Vosc range from 2 volts to 5 volts, therefore a Vosc 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 Vosc, 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.

D A T A

HEATER

| l_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_e | ... | -2.0 V |
| g_m | ... | 6.2 mA/V |
| r_a | ... | 400 k Ω |

| Triode Section | | |
|----------------|------------------|
| V_a | ... | 100 V |
| I_a | ... | 14 mA |
| V_e | ... | -2.0 V |
| g_m | ... | 5.0 mA/V |
| µ (approx.) | ... | 20 |

TYPICAL OPERATING CONDITIONS

As a frequency changer

| V_a | ... | 170 V |
| V_g2 | ... | 170 V |
| R_g2 | ... | 100 k Ω |
| R_k | ... | 820 Ω |
| I_a | ... | 5.2 mA |
| I_g2 | ... | 1.5 mA |
| VOSC (r.m.s.) | ... | 3.5 V |
| g_c | ... | 2.1 mA |
| r_a | ... | 870 k Ω |

BASE B9A

LIMITING VALUES

Pentode Section

| V_b | max. | ... | 250 V |
| p_b | max. | ... | 1.7 W |
| V_g2 | max. (I_b = 14 mA) | ... | 175 V |
| V_g2 | max. (I_b = 10 mA) | ... | 200 V |
| p_b | max. | ... | 0.5 W |
| I_k | max. | ... | 14 mA |
| V_b-k | max. | ... | 150 V |

Triode Section

| V_b | max. | ... | 250 V |
| p_b | max. | ... | 1.5 W |
| I_k | max. | ... | 14 mA |
| V_b-k | max. | ... | ± 90 V |

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 MV267
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Use the BRIMAR 12AT7

with improved performance — at NO EXTRA COST

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**STAND No. 76**
**R.E.C.M.F. EXHIBITION**

*COSMOCORD LIMITED • ENFIELD • MIDDLESEX*
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."

---

### 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—with 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: 1\(\text{in.}\) x \(\frac{1}{2}\text{in.}\) dia.**

Many ratings of the well-known general purpose instrument fuse-link, L.1053, 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 7-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*
EMI RECORDING EQUIPMENT

USED BY
THE EXPERTS
IN THE WORLD'S
GREATEST
BROADCASTING
ORGANISATIONS
AND LEADING
RECORDING
STUDIOS

Model TR/50 — A mains/transportable professional tape recorder available in two versions. Two speeds, either 15" and 7 1/2", or 7 1/2" and 3 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 1/2", 3 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/-.

Leaflets on these products are obtainable from:

EMI SALES & SERVICE LTD.
RECORDING EQUIPMENT DIVISION
HAYES, MIDDLESEX
Telephone: SOUTHWELL 2168

EMICORDA
Model L/2
Model TR/50
EMITAPE
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.

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Surveyed, planned, installed, maintained

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A NEW TREND IN PIEZO-ELECTRIC PICK-UP DESIGN

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.

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.
The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22¼in. x 15½in. and weighs 30 lb.

**PRICE**, complete with **WEARITE TAPE DECK** ................................................. £84 0 0

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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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The new Cossor Double Beam Oscillograph

MODEL 1052

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and Voltage Calibrator

MODEL 1433

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Both types operate at minimum input levels of 0.5 volts, type M1 at frequencies up to 5 Mc/s and type M3 up to 100 kc/s.

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AGC rectifiers: muting circuits; contrast expansion and compression; level indicators; modulation depth indicators; limiters; automatic frequency control.

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- Self Capacitance: 0.22 pF
- Forward Resistance at 5 V.D.C.: 10 kΩ
- Reverse resistance at 5 V.D.C.: 1,000 MΩ
- Maximum Peak Inverse Voltage: 68 V
- Minimum A.C. Input: 0.5 V
- Maximum Frequency: 5 Mc/s

**Type M3**

- Self Capacitance: 0.65 pF
- Forward Resistance at 5 V.D.C.: 1.2 kΩ
- Reverse Resistance at 5 V.D.C.: 45 MΩ
- Maximum Peak Inverse Voltage: 68 V
- Minimum A.C. Input: 0.5 V
- Maximum Frequency: 100 kc/s
Manufacturers of equipment, and development groups are invited to send today for this NEW complete catalogue of Ediswan Clix Radio, Television and Electronic Components. Just write “Components Catalogue please” on your business letterhead and we will send you a copy.

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CLIX

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Ideal for critical installations where clear speech reproduction is of first importance. Gives three or four times the coverage of conventional cabinet speakers. Excellent as a local intensifier. Handles up to 3 watts.

LIST PRICE £7 Less Transformer (No RT)

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ROLA CELESTION LTD.
Ferry Works, Thames Ditton, Surrey.
Phone: Emberbrook 3402-6.

We are indebted to Mr. Wm. Buxton for the following comments on our Radiograms:-

“Having heard many Radiograms costing between £80 and £120, and never somehow feeling satisfied at the quality of tone, etc., I luckily heard a friend of mine had purchased a Sound Sales Radiogram, and of course I had to go and hear what it was like, suspecting that it would be like the rest of them, but, 'Oh Boy' this was 'IT'—the best of the best.”

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3-speed Model . . . . . . . . . . . £64.1.5 (including purchase tax)

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A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.
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Frequency Response: ±1 db 20 c/s to 20,000 c/s.
Harmonic Distortion: 0.1%, 1,000 c/s, 7.5 watts output.
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Damping Factor: 25.
Hum: -80 db referred to 10 watts.
Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

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The handsome gold escutcheon plate contributes to the elegant appearance, and blends with all woods.
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The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.
★ Radio
The radio input sockets at the rear permit the connection of any tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.
★ Distortion
Of the order of 0.1%
★ Hum
Negligible, due to the use of recently developed valves and special techniques.
★ Input selector
Radio, tape, records; any and all records can be accurately equalised.
★ Treble
Continuously variable, +9 db to -15 db at 10,000 c/s.
★ Bass
Continuously variable, +12 db to -13 db at 40 c/s.
★ Volume Control and switch
The switch controls the power supply to the TL/10 power amplifier.
★ Tape Recording Jacks
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Type 12/20 moving coil loudspeaker is usually employed as a L.F. reproducer in dual channel systems of this type used in cinemas. Power handling capacity is 40 watts.

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Type B.52 microphone incorporates matching transformer in place of switch and connects to grid or collector circuit for high grade sound reinforcement.

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<th>Value</th>
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<td>1Ω, 2Ω, 3Ω, 4Ω, 5Ω, 6Ω, 7Ω, 8Ω, 9Ω, 10Ω</td>
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<td>60, 90, 120, 150, 180, 210, 240, 270, 300, 330, 360, 390</td>
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In the 1954 Edition some important changes have been made: the Names and Addresses Section now segregates firms by countries; in the Glossaries, proprietary names of foreign products are followed by the country of origin.

Apart from these changes the Year Book follows the pattern of recent years. Section I contains the annual review of Patents which, as usual, is entirely different from the last edition and is of inestimable value to all readers. The remaining sections have been thoroughly revised and, where necessary, amended. The information in BRITISH PLASTICS YEAR BOOK cannot be obtained in this form from any other source.

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A 3 /in. P.M. speaker accurately matched
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A 4-valve

A COMPLETELY ASSEMBLED 4 VALVE T.R.F. CHASSIS

This receiver is less the very latest design and is for use with the aerial system. It covers both Long and Medium Wavebands and includes the modern B.V.A miniature valves. The line up being 71 B.C. 12A7E-12A6-12A5. 35/3V4. It incorporates 'Promo-Finity' Tuned Colle, thus ensuring excellent selectivity and sensitivity. The overall size of the complete chassis including speaker is 15in. x 4in. x 6in. An attractive Bakelite Ivory finished Cabinet size 11in. x 51in. x 11in. is available for 1210/6 (plus carriage and insurance).

The DENCY M.T.O.1 Modulated Test Oscillator £3/15/-
(Plus 1/6-4/-, ex. taxa.) Has Frequency range continuously variable from 270-470 Kc/s and 500-1,000 Kc/s. Battery operated and theory completely self-contained.

"PERSONAL SET" BATTERY ELIMINIATOR
A complete Kit of parts to build Midget "Alpha" Battery Eliminator ranging up to 60 volts and 1.4 volts. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltages as above, up to 60 volts. The Kit is quite easily and quickly assembled and is housed in a light aluminum case size 4in. x 11in. x 2in. Price of complete Kit with easy-to-follow assembly instructions 49/6. In addition we can offer a similar COMPARE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled unit 7in. x 11in. x 5in. Price 47/6.
**Constructors everywhere are amazed!**

**AT THE EXCELLENCE OF**

**The "TELE-VIEWER"**

**5 CHANNEL TELEVISOR DESIGN OF A COMPLETE 12" SUPERHET T.V. RECEIVER**

**HUNDREDS SOLD IN 4 MONTHS**

**SIMPLE DIAGRAMS MAKE CONSTRUCTION EASY**

**PERFECT FRINGE AREA RECEPTION**

**BETTER RECEPTION AT HALF COMMERCIAL COST**

Here are some of the features which combine to make this such a fine receiver.

- The Superhet circuit easily tuned to any of the five channels, i.e., LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE and KIRK-O-SHOTT. (The extreme ease of tuning is accomplished by the provision of pre-aligned I.F.T.s.)
- A lifelike, almost stereoscopic, picture quality made possible by the following factors:
  a. Excellent bandwidth of I.F. circuits.
  b. A really efficient video amplifier.
  c. C.R.T. Grid modulated from low impedance source.
  d. High E.H.T. voltage (approx. 10 kV.)

- This receiver is easily tuned above the average and enables comfortable viewing with normal room lighting or daylight.
- A frame picture "HOLD" circuits (Frame-Line) ensures a steady picture, free from bounce or flicker even under the most adverse conditions met with in "fringe" areas and excellent "interlace" ensures the absence of "liney effect."
- Negative feedback is used in the audio frequency circuits which provide 2/3 watts of high quality sound.
- Entire receiver built on two chassis units each measuring 14" x 6" x 3½".
- Complete assembly instructions, diagram, etc., available for 5/6.

**NOW available at Sterns**

The "WIDE ANGLE" TELE-VIEWER

- A design that retains all the distinctive features of the 12in. Televisor but with increased Time Base efficiency, producing 15 to 18 volts E.R.T. with single winding power for G.E. Tubes up to 12in.
  - It can be completely built including supply of all valves for £34 (plus cost of C.R.T.) and is as simple to construct as the 10in. model.
  - This is the most efficient "WIDE ANGLE" large screen design yet offered to constructors, and yet it can be built for almost half the cost of similar designs.
  - Complete assembly instructions, diagram, etc., available for 5/6.

**SPECIAL OFFER NEW C.R.T.'s.**

Unused 12in. C.R.T.'s by one of the leading manufacturers, 6.3 volt heaters, 7-9 kV. standard size. Supplied in maker's sealed cartons.

(Plus 5/-; Carr. & Ins.)

**£12 19/6**

**BRAND NEW C.R.T. MASKS**

Latest aspect ratio for 12in. "Round" picture, finished Every.

(Plus 1/-; postage)

**12/6**

**HALF WAVE MAINS TRANSFORMERS**

Primary 220/240, 100/121 volt. Secondary 250 volts 50 mA.

(Plus 1/-; postage)

**16/9**

**SPEAKER BAGGAGES**

<table>
<thead>
<tr>
<th>Model</th>
<th>5 ohm V/coil</th>
<th>15 ohm V/coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLESSY, 10in.</td>
<td>£5 5/0</td>
<td>£5 10/6</td>
</tr>
<tr>
<td>M.A. 10in. 3 ohm</td>
<td>£5 10/6</td>
<td>£5 15/6</td>
</tr>
<tr>
<td>BAKERS, 12in. 3 ohm</td>
<td>£5 15/6</td>
<td>£5 20/6</td>
</tr>
<tr>
<td>GOODMAN, 12in. 5 ohm</td>
<td>£6 5/0</td>
<td>£6 10/6</td>
</tr>
</tbody>
</table>

**ROLA, 12in. 3 ohm V/coil**

Price of complete chassis, speaker, etc., £2 10/6.

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.F. 8-inch</td>
<td>£3 1/6</td>
</tr>
<tr>
<td>H.F. 9-inch</td>
<td>£3 5/0</td>
</tr>
<tr>
<td>H.F. 10-inch</td>
<td>£3 10/6</td>
</tr>
</tbody>
</table>

**THE NEW HI-FI SPEAKERS ARE IN STOCK**

Model H.F. 6-inch.

Model H.F. 8-inch.

Model H.F. 10-inch.

These speakers are of the very latest design and provide quality reproduction for the lower-price range. 5 or 12 ohm models are available.

**SPECIAL MICROPHONE OFFER**

A Famous Manufacturer's surplus!

CRYSTAL MIKE in moulded Bakelite Case and incorporating Off-On switch. Substantially full response from 50-c.000 c.p.s. Can be used as Hand or Desk Mike.

(Plus 1/-; post and packings)

**BATTERY CHARGER KITS**

All Kits are for A.C. mains 200 to 250 Volts. They comprise a Metal Rectifier and Transformer, tagged for 6 or 12 volt charging, and a tapped Resistor, with Variable setting, to enable the charging rate to be varied as required.

- For 6 volt batteries at max. 4 amp.
- For 12 volt batteries at max. 2 amp.

An easily followed Wiring Diagram is included with each Kit.

**£3 1/6**

**£3 5/0**

**£3 10/6**
**Modernise your old Radiogram for only £25**

**THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS**

- Model B.3.P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P.P. 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 220/240 volts, and employ the very latest miniature valves. They are designed to the most modern specifications, having attention being given to the quality of reproduction which gives excellent clarity of speech and music on both bands, and radio, making them the ideal replacements chassis for that "old Radiogram," etc.

Brief specifications:
- **Model B.3.**
  - Valve line-up: 5E8G, 5AR4 G.T.
  - 6X4—waveband coverage short 10-250 medium 192-550 long 900-2,000 metres.
- **Model B.3.P.P.**
  - Complete assembly instructions, layouts and a complete diagram is provided, making it the ideal receiver chassis, incorporating a 7-valve model.
- **Model B.3.P.P.P.**
  - Complete assembly instructions, layouts and a complete diagram is provided, making it the ideal receiver chassis, incorporating an R.F. stage with PUSH-PULL OUTPUT.

The extreme flexibility of the bass and treble controls is afforded ample compensation for all types of pick-up or away from the main amplifier, i.e., on the front panel, or away from the main amplifier, i.e., on the front panel.

**ANNOUNCING A NEW DESIGN THE STERN'S "SUPER SIX"**

- **FACET COMPONENTS EX STOCK.** The assembly consists of two complete receivers, for A.C. mains supply 200-250 volts, and have separate amplifiers for E.E.P. and 78 r.p.m. records.
- **Complete with High Fidelity Crystal.**
- **Tuner,** which includes separate style for E.E.P. and 78 r.p.m. records.
- **Minimum Base plate size** 14in. x 21in., with height above 34in., and below base plate 34in.
- **Brand new in Makers complete with Mounting instructions.**

**This AUTOCHANGE UNIT BY a Famous Manufacturer is offered for only £11 ’14/6**

- We will supply this 3-speed Autochanger and the complete receiver B.3 chassis on the left, together with a 10in. for £22 6/6, P.M. speaker, complete with the B.3.P.P for £25 6/6., B.3.P.P.P. for £28 6/6. Complete and extras.

**The Collaro 3R/521 3-Speed AUTO CHANGE UNIT — £29/19/6**

- Complete with High Fidelity Crystal.
- **Hand** which includes separate style for E.E.P. and 78 r.p.m. records.
- **Minimum Base plate size** 14in. x 21in., with height above 34in., and below base plate 34in.
- **Brand new in Makers complete with Mounting instructions.**

**HIGH-FIDELITY PICK-UP**

- Incorporating the famous COLLARO 3R0/521 3-Speed Auto Change Unit £3/19/6.
- £3/2/6.

**COMpletely Assembled Radio-Gram Receiver CHASSIS.**

- **Covers all necessary data are included in the C.3.1. Receiver, which consists of two completely new models.**
- **TUNER.**
- **The DENCO ULTRA MIDGET SUPERHEAT TURRETS WITH A ROTARY TURRET ACTION.**
- **Uses** 231/9/6.

**The DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT provides akształnt of control of bass and treble in conjunction with a made Valve/Mixer Control.**

- **Complete with High Fidelity Crystal.**
- **Price** £3/19/6. (Plus 2/- carr. and Ins.)
- **Hand** which includes separate style for E.E.P. and 78 r.p.m. records.
- **Minimum Base plate size** 14in. x 21in., with height above 34in., and below base plate 34in.
- **Brand new in Makers complete with Mounting instructions.**

**THE DENCO ULTRA MIDGET SUPERHEAT TURRETS WITH A ROTARY TURRET ACTION.**

- **Uses** 231/9/6.

**Filament Transformer**

- **Uses** 231/9/6.

**Selenium Rectifiers**

- **Uses** 231/9/6.

**The "REGENT" Crystal Hand Microphone — 25/6**

- **Uses** 231/9/6.

**STERN RADIO Ltd.**

- **109 & 115, FLEET STREET, E.C.4**

**Tel.: CENTRAL 5812-3-4**
FULLY SHROUDED UPRIGHT MOUNTING

Primaries 200-250-520 v. 50 c/s...
200-250-520 v. 50 c/s...
200-250-520 v. 50 c/s...
200-250-520 v. 50 c/s...
200-250-520 v. 50 c/s...

Midget type 23-363...
25/9...
25/9...
25/9...
25/9...
25/9...

Silver Mica Condensers...
Silver Mica Condensers...
Silver Mica Condensers...
Silver Mica Condensers...
Silver Mica Condensers...
Silver Mica Condensers...

Bakelite and Walnut veneered cabinets...
Bakelite and Walnut veneered cabinets...
Bakelite and Walnut veneered cabinets...
Bakelite and Walnut veneered cabinets...
Bakelite and Walnut veneered cabinets...
Bakelite and Walnut veneered cabinets...

Wire wound pots...
Wire wound pots...
Wire wound pots...
Wire wound pots...
Wire wound pots...
Wire wound pots...

Electrolytics...
Electrolytics...
Electrolytics...
Electrolytics...
Electrolytics...
Electrolytics...

Miscellaneous ex-Govt items...
Miscellaneous ex-Govt items...
Miscellaneous ex-Govt items...
Miscellaneous ex-Govt items...
Miscellaneous ex-Govt items...
Miscellaneous ex-Govt items...

EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...
EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...
EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...
EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...
EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...
EX-GOV'T. MAINS AND OUTPUT TRANSFORMERS...

Selemium rectifier...
Selemium rectifier...
Selemium rectifier...
Selemium rectifier...
Selemium rectifier...
Selemium rectifier...

Special purpose...
Special purpose...
Special purpose...
Special purpose...
Special purpose...
Special purpose...

Microphone transformers...
Microphone transformers...
Microphone transformers...
Microphone transformers...
Microphone transformers...
Microphone transformers...

Wireless World
April, 1954

WIRELESS WORLD
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. 450 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZES 14-10 x 10 in. $10 extra. Output impedances for 3 and 15 ohms speakers.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR $3/15/-, plus carry, 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 loads. (We can supply a very suitable 10m unit by Rola at 27/6.) The amplifier can be supplied ready for use for 25/- extra. Full descriptive leaflet 7/6.

R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen-Talk Back Units." individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are included. 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 is 4 watts. Price only 5/$19/6. "Listen—Talk Back Unit" as illustration can be supplied at 30/- each. Full descriptive leaflet 10/6. The Master Unit can be supplied assembled and tested for 35/- extra.

PERSONAL SET BATTERY SUPERSEDURE KIT. All parts for an "All Dry" Battery Eliminator. Complete with case, Supplies 100 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 38/6. Or ready for use, 42/6. Size of unit 5-1/2 x 11-1/2in.

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. 500 w or 60 v at up to 15-20 mA. and 80 v at 15-20 mA. fully smoothed, at L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only 48/6. Supplied ready for use for 75/- extra.

Available in kit form at the amazing low price of 9 gns. Plus the incredibly low price of 45/- extra. Complete with integral pre-amp. Tone control stage (as amplifier) and tone control for 25/- extra. Complete with integral pre-amp. Tone control stage (as amplifier), and tone control for 25/- extra. All parts for an "All Dry" Battery Eliminator. Complete with case, Supplies 100 v. 10 mA and 1.4 v. 250 mA, fully smoothed, from normal 200-250 v. 50 c/s mains. Complete kit of parts complete in every detail, including Dial and Drive Knobs and every item required.

R.S.C. 10-watt "Push-Pull" HIGH-FIDELITY AMPLIFIER A3

Complete with integral pre-amp. Tone control stage (as amplifier), and tone control for 25/- extra. Complete with integral pre-amp. Tone control stage (as amplifier), and tone control for 25/- extra. All parts for an "All Dry" Battery Eliminator. Complete with case, Supplies 100 v. 10 mA and 1.4 v. 250 mA, fully smoothed, from normal 200-250 v. 50 c/s mains. Complete kit of parts complete in every detail, including Dial and Drive Knobs and every item required.

R.S.C. 10-watt "Push-Pull" HIGH-FIDELITY AMPLIFIER A3

Complete with integral pre-amp. Tone control stage (as amplifier), and tone control for 25/- extra. Complete with integral pre-amp. Tone control stage (as amplifier), and tone control for 25/- extra. All parts for an "All Dry" Battery Eliminator. Complete with case, Supplies 100 v. 10 mA and 1.4 v. 250 mA, fully smoothed, from normal 200-250 v. 50 c/s mains. Complete kit of parts complete in every detail, including Dial and Drive Knobs and every item required.
THAT YOU MAY NEED WILL BE WELCOME. THESE ITEMS ARE ONLY A SMALL SELECTION FROM OUR STOCK OF EQUIPMENT. YOUR ENQUIRIES FOR ANYTHING TAYLOR CIRCUIT ANALYSER, MODEL 132 WIRELESS WORLD

Avo Wide-range Signal Generator, as new

Taylor 65B Signal Generator, as new

H.R.O. Senior, with H.R.O. power-pack and coils (6)

Advance Model E.2 Signal Generator, as new

Taylor Circuit Analyser, Model 119, as new

E.M.I. Ribbon Tweeter with TX from 5 ohms crossover frequency 5

BC211's with correct charts, as new

Trixette (latest model) 3-speed record amplifier and speaker, as new

Taylor Windsor Model 170a Electronic Test Meter. As new. Price £16 10

Grundig Portable Tape Recorder, single speed, as new, with mike. Price £45 0

Acoustical (QUAD) amp. and control, as new. Price £21 0

Acoustical 30 watts, A.C., 12 volt. amp. As new. Price £14 0

Avo 1948/9 All-wave Sig. Gen., Perfect. A.C. mains. Price £8 10

Evershed 500 v. Wise Megger, leather case, as new. Price £9 0

Evershed 500 v. Bridge Megger, As new. Price £25 0

Philips PRC I with A.C. P.P.

FLEXIBLE STAGE WIRES, 20 ft. long, brand new boxed, 12/6. post and packing 1/2.

BOMB COMPUTERS, 40/-, carriage 10/-.

MANIUM CRYSTALS, 2/-, post 3d.

CRYSTAL SET COILS, med. and L-wave, with variable units, size 3in. x 2f in.

TOGGLE SWITCHES, 24-v. 20 -amp. on/off, 1/-, post 3d.

BOMB COMPUTERS, 40/-, carriage 10/-.

UNIVERSAL SWITCHES, twin press -button, 250 v. 5 amp. A.C., boxed with circuit, 2/6, Post 3d.

THERMOSTATS, close at low temperatures, adjust 30-60 deg. F., ideal for greenhouses, car heaters, frost warning, etc., 2/6, Post 4d.

SUPPRESSORS, car plug fitting, standard 15,000 ohms, for easier starting, T.V. and radio aerial. Price 1/6.

SPARES A large selection available for SCR399 (BC610),努力-33和SCR610, both complete with Power Pack and tele-serial equipment.

MAGNETO 10 LINE U.C. TELEPHONE SWITCH-BOARDS, complete.

SCR510's, SCR610's, both with Complete Pack and tele-serial equipment.

A.R.88D's, A.R.88LF's, A.R.77's, S27's, HRO, R.I09 and others, 12/6 each.

G.E.C. Miniscope in portable case

Prices E25

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.

P.C.A. RADIO

New Address, Offices and Works: BEAVOR LANE, HAMMERSMITH, LONDON, W.6

Telephone: RIV 8006

SPARES A large selection available for SCR399 (BC610)-ET4336, SCR610, EE8, Telephones, and Teleprinter type 7B.

TX VALVES 805, 807, 813, 861, 866A, 100TH, 250TH, and many others.

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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WE URGENTLY REQUIRE FIRST CLASS NEw OR USED STANDARD OR SUB-STANDARD SIGNAL GENERATORS OF EVERY DESCRIPTION. TEST EQUIPMENT, ETC. CON- VERTERS, 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 EQUIP- MENT. WHEN SENDING GOODS STATE WHETHER.T.M.O. OR CHEQUE REQUIRED.

WE HAVE A LARGE SELECTION OF AS-NEW WHAREDFEPEAK S, ALL TYPES, AT BARGAIN PRICES.

OUR BRANCH AT 39a (opposite) IS OPEN ALL DAY THURSDAY.

Phone: GERrard 4447, 8582 and 5507. Hours 9 to 6. Thursdays 9 to 1.

MIDLAND INSTRUMENT CO.

VENNER 24-VOLT TIME DELAY SWITCHES, consists of a high-grade clockwork motor with external wind, 8-electro-magnets, 8-pole case operated contacts, in smart metal cases size 3in. x 2f in. x 1t1/2in., fitted c-w terminal block, broad new brand, each 6/-, post 3/-.

PROJECTING UNITS, consists of an enclosed lamphouse, fitted 36- 15-watt lamp, highly polished reflector, attached mount containing 24 lenses, one a concave and the other a Dallmeyer bloomed " Achromatic " 40 mm. dia., 3f in. focal length lens, highly polished reflector, attached mount containing 21 lenses, one a concave/convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polished reflector, 21 lenses, one a concave, and one a convex, highly polishe

As new.

Each (6).

BOSTIK CEMENT, 0 -lb. tubes, 1/6, post 7d.

PROJECTION UNITS, consist of an enclosed lamphouse, fitted 24-v. 15 -watt lamp, smart metal cases size 31/2in. x 2f in. x 2fIn., fitted 4-way terminal block, brand new, unused, 11/-.

VENEER 24-VOLT TIME DELAY SWITCHES, consists of a high-grade clockwork motor, complete with c-w or d-c mains, fitted 24-v. 15 -watt lamp, smart metal cases size 31/2in. x 2f in. x 2fIn., fitted 4-way terminal block, brand new, unused, 30/-. post and packing 2/-.

BUZZERS, 3 to 6-v. high note, platinum contacts, knob note control, fraction of original cost, new, unused, 5/-, post 1/-.

RCA TRANSMITTERS. Type ET-4336. Complete with original speech amplifier, crystal multiplier and VFO units. Unused and re-conditioned. Can be supplied with very large quantity of spares.

RCA TRANSMITTERS. Type ET-43.2 modified by R.A.F. for use on crystal or master oscillator. Complete with speech amplifier.

MAGNETO 10 LINE U.C. TELEPHONE SWITCH-BOARDS, complete.

SCR510's, SCR610's, both with Complete Pack and tele-serial equipment.

A.R.88D's, A.R.88LF's, A.R.77's, S27's, HRO, R.I09 and others, 12/6 each.

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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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 EQUIP- MENT. WHEN SENDING GOODS STATE WHETHER.T.M.O. OR CHEQUE REQUIRED.

WE HAVE A LARGE SELECTION OF AS-NEW WHAREDFEPEAK S, ALL TYPES, AT BARGAIN PRICES.

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Phone: GERrard 4447, 8582 and 5507. Hours 9 to 6. Thursdays 9 to 1.
HIGH-MID-PUMP PLASTIC RECORDING TAPE, by famous manufacturer, sold on aluminum spool, 61/2—200 ft. on aluminum spool 17/6, post paid.

D. COHEN

RADIO AND TELEVISION COMPONENTS

Terms of Business: Cash with order. Dispatch of goods from receipt of order. Where post and packing charge is not stated please add 1/- to 10/-, 1/- to £1, and 2/- to £2. All enquires and lists, S.A.E. SPECIAL NOTICE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.

23 HIGH STREET (Uxbridge Road)
ACTON, W.3 Telephone: ACOI901

Hours of Business:
Saturday 9—6 p.m. Wednesday 9—1 p.m. Other days 9—4.30 p.m.

MICROPHONES ONLY

R. I. COHEN MAINS TRANSFORMERS

Prima 250-300 100 ma. 6 v. 4 amp. 220/6.
280-300 70 ma. 8 v. 4.5 amp. 220/6.
250-250-300 80 ma. 6 v. 4 amp. 33/6.
Prima 250. 250-300 50 ma. 11 amp. 220/6.
Drop thro' 290-260 300 ma. 6 v. 4 amp. 27/6.

-Drop thro' 274-260 60 ma. 4 v. 3.5 amp. 13/6.

Drop thro' 270-260 100 ma. 6 v. 3 amp. 11/6.

Auto Trans. Type 200/250 61/2 x 11/2 in. 60 ma. 300 ma. Separate. Built-in line and width control. Mounted using all-can 21 x 110., LEI each. All-can 16 x 11 in. 13/6 each. 2 iron-cores 7/6.

Twin Gang Line Cord, 2-way 0.3 amp., 60 ohms. long spindle double pole switch, miniature, 50K, 500K, 1 meg., 2/6 each. 16 miniature resistors 4/6. mA., 1.4 v., .25 amp.

Metal casesize 8 x 5 x 3 in. incorporating spare parts and rectifiers, graded to size by famous manufacturer, 200/251.

Completely will take 61 or 8 in. speaker 17/6.


Sin. P.M. SPEAKERS (closed field) to 100 mfd. in 3 ranges.

In leatherette covered case with carrying lid.


Cream, 17/6 plus 1/6 P. & P.


2.5 amp., 6 v. 2 amp., 14/6.

131 x 110., LEI each. 161 x 81/2 x 3 in. deep by very famous manufacturer, 200/251.

CONSTRUCTOR'S PARCEL 50.1

These last four items by very famous manufacturer.

FULLY SHROUDED CHOKE 15 Henry 180 mills, 15/, P. & P. 2/... Sin.

200-0-200 35 mA., 6 v. 2 amp., 14/6.

250-0-250 75 mA. 6 v. 3 a. 4 v. 5 a. 5 v. CT. 1/6. F. P. on the above transformers 3/6.

500-0-500 125 ma. 6 v. CT. 4 a. 4 v. CT. 2 a. 24/6.

500-250 500 ma. 4 v. 4 a. 3 v. 4 a. CT. 3 a. 24/6.

900-0-900 250 ma. 4 v. 4 a. 3 v. 4 a. CT. 5 a. 3/6.

P. F. on the above transformers 3/6.

Lid and E.M.T. transformer 9KVA, ranging from 6a.6 to 75a.6, complete with built-in filter and with control. Mounted using all-can 21 x 110., LEI each. 41/6 x 41/6 x 7 in. KE13 rec. winding, 27/6.


6V6, 8/8.

6V6.

Sin. P.M. speaker. In first-class working order. £7 '19/6. P. & P. 12/6. We have a few

Other days 9—4.30 p.m.

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/- to 10/-, 1/- to £1, and 2/- to £2. All enquires and lists, S.A.E. SPECIAL NOTE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.

WIRELESS WORLD

CONSTRUCTOR'S PARCEL 50.1

These last four items by very famous manufacturer.

FULLY SHROUDED CHOKE 15 Henry 180 mills, 15/, P. & P. 2/... Sin.

200-0-200 35 mA., 6 v. 2 amp., 14/6.

250-0-250 75 mA. 6 v. 3 a. 4 v. 5 a. 5 v. CT. 1/6. F. P. on the above transformers 3/6.

500-0-500 125 ma. 6 v. CT. 4 a. 4 v. CT. 2 a. 24/6.

500-250 500 ma. 4 v. 4 a. 3 v. 4 a. CT. 3 a. 24/6.

900-0-900 250 ma. 4 v. 4 a. 3 v. 4 a. CT. 5 a. 3/6.

P. F. on the above transformers 3/6.

Lid and E.M.T. transformer 9KVA, ranging from 6a.6 to 75a.6, complete with built-in filter and with control. Mounted using all-can 21 x 110., LEI each. 41/6 x 41/6 x 7 in. KE13 rec. winding, 27/6.


SPECIAL
THIS MONTH!

INDICATOR UNIT TYPE 922. Complete with VCVR C.T., 3-VB1 (KV90), 5-VB1 (KV91), 5-VB4 (KV94), 5-VB9 (EA20) valve resistors, valves, 1.25 K. control panel movements, pots, etc. Price £3/6/6 (previously £5/6/6).

Mains Transformers for the 1122A Receiver or 1155 Power Pack. Input 200-200-200-200-200 v. Output: 200-200-200-250 v. 100 mA, 6.3 v., 0.5 amp., 2.5 amp. These transformers are brand new and we offer them at the very low price of £1/6/6 each. Plus 3/- each.

R.F. UNITS TYPE 24. The well-known unit used with the 1355 receiver for TV. Complete with valves, resistors, panel movements, etc. In new metal case: £2.5/6. Brand New at £3/6/6 each. Plus 3/6 post.

AMPLIFIER UNIT TYPE 1271. Complete with 456 valve, 807 etc. Resistors, and panel movements, etc. Supplied in grey mottled cabinet size 13in. x 8in. £7/16/6 each. Plus 2/6 post and packing.

PROJECT SCREEN (size 15in. x 12in.). As used in projection cabinets. 10/6 each.

POLYTHENE RODS, 1/2in. dia., 12in. long, 6/6 doz.

TUBE STANDARDS. 11-VR65, 1-VR92 (EA50), 1 VR53. A few only available at 5/ each, plus 2/- post.

Mains Isolation Transformers, 0/230 to 250 volt 50 cycle input. Output 230 volt a/c., 60 mA., 6.3 volt, 0.3 amp. £2/6 each.

HARADIOT (LOADED EBONITE) RODS. 21in. x 26in. long. £3/6/6 each.

VIBRATORS. 4 pin 12 volt (ZA4878) made by Mallory (Type 650) also 4 pin 6 volt (ZA4770) made by Mallory (Type 300). £1/3/6 each. Plus 3/6 post and packing.

H.M.A. Switches. Ex-W.D. totally enclosed. Size 3 in. x 3 in. x 3/4in. £1/6/6 each. Swingers.

C. MARKS & CO., 90 COMMERCIAL ST., NEWPORT, MON. Telephone: Newport 4111

All mail orders and enquiries send to Newport branch please.
TRUVOX TAPE DECK MARK III.

THE LATEST LANE TAPE TABLE.

46/12/6 plus 5,- carriage, etc. transformer, ensuring isolated chassis.

general-purpose from record players or changers ; controls

portability without sacrifice cabinet design, giving exceptional lightness and

RECORDER : We are appointed stockists for

“ UNITELEX PRIMA” PORTABLE TAPE

PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND

mary 10-0-200-220-240 volts.

PORTABLE TAPE RECORDER, single speed

LATOR UNITS.

medium and short waves.

of this and of suitable amplifier.

Delivery from stock.

track heads.Two -speed capstan, for tape speeds

heads ;

heads, dual -speed (74in. and 31in. per sec.), giving

APRIL,

5 OBELISK PARADE, LEWISHAM, S.E.13.

HEADS.

100

Housed

PLUGS

TELEVISION MATCHING UNIT

No other Aerial needed within 30 miles of the

Discount in dczen lots.

S.W. TUNING CONDENSERS.

Price, complete with filter cell micro-

used ;

昙io each, 9'. per doz. DP on -off I:3 each, 12/- p at:

MICA

amp. Open type construc-

Tape: E2 per 1,200ft. reel.

Tape, HOPLIGHT, the new

Price 1/9 each.

EHT CONDENSERS.

Flexible mounting enables it to

MOULDING MACHINE.

Suitable for use on metals or plastics.

WIRELESS WORLD
COMMUNICATIONS RECEIVER RI155. The famous ex-
box Brown RI155, now becomes available over to
be superior 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 easily and simply
adapted to much wider wave ranges. These tuning
units are all new, full details being supplied. Aerial
tested before dispatch. These are IN EXCELLENT CONDITION
IN MAKE AND CONTENTS, ONLY 1/- per.
A new of the RI155N model can also be supplied. This is the
latest version which covers the Trawler Bands, and in addition
is fitted with a variable dial tuning. Used, but tested working
before dispatch. ONLY 19'/6.

A Facade Radio Pack : Output Stage and Speaker, contained
in a black crackled cabinet to match the receiver, can
be fitted with ultra slow motion tuning.

DUCT 10/- IF PURCHASING RECEIVER AND POWER
PACK TOGETHER.

GANGED POTENTIOMETERS.

TRANSFORMERS, EX-W.D. AND ADMIRALTY, built to
TRANSFORMERS, EHT.

500 KCS. CRYSTALS.

Recommended for the TR 1196 Receiver conversion. ONLY 48/.
valves. ONLY 12/6 (postage, etc., 2/6).

TRI196 TRANSMITTER SECTION. In perfect condition, less
power unit, 10/-.

made for use with the R.I 132A, this

can be rewritten to suit requirements.

Please add carriage costs of 10/6 for receiver, and 5/ -for power pack.

DEDUCT 10/- IF PURCHASING RECEIVER AND POWER
PACK TOGETHER.


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Recommended for the TR 1196 Receiver conversion. ONLY 48/.
valves. ONLY 12/6 (postage, etc., 2/6).

TRI196 TRANSMITTER SECTION. In perfect condition, less
power unit, 10/-.

made for use with the R.I 132A, this

ca
SWITCH.

STANDARD 2 mega. All log; 1 mega; 1 mega ; 5000 wire wound, 2/10 each. 5 k double type ;50 k 11 double type. At

EX-GOV. CONTROLS-ALL'0ARBON log;

SWITCH.

CONTROLS WITH DOUBLE POLE 5n; 2000; 2 k41 WELL KNOWN MAKES.

WIRE WOUND CONTROLS 20 S.W.G.,2/2 chassis, dial, back plat,.

1 mega ; 2 mega ; 2110; 1,5000 double type; 2 mega ; 2110; 1 mega ; 50 k double type.

SOLDERING IRONS.


Bridge Rectifiers 12 v. 3 A.,13/9 ea. each.

Speaker One replacements available as follows

GABLE 8in. Rolls 5 OA type, and other midgets with 10 pin jacks.
All readers are cordially invited to call and inspect our stocks.

AMPLIFIERS  RECORDERS  SOUND EQUIPMENT

RECEIVERS

BRITISH TEST EQUIPMENT
AVO Model 71 as NEW, £15. Model 40, £12. AC/DC meter, £6.15-
Rheostat with variable c.c. £12. Electronic test meter by AVO, £6.
Wide range signal generator, £22. AVO valve characteristic meter, £50
AVO signal generator £9. Taylor 65C6 signal generator, £13. 90A
test meter, £10. 260A TV Ambassador, as NEW £30. Evershed Wes
generator types TF146G, TF517, TF390G. Marconi valve voltmeters
type £87, £15. Outputs. Moseley BFO type LOBOA, etc. Cossor
Double Beam oscilloscopes, type 3339, 399 from £35. Evershed Wes
Meggers 500 volts, £13. Bridge types in stock. Simmonds "Q" meter £75.

TRANSMITTERS
British No. 12 transmitter £25. Hallcrafters type HT17 transmitter, £30.
ELMAG transmitter 50 v. Phone or CW. VFO or crystal control, 75,
20, 11, 10 bands. Dual scale meter, less power supply mobile or fixed.

RECEIVERS
All receivers are in good working order and condition unless stated.
HALLCRAFTERS SX28, 550 kHz-42 M.C/s., £25. SX1, 550 M.C/s.
base, £125. £18. SMA-1, 100 M.C/s. £15. £25. £40. £50. £60.
SPECIAL OFFER, AR88 SPARES. Cabinets complete with all
cables and parts, E6.15- each. Pkgs. and Carr. 5/-.

DEAF AID CRYSTAL MIKE UNITS £12/6 each, post 9d.

CRYSTAL HAND MICROPHONES. Complete with lead and plug.
High Quality, very sensitive chrome finish. List price 2 gs.
Our price £2, few only.

COAXIAL CABLE. Air spaced 150 ohm (normal price 3/-1 for
20yd. coils only). £1 per coil, post free.

SPECIAL OFFER, AR88 SPARES. Cabinets complete with all
cables and parts, £6.15 each. Pkgs. and Carr. 5/-.
Set of 14 valves for "D" or "LF" model receivers, £5/10.

DEAF AID CRYSTAL MIKE UNITS £12/6 each, post 9d.

CRISTAL HAND MICROPHONES. Complete with lead and plug.
High Quality, very sensitive chrome finish. List price 2 gs.
Our price £2, few only.

COAXIAL CABLE. Air spaced 150 ohm (normal price 3/-1 for
20yd. coils only). £1 per coil, post free.

SPECIAL TRANSFORMER OFFER. PRI, 115, 210, 240 v. SEC,
263/260 v. 100 ma., £3 v. 3 a., £2 v. 1 a. (for 6X5 Rec.).
Limited Quantity. 17/6 each, post free.

SPECIAL VALVE OFFER. 866A, 17/6 each, or 30/- pair. 20/-
10/- each or 17/- pair. 9/-1. £45. 82/-, 33/-, 82/-, 80/-, 81/-.

NOISE LIMITERS. Plug-in type, no rewiring required. 3 posi-
tions. Brand new in cartons. 15/- each, post 1/-.
Carriage paid on all orders over £1 except where stated. Please
include small amounts for orders under £1.

Please print your name and address.

CHAS H. YOUNG, G2AK
Mail orders to 102 HOLLOWAY HEAD, BIRMINGHAM 1
"Phone: MIDLAND 3154
All cashiers to 101 DANE END, BIRMINGHAM, 4
"Phone: CENTRAL 1635

U.S.A. MICROWAVE TEST GEAR
No technical manuals for sale. Please write for prices.
TS1. 5 band power frequency meter. TS10. APMI Test set. TS13. AP.
X band signal generator. TS14. 5 band signal generator. TS12. Radar
syncroscope. TS16. X band power meter. TS19. 500-200 Mc/s. fig-
quency meter. TS17. 300-700 Mc/s. frequency meter. TS28. 100-1,000
Mc/s. power meter. BC21. Frequency meter (Bendix). BC27. 5
band signal generator. TS45/AP. 3 cm. signal generator. 1-22A.
6-15 Mc/s. 150-220 Mc/s. signal generator. 18-19. signal generator.
TS89. Pulse voltage divider. TS47. 40-50 Mc/s. signal generator.
TS174. 20-250 Mc/s. PERF. 22A signal generator, Dumont scope,
type 22A. GENERAL RADIO 804B. 200-300 Mc/s. signal generator.
C546. ABW 3cm Wave and Output meter.

RECEIVERS  KLYSTRONS  MAGNETRONS
American Receivers. APR4 and tuning units. 30,100,000 Ms, APR6.
1,000,000 Ms. Klystrons 276AF, 720AF, 707AF. CV723/26AF.
Radar 640, E22. 8-15 Mc/s. Type 379X. 2K33, 100-200 Mc/s.
690, E35; 504, £25. RCA receivers, AR88D and LF from 655.

20 complete kits of AN/TPX3 RADAR spares and
vals. Lot of spares for BC/640 (original packing).
Lot of spares and complete sets of valves for R.C.A.
Transmitters (original packing).

BRITISH SURPLUS STOCK IN BELGIUM
8 Telephone Switchboards 200 LINES with spares.
8 F. & F. Telephone Switchboards, 750 Telephone
Sets Mk. V. Telephone Relays, etc.

10 bands. Dual scale meter, less power supply mobile or fixed.

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Shop hours, 9.30 a.m. to 6 p.m.

Write, Call or Telephone "ATELIERS HANSET" s.p.r.I.
39, rue Thomas Vinçot, BRUSSELS, 4, Belgium.
PERSONAL SHOPPERS ALWAYS WELCOMED

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TELEVISION

TERMS OF BUSINESS : Cash with order or C.O.D. Post items only; all orders for small items totalling over 23 p. post free.下面小编的 ordered.

Could we ask you to take this opportunity of building the receiver illustrated in the April Selection Booklet, Islanding restrictions don the study for THEMSELVES our comprehensive study flouting it.

This money will be refunded if circuit diagram is returned as NEW within 7 days.

CONSTRUCTOR'S PARCEL

We can supply all the parts (including valves, tin, moving coil speaker, cabinet, chassis, and everything down to the last nut and bolt) 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, side by side horizontal, 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.

SPECIAL ANNOUNCEMENT

Our NEW GRAMOPHONE RECORD Dept. is now open for business for radio constructors. 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 p. post. Over £1 post free.

ELECTROLYTIC CONDENSERS

4 watt AMPLIFIER KIT

This is a 3 valve stage Amplifier for use with Gramophone, Microphone or Radio. Valve-line-up as follows: 6E7, 6D7 (Def) and 6V6 (Output). The dial is illuminated and when assembled the receiver presents a very attractive appearance. Coverage is the Medium and Long Wave bands. Operates on 200/250 volts AC mains.

BATTERY CHARGER KIT

Incorporates metal rectifier charger, suitable for A.C. mains 200/250 volts. Charges either 6, 8 or 12 volt accumulators. Complete with circuit diagram. Price £2 6s. 6d. post and packing.

CHARGER TRANSFORMERS

Primarily designed for use with T.R.F. receivers and type T.R.F. tubes to charge 12, 6 and 2v. at 25 amp. Complete with circuit diagram. Price £2 6s. 6d. post and packing.

METAL RECTIFIERS (FULL WAVE)

12 v. 1 amp. (Bridge Type). 76. 12 v. 3 amp. 11/2. 12 v. 3 amp. 11/2. 12 v. 4 amp. 11/2. Available for use with the above transformers.

METAL RECTIFIERS—BRAND NEW!

May be used in series or voltage doubling to give any required voltage, 300 v. 1.7. Also 500 v. 400, 600 v. 400. For power supplies.

MAINS NOISE SUPPRESSOR KIT

Consists of a 2 and 3 stage suppressor. Extremely effective, cuts out all mains noise. Can be established in existing receiver as desired. Complete with circuit diagram, 4/311. post: 1. F.O.

COPPERED STEEL ANTENNA ROD RECEPTIONS

All steel coppered rods measuring 12in long. Q.D. PRICE 1/9 per dozen, plus 9d. per gross, plus 3/6 post.

LIGHTWEIGHT MAGNETIC PICK-UP

List Price 3/11

Our price 2/6 per pack.
For Quality Bargains Always
-Best Buy at Britain's

SPECIAL VALVE OFFER. 7/93/DC22 General-purpose triode, 6.3 v. 3 a. and 6.3 volts 6 diodes. Discounted to bring top caps, international octal base. Brand new and boxed in original cartons at 6 x 1/10, post paid. Minimum quantity 6. Unboxed ones at 15/- per dozen. Minimum price 30/- each. A rare opportunity to buy.

BAND III TEST SET. Covers 160-230 M.C.s. and incorporates 5 M.C.s crystal oscillator. Complete with 4-V9R1 (EFS0) and 1N-M135 and 5 M.C.s crystal, circuit diagram and instruction booklet. See March issue for full details. BARGAIN at only 35/-, plus 5/- carriage.

COMMUNICATION RECEIVERS. Please note that we have a good selection of American and other types of communication receivers, including new models, Hermes, etc. All thoroughly reconditioned, realigned and in perfect working order, which we will be pleased to demonstrate at any time.

COMMUNICATION RECEIVER RI155 for world-wide reception can be heard at any time during shop hours. Air tested prior to dispatch. Brand new at 42/- each. A few slightly used sets at 27/- each.

TRAWLER BAND RI155N with super slow motion dial, available at 17/-9/6. Carriage in original transit cases 10/- extra on all models. Send 1/3 for circuit and full details.

A.C. MAINS POWER PACK AND OUTPUT STAGE enables the RI155 to be used to full advantage. Any modification on whatever is available from 200/250 volts A.C. All our power packs have heavy duty transformers, are complete with leads and Jones plugs and are guaranteed for six months.

TYPE A, in smart black metal case size 8in. x 4in. x 6in. Less speaker.
Price 8/-9/6.

TYPE B, with built-in speaker in black metal case size 13in. x 5in. x 7in. Price 11/-9/6.

TYPE C, with an (in. R. & A. speaker in specially designed beautiful black crackle cabinet to match the receiver. Size 11in. x 10in. x 6in. A 6 1/2 x 6 1/2 x 1 7/8. Includes a 5-1/2 f. base.
Price 25/-.

SAVE VALUABLES. Deduct 10/- when purchasing any RI155 and power packs together.

POLICE, FIRE, WROTHAM. Special offer of R1132A receiver, complete with 11 items, circuit diagram, brand new and guaranteed for six months. Brand new and ready for immediate use, ONLY 9/-1/2, plus 12/6 car.

INDICATOR R193A. Contains 3-EFS0, 1-5UG4, 4-S661 and 64C, C.T. type VCR517. This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a more pleasant tube contour. Contains in addition a very large assortment of pots, resistors, condensers, etc. Tubes demonstrated. Supplied brand new (less relay) for only 47/6, plus 7/6 car., in original transist case. Original circuit supplied free with each order, or 1/8 separately.

45M.C.S. P.Y. STRIP. The Vision unit for London frequency, complete with 6-EFS0. A few slightly used sets at 27/- each.

E.H.T. TRANSFORMER, for the VCR97, etc. Mains input. Output 2,500 volts, 4 a. 2-0-2 volts. Fully guaranteed at 35/- each, plus 1/- post.

CO-AXIAL CABLE. Brand new 70/80 ohm. with stranded inner conductor. Not exchangeable. Price 9d. per yard. Minimum per post, 7/6 per dozen yards.

HEAVY DUTY TWIN CIRCULAR POLYTHENE CABLE. Weatherproof, suitable for extension mains leads, etc. Price 9d. per yard. Minimum per post, 9d. per dozen yards.

H.R.O. 6-VOLT VIBRATOR CABLE. Price 9d. per yard. Includes a 9d. f. base.

100 MICRO-AMPER. METERS. 2-in. barrel, 3-in. flange, panel mtg. Scale 0-1500 in 18 clear divisions. Brand new in original merchant's cartons. Now in short supply, they are a REAL bargain at 12/- each. 5 MILLI-AMPER. METERS, 2-in. square panel mtg., 7/6.

300 MILLI-AMPER. METERS, 2-in. dia. flush panel mtg., 10/6.

20 Volt MET. Meters, 1.5 in. dia., 7/6.

20-VOLT MET. Meters, 1.5 in. square panel mtg., 7/6.

500 MILLI-AMPER. METER. Thermoouple 2-in. square panel mtg., 5/-.

ALL THESE METERS ARE BRAND NEW AND BOXED.

METER RECTIFIERS. New brand, 1 mA. at 1/12, 5 mA. at 8/6.

SPECIAL BARGAIN of 3,500 moving coil 31/2in. projection type meter for ONLY 15/-.

TRANSFORMER BARGAINS. 350-0-350 volts at 180 mA., 6.3 v. 5 amps. and 5 x 3 amps. Standard unit 250/250 volt 50 cycles screened primary. Size 8in. x 4in. x 5in. Brand new and unused, 29/-6, plus 2/6 post. Filament Transformers Standard capped primary-two types-Type " A " 12 volt 14amps, 6.3 volts 6 amps. Type " B " 12 volts 16amps, 4 volts 16 amps.

HEAVY-DUTY RECTIFIER. Selenium type with square cooling fins, size 8in. x 4in. x 4in. 2 units required for full wave bridge, giving 48 volts at 10 ams. Brand new at 4/-10/- per pair.

U.S.A. DYNO-MOTOR. 12 volts D.C. input, 250 volts 60 mA. output. Price 18/- each. 4-in. dia., 5-in. dia. Price 35/- each. For car radio, mobile amplifiers, small transmitters, etc. All tested prior dispatch. ONLY 22/-, plus post paid.

VALVES, selenium types. Rated 1 650 V.A. oil filled. Adjustable for 30 volts above and below the mains voltage. Price 6/-1/2 each.

HEAVY-DUTY SLIDING RESISTORS, 350 watts rated to carry 20 ams. Resistor for radio, mobile amplifiers, and similar work, etc. Laboratory type, with knob, on metal stand. Size 8in. x 4in. x 6in. high. Price 12/- each.

H.R.O. SENIOR RECEIVERS. With A.C. P.P., 5 coils, £17/10/-. D.S.T. 100 RECEIVERS, as new. Coverage is 7 bands from 30 M.C.s. to 50 K.C.S. £30 each.

HAMMERlund BC79F. Mint condition, rack mgt., £42/-10/-. HALLICRAFTERS SXC1. Special offer, mgt., £65/-10/-. Complete with power pack, 200/250 v. A. C. less valves, £6/-10/-. Values-2 type PX25, 1 M.B. and 1 M.U4, 4/2/- each per set.

NEW M/C MICROPHONES, hand type, with 12 yds. heavy duty screened cable, £13/-5/6 each.

B.C.21 FREQUENCY METER, from stock. Many items of American equipment available.

TEST EQUIPMENT. We hold a comprehensive stock. Multi-range meters at 1,000 and 20,000 o.p.s., valve testers, signal generators.

C.R.Y. RECEIVER. Mint condition. £65.-

EDDYSTONE " 480 " RECEIVER. Perfect. £28-

UNISELECTORS. 4-bank, double wiper, 24/- each. 10,000 Q. POTENTIOMETERS, large size, by Calvern, enclosed 8/- each. 100k, 15k, 9/- each.

MAIN TRANSFORMERS, Special offer. mgt., W.D., 200/250v., input tapped. Output 250-250 v. 100, 3 a., 5, 3 a. 6.3 v., 2.5 a. each. 350-0-350 v. Efficiency at 120 a., 6.3 v., C.T. 5 v. 3 a., 35/6. All in perfect condition.

MASTER STOCKS OF MOTORS. A.C./D.C. and A.C., 1/16, 1/12, 1 h.p.

EVERSHED BRIDGE MEGGERS, 250 v. Special price, £17/-10/- each.

COSSOR DOUBLE BEAM OSCILLOSCOPE, perfect, £33.-

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154 WIRELESS WORLD APRIL, 1954
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April, 1954

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1mfd. 100 volts 7/6 dozen, post 9d.
COAXIAL CABLES, 12/4 volts D.C. 750 m.a.
carry 5/16in. carry 15/20 amps., make two circuits, on

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Instruction Book. In Maker's original case, £35, carr. at cost.

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Variable 150-500v, 5-1500w. 30 or 100w.
Power units designed & built to special
Contractor wiring and assembly wanted.
Plastic castings, single or repetition.
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Walnut, Mahogany or Oak veneered. 30", high.

For 8 in. Speakers, 9/10 in. Speakers, 12 in. Speakers.
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Complete Kits in unwired acoustic cabinets.
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We will assemble and fix feet for 7/4d. extra.
A. DAVIES and Co., Ltd., 3 Parkhill Place, off Parkhill Road, London, N.W.4
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TAPE RECORDER

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ENGINEER required to undertake the design of electronic instruments; the successful candidate will be required to accept responsibility for the production to stage degree of development preferred; the salary will be commensurate with qualifications and experience.—Apply in writing to Advance Components, Ltd., Back Rd., Shenburn Hall, Linton, Ely.

DRAUGHTSMEN, senior and intermediate. Requirements at Farnham and Acton by Macom’s Wireless Telegraph Co. Ltd., experience in the design of radar or similar apparatus preferred; these are permanent positions in expanding groups; applicants should write, giving full details and quoting ref. D.D.P. 136/7 Strand, W.C.2.

DRAUGHTSMAN required with experience in layout of automatic moulding, press, electronic equipment, involving mechanical drawings, sub-assemblies, circuits, and parts samples, suitable for prototype and batch production; apply, in writing, to—Works Dept., The Streetly Mfg. Co., Ltd., Aldridge Rd., Streetly, staffing age, experience and salary.

ENGINES, mathematicians or physicists required for design and development work on new projects in the telecommunication field, suitable in this type of work, but not essential.—Apply, giving full details of qualifications, experience and salary required to the Personnel Manager, Standard Telephone, Qualifications and Appointments Dept., Newport, Mon.

LABORATORY Assists., aged 26 to 34, required to deal with the charge of engineering department for factoring standards, monitoring work.要有基本的大学学位, and experience of industrial or service laboratories. Necessary training will be given. Full details of requirements must be sent to the Regional Canary Wharf, London E.1.

PRODUCTION Manager required for radio and television apparatus in the London area; engineers able to undertake immediate, development work on broadcast radio and television apparatus would be offered an attractive salary, the successful candidates will be eligible for company superannuation schemes. —Please reply giving full details of experience to Box 3353.

W.R. Department requires lecturer at W.R.E. Trincomalee, Ceylon. Qualifications: Degree in Electrical Engineering or equivalent experience in radio or radar engineering essential. Salary in accordance with Burmese Technical Scale for Assistant B, with allowances for degree, other special qualifications, and extra working time compared with Technical Colleges. Normal teaching hours 9-5, but extra duties may be involved. Terms to be discussed. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London W.C.2. Closing date 25th April, 1954.

LABORATORY engineer required for design and development work on test equipment for coaxial and telephone cables; engineering degree essential. Experience in working with commercial Telecommunication Group. Salary £175/-. Apply, giving full details of qualifications, experience and salary required to the Personnel Manager, Standard Telephone, Qualifications and Appointments Dept., Newport, Mon.

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No other filter combines all the advantages of this model which are, briefly, to cut response above any desired level with steep cutting 'edge' on some L.P. records, and to cut distortion on some records where this condition is found.

M I C H A E L RADIO, Ltd., require senior and junior engineers in their equipment development and production laboratories; training and experience in the field of applied electronics (in particular, the development and production of radio frequency electronic equipment) essential. Applications are invited from people working with Government Departments are the equivalent of University Diploma. Write, stating age and full details of training, qualifications and experience, to the Personnel Manager, Equipment Development Division, Michael Radio Ltd., England.  

ASSISTANT electronic engineers and technicians ad for junior to take part in an extensive design and development programme on radio frequency electronic equipment. All candidates will receive training in all aspects of the equipment. The successful candidates will be required to work on projects in expanding groups; applicants should write, giving full details and quoting ref. D.D.P. 136/7 Strand, W.C.2.

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TRANSFORMER ENGINEERS required for the development of projects involving audio-frequency power transformers, line transformers, oil-filled units, etc.—Apply stating age, qualifications and experience, to: The Personnel Manager (Ref. R.G.), Ferranti, Ltd., Manchester 1, Manchester, or Mr. V. G. Cooper, Ferranti, Ltd., Longsight, Manchester. [2503]

THE BRITISH TABULATING MACHINE Co., Ltd., manufacturers of Hollerith accounting machines, will shortly open a new research laboratory at Letchworth. Engineers interested in the development of electronic digital calculating techniques, for business or scientific accounting machines, and who are seeking employment of this nature in England, 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.

Applicants should be able to demonstrate knowledge and experience with equipment and qualifications, a knowledge of machine design in one or more of the above fields being essential. Applications from overseas (excluding New Zealand) are invited to be addressed to Personnel Officer, British Tabulating Machine Co., Ltd., Letchworth, Herts. [12504]

The General Electric Co. Ltd., Brown's Lane, Coventry, require senior and junior engineers for work on guided weapons and related electronic equipment. As work is carried out in two principal fields of microwave electronics and digital systems, qualifications in electronic engineering, mechanical development, design, draughtsmanship and straightening processes, preferably with experience of radar-type equipment, are required. Further details are available for the above projects, which will be made in accordance with age, qualifications and experience. Applications by letter, stating age and experience, to the Personnel Manager (Ref. R.G.). [10259]

Senior television development engineer required by well-known radio and television manufacturer in London area: applicants must have had wide experience in development and production of mass production of commercial radio and television receivers; a salary of £200 plus will be paid to a person possessing drive and leadership ability. Preference will be given to applicants who have through projects from development to production stage. Under the supervision of the Senior Engineer, kindly state full particulars of technical educational and experience to Nov. 1954. [2565]

Senior Electronic Engineer required to lead a group working on advanced valve applications. The applicant should have a sound knowledge of modern circuit techniques and be thoroughly familiar with application to radio and television and should hold a University 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., Ltd., 39-45, Green Manor, Wellingborough, N.W.3, stating age, qualifications and details of experience.

Electronic Engineer to work within our experimental division at Edinburgh, the nature of the work involves conducting trials and concluding the performance of fire control, navigational and landing systems under development. Candidates should possess a Physics degree or considerable recent practical experience in this field: good opportunity for expanding department; staff pension scheme. Apply, quoting Ref. EE/TED and giving full details of qualifications and experience, to: The Personnel Officer, Ferranti, Ltd., Perry Rd., Edinburgh, S.2. [2580]

The National Physical Laboratory, Teddington, Middlesex, has vacancies for: Junior Scientific Staff in laboratory or drawing office, in work on electronic computers and other electronic equipment, age 16-26, salary £225 to £410, according to age, with regular increments (lower maximum for women); mathematical minimum an A-level in Mathematics (Linear Algebra) and a qualification General Certificate of Education at ordinary level. In our subject, including English Language and a scientific subject or mathematics, posts available with opportunities of established (pensionable) posts, and of promotion to higher grades.

A desirable qualification for these posts is a University degree in Science, Engineering or Mathematics. Graduates of appropriate professional institutions, Higher National Certificates, etc., will be considered for appointment. To apply: State age, qualifications and experience, to the Personnel Officer, National Physical Laboratory, Teddington, Middlesex, S.W.19. [2580]

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Hi-Fi, Lecturers. A number of specialist Hi-Fi and electronic and electrical engineers offer interesting posts for professional engineers and technicians in their expanding organisation on research and development projects in valves, cold cathode tubes and transistors: previous experience in this field is an advantage, but not essential, as training will be given, wherever possible, to the applicants of outstanding ability. 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, previous experience as Scientific Officer (1st or 2nd Class) or equivalent, degree or H.N.C. may be an advantage and technical experience in Forces or industry desirable), £264 (age 18) to £456 (age 29) respectively) and operation of wireless telegraph apparatus in conjunction with any of our amplifiers. 

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RETIRING H.N. engineer, after 20 years radio branch, seeks position home or abroad;
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ELECTRICAL engineer, A.M.I.E.E., 30, single, 8 years experience, 6, 8, 10, 12 volt equipment
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