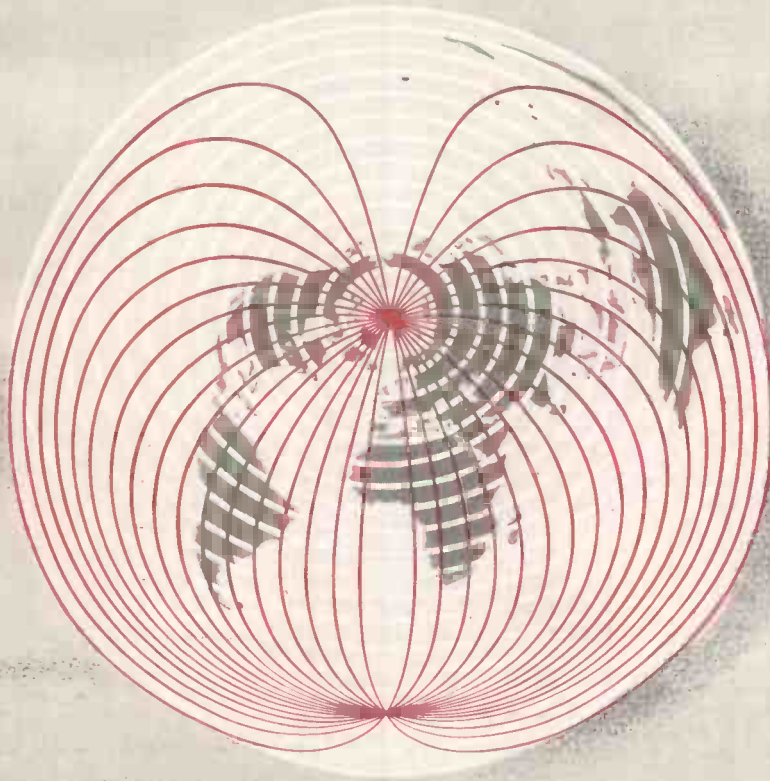


APRIL 1955

TWO SHILLINGS

# Wireless World

Radio · Electronics · Television



**FORTY-FIFTH YEAR OF PUBLICATION**

# TELEVISION



# EUROVISION



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# Wireless World

RADIO, ELECTRONICS, TELEVISION

*Managing Editor:*

HUGH S. POCOCK, M.I.E.E

*Editor:*

H. F. SMITH

APRIL 1955

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# VALVES, TUBES & CIRCUITS

## 28. A NEW 25W AUDIO OUTPUT PENTODE

The EL34 is an indirectly-heated octal-based output pentode which is now being added to the Mullard range of audio valves. It has a rated anode dissipation of 25W and the high mutual conductance of 11mA/V. This valve covers all applications requiring powers between 11W (single valve) and 100W (push-pull), and is equally suitable for high quality domestic amplifiers and public address equipment. It has a comparatively small diameter for a 25W output pentode: the straight-sided envelope rises directly from a foot less than 38mm in diameter. The maximum overall length is 113mm and the maximum seated height 98mm.

Two triode-connected EL34's operated in push-pull for a domestic amplifier give an output of either 14W at less than 1% total harmonic distortion with a line voltage of 430V, or 16W at 3% distortion with a line voltage of 400V. For public address equipment two EL34's may be operated in pentode push-pull, again using cathode bias, and with a line voltage of 375V the available output is 35W at 5% total harmonic distortion. For even higher powers fixed bias may be used with anode voltages of up to 800V; the power output when the anode voltage is 800V is 100W at 5% distortion.

A single EL34 operated in Class A gives an output of 11W at 10% distortion with a line voltage of 265V.

A special technique has been devised to enable the EL34 to operate at high anode voltages whilst retaining a single-ended octal-based construction. The valve envelope is made completely of glass, with a conventional pressed glass foot, and clamped into a metal ring which holds together the glass and the plastic material of the octal base. The stiff wire leads projecting from the glass envelope line up exactly with the pinning in the octal base; during manufacture these leads are passed straight inside the octal pins, without crossing over outside the bulb, and so the risk of flash-over is very much reduced. For high voltage operation the valvholder of course must also be able to withstand the high tension.

Such a small valve as the EL34, dissipating a large amount of power at the anode and screen grid as heat, needs reasonable ventilation. It should be mounted vertically, and the air should be able to circulate freely. The distance between two EL34's should be at least 40mm, and the distance from the cabinet and other components at least 30mm. Wirewound resistors, mains transformer, and rectifier should not be in the immediate vicinity.



| Abridged Data                       |   |            |
|-------------------------------------|---|------------|
| <b>HEATER</b>                       |   |            |
| V <sub>h</sub>                      | 6.3   | V          |
| I <sub>h</sub>                      | 1.5   | A          |
| <b>TYPICAL OPERATING CONDITIONS</b> |   |            |
| Single valve                        |   |            |
| V <sub>b</sub>                      | 265   | V          |
| V <sub>a</sub>                      | 250   | V          |
| V <sub>g2</sub>                     | 265   | V          |
| V <sub>g3</sub>                     | 0   | V          |
| V <sub>g1</sub>                     | -13.5   | V          |
| I <sub>a</sub>                      | 100   | mA         |
| I <sub>g2</sub>                     | 14.9  | mA         |
| g <sub>m</sub>                      | 11  | mA/V       |
| r <sub>a</sub>                      | 15  | kΩ         |
| μg <sub>1-g2</sub>                  | 11  |            |
| R <sub>a</sub>                      | 2   | kΩ         |
| V <sub>in</sub> (r.m.s.)            | 8.7   | V          |
| P <sub>out</sub>                    | 11  | W          |
| D <sub>tot</sub>                    | 10  | %          |
| <b>Pentode Push-Pull</b>            |   |            |
|                                     | Self Bias   | Fixed Bias |
| V <sub>b</sub> (a)                  | 375   | 800        |
| V <sub>b</sub> (g <sub>2</sub> )    | 375   | 400        |
| R <sub>g2</sub> (common)            | 470   | 750        |
| I <sub>a</sub> (o)                  | 2 x 75  | 2 x 25     |
| I <sub>a</sub> (max. sig.)          | 2 x 95  | 2 x 91     |
| I <sub>g2</sub> (o)                 | 2 x 11.5  | 2 x 3      |
| I <sub>g2</sub> (max. sig.)         | 2 x 22.5  | 2 x 19     |
| V <sub>g1</sub>                     | -22.5   | -39        |
| R <sub>k</sub>                      | 130   | —          |
| R <sub>a-a</sub>                    | 3.4   | 11         |
| V <sub>in</sub> (g-g) (r.m.s.)      | 42  | 47         |
| P <sub>out</sub>                    | 35  | 100        |
| D <sub>tot</sub>                    | 5   | 5          |
| <b>Triode Push-Pull (Self Bias)</b> |   |            |
| V <sub>b</sub>                      | 400   | 430        |
| R <sub>k</sub> (common)             | 220   | 250        |
| I <sub>a</sub> (o)                  | 2 x 65  | 2 x 64     |
| I <sub>a</sub> (max. sig.)          | 2 x 71  | 2 x 67     |
| V <sub>g1</sub>                     | -29   | -32        |
| R <sub>a-a</sub>                    | 5   | 10         |
| V <sub>in</sub> (g-g) (r.m.s.)      | 44  | 48         |
| P <sub>out</sub>                    | 16  | 14         |
| D <sub>tot</sub>                    | 3   | <1         |
| <b>LIMITING VALUES</b>              |   |            |
| V <sub>a</sub> max.                 |   | 800        |
| P <sub>a</sub> max.                 |   | 25         |
| V <sub>g2</sub> max.                |   | 425        |
| P <sub>g2</sub> max.                |   | 8          |
| I <sub>k</sub> max.                 |   | 150        |
| <b>BASE</b>                         |   |            |
|                                     |   | Octal      |
| Pin:—                               | 1 2 3 4 5 6 7 8   |            |
|                                     | g <sub>3</sub> h a g <sub>2</sub> g <sub>1</sub> NC h k |            |



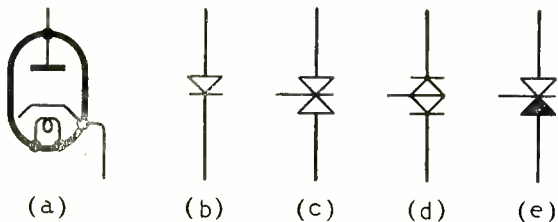
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## Transistor Symbols

**J**UDGING by our correspondence columns, there has been for some time a feeling that existing graphical symbols for transistors are unsatisfactory, and fail to convey a useful picture of the working of the device. We think this is probably because the base is almost invariably represented graphically by a heavy line, thus suggesting that it is analogous to the cathode of a thermionic valve. Colour is lent to this false idea because most transistor circuits show the base earthed. In fact, of course, it is the emitter which is analogous to the cathode and the earthed-base circuit is the transistor counterpart of the earthed-grid valve circuit.

To avoid this kind of confusion it seems imperative that any heavy line that looks like the graphical representation of a valve cathode should not be used in symbols for anything but the emitter. But to use such a line for the emitter would confuse those accustomed to the present symbol, in which it represents the base. Clearly, a radically different symbol is needed, and a possible solution would be to adopt the general idea suggested by P. M. Thompson in *Wireless World* for July, 1954 (p. 325). Mr. Thompson there described the system of symbols used by the Canadian Defence Research Establishment, in which transistor symbols are based on the conventional rectifier symbol.



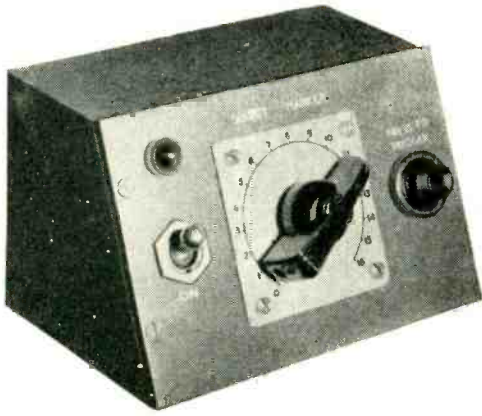
In the rectifier symbol, which is universally employed for any kind of two-electrode semi-conductor device having asymmetrical conductivity, the convention is that the bar represents the cathode of the equivalent thermionic diode and the triangle the anode (see (a) and (b) in the Figure). The junction transistor comprises two semi-conductor

junctions back-to-back, and it seems logical to adopt a pair of rectifier symbols, also back-to-back, as at (c) and (d). As shown, the bottom element of these basic transistor symbols is intended to represent the emitter, the top the collector and the middle one the base. By analogy with (b) if conventional current flows out of the emitter when the base is positive to it, the symbol takes the form of (d) and represents an *n-p-n* transistor. Consequently (c) represents a *p-n-p* transistor, operating with negative base and collector and having current flowing into the emitter.

These symbols as shown have one serious defect, in that they do not distinguish between emitter and collector. It is essential to be able to identify the two easily in order to trace a circuit rapidly. In any complex valve circuit, for example, one generally starts by identifying the input and output circuits by their connection to grid and anode and one should be able to do the equivalent in a transistor circuit. Fortunately, the difficulty is easily overcome by thickening or blacking-in the emitter element of the symbol as at (e) and (f) and it is these symbols that *Wireless World* suggests might be adopted for junction transistors. The symbols can be extended on the same lines for multi-electrode transistors.

In support of this system of symbolism, it may be urged that it represents the "historical" approach towards a new device; the user is going from the known to the unknown. And, if anyone raises the objection that a transistor is not a rectifier, the answer seems to be that the basic symbol here advocated primarily represents a semi-conductor junction. One such symbol, then, stands for a junction acting as a rectifier; two in conjunction may fairly indicate an amplifying transistor.

A related question—that of the appropriate reference letter or letter symbol to denote a transistor in circuit diagrams or lists of parts—was raised by E. A. W. Spreadbury in our March issue. At this stage of development, however, there seems to be some doubt whether it is necessary or desirable to introduce a special symbol; the transistor might be allowed to share the letter V with the valve without risk of confusion or ambiguity.



Complete selector unit, housed in case with sloping panel.

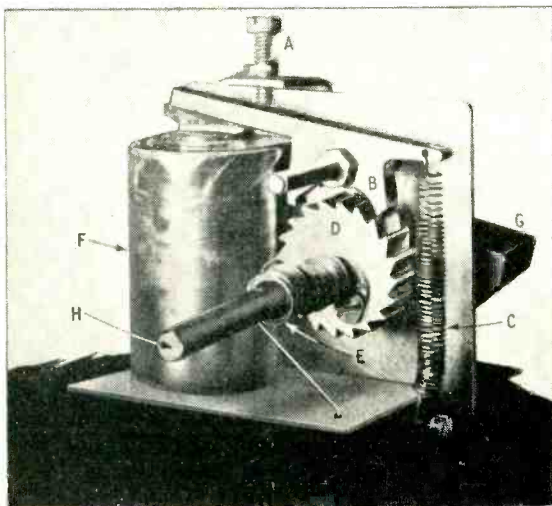
IT may seem a simple matter to those who are unaccustomed to the use of tape recorders to pick out a three-minute tune from several recorded on a half-hour reel of tape. However, people who own a tape recorder know from bitter experience how easy it is to overshoot by two or three yards. Paper markers solve this problem to a limited degree, but even so are far from satisfactory.

The device\* to be described enables any given section to be selected with a high degree of precision. It consists of a specially designed switch, through which the tape passes, and a selecting mechanism. The tape may be divided into as many sections as is desired, the one required being chosen by means of the selecting mechanism, the number of sections being limited only by the number of positions on the selector.

At the beginning of each section a piece of adhesive

\* Provisional patent 33963/54.

Selector with front removed. A, escapement adjusting screw (6BA); B, escapement; C, escapement return spring; D, ratchet wheel attached to H; E, actuating spring; F, solenoid which is mounted in slots to adjust height. G, arm attached to H which closes contacts S (Fig. 1); H, control knob spindle.



# TAPE SELECTOR MECHANISM

## A Useful Accessory for Magnetic Tape Recorders

By J. E. PRICE and R. A. FREWER,

B.Sc.(Eng.), Grad.I.E.E.

tape about half an inch long is affixed to the back of the recording tape in order to thicken it by about four times. The modern plastic adhesive tapes are very suitable for this application. Since this type of tape is very thin, it has been found necessary to use four layers, the top layer being rather longer than the other three. The overlap thus formed gives a "streamlined" effect and aids the tape in passing the felt pressure pads. During a period of about six months no deterioration in either the pressure pads or the recording tape has been noticed.

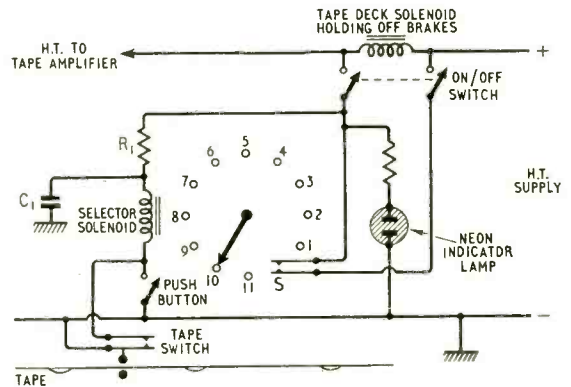
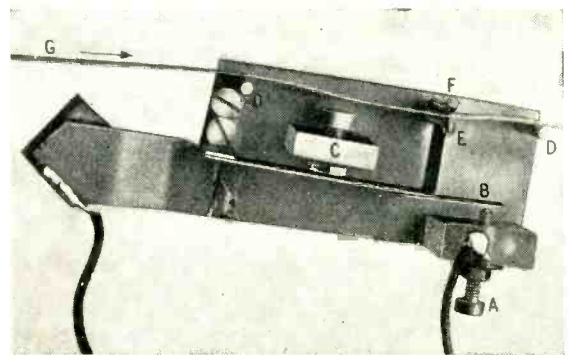
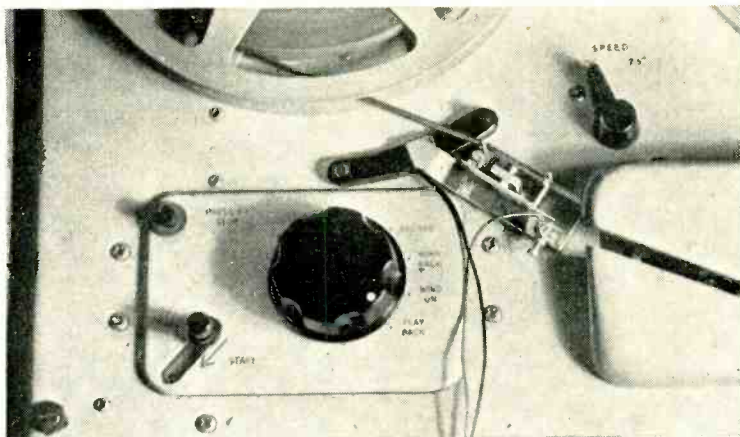


Fig. 1. Circuit diagram showing connections of tape switch and selector mechanism.



Tape switch. A, contact adjuster screw (6BA); B, contact spring; C, pillar spacing adjuster; D, tape guides; E, moving pillar attached to B; F, stationary pillar; G, tape, normal direction shown by arrow, coated side facing away from switch.

The recording tape is passed between two pillars which are forced apart by the thickened portion, thus causing a pair of contacts to be closed. The initial spacing of the pillars is at least twice the thickness of the tape in order to allow any joins to pass through. For use on half-track machines the switch could readily be modified so that only the lower half passes between the two pillars. For ease of loading the pillars are opened slightly at the top in the form of a Y. After consideration of many other types the present design of tape switch was chosen on account of its simplicity, freedom from contact bounce, high rate of response and in particular its complete freedom from any possibility of wear on the tape.



Tape switch as fitted to a "Wearite" tape deck.

The selector itself consists of a spring-loaded ratchet which is initially set to the number of the section required. Each pulse then allows the selector to fall back one position until it reaches zero, when a short-circuit is applied across the solenoid in the tape deck, thus causing the brakes to be applied. The selector may also be operated manually by a push-button switch. Since the selector solenoid simply releases the holding-back mechanism the power required is very small, and has been reduced still further by use of a capacitor C, which charges through R, and discharges through the selector solenoid when the tape switch is closed giving a current pulse of short duration.

The selector switch is capable of very rapid operation, due to the lack of inertia of the moving parts, and the mechanism is capable of responding at much higher speeds than are met with on any existing wind-on mechanism; thus the speed of response depends, to a large extent, on the efficiency of the tape recorder brakes.

This device is very useful when, for example, a number of three-minute tunes are recorded on one reel of tape. Contacts at either end of the recording tape can be arranged so that the brakes are applied

when a few turns of tape are left on the reel, thus obviating the continual irritation of re-threading prior to playback after rewinding the complete tape. Also the mechanism can be used with equal ease in both directions so that if it is desired to hear again a particular section the mechanism is set to 1 and the tape is rewound.

It would be almost indispensable for recorded sound effects in the theatre. Anyone who has stage-managed a play will appreciate the almost limitless possibilities of tape recording in this field, but when sound effects become numerous, and have to be repeated, confusion can be caused only too easily. This device enables any particular sound effect to be selected at will, in a very short space of time, thus limiting extraneous noise due to unnecessary operation of the recorder controls, and enabling every effect to be reproduced dead on time and in exactly the right place. By reducing the spacing of the pillars on the contact switch, this device may be adapted for use as a detector of joins in a reel of tape. This may be a useful industrial application. Finally, dare we mention it, by the use of this device it would become possible to use tape recorders in that modern teenager's delight, the "Juke Box."

## Tubeless Television?

**S**OME publicity has been given recently to various devices which, it is claimed, may replace the cathode ray tube for picture presentation in the television set of the future. The devices so far known depend for their operation on the phenomenon of electroluminescence. This was discovered in 1936 by Professor G. Destriau, of Paris, but his results were disregarded until about 1948, when various laboratories began to examine them further. Destriau found that the application of an alternating electric field across a thin layer of phosphor crystals resulted in the emission of light pulses at twice the frequency of the applied field. The light output of the layer increases as the frequency or the applied voltage is raised, over a considerable range, but the exact form of the relationship between these factors is rather complex. There is a threshold field below which no light is emitted. Special phosphors are used for electroluminescence but their base materials are usually zinc cadmium sulphides, as found in conventional cathode ray screens.

So far, the efficiencies of electroluminescent cells have proved to be very low. The higher figures quoted are about 5 lumens of green light per watt, which must be compared with 30 lumens per watt for a normal white phosphor under 10 kV electron bombardment.

Recently a new phenomenon allied to electroluminescence has been discovered by Professor Destriau and by D. A. Cusano in America. A d.c. field has been found to enhance the luminescence of a phosphor excited by ultra-violet radiation or x-rays, and gains of 50 times in brightness have been claimed. The decay time after removal of the stimulating radiation is several seconds.

Two types of "light amplifier" depending on the effects mentioned above have already been demonstrated. In one, developed by R.C.A., a layer of electroluminescent phosphor is sandwiched between a transparent conducting electrode and a photo-conducting electrode. An alternating voltage of 1-5 kc/s is applied to the two electrodes. When the photo-conductor is illuminated its impedance falls

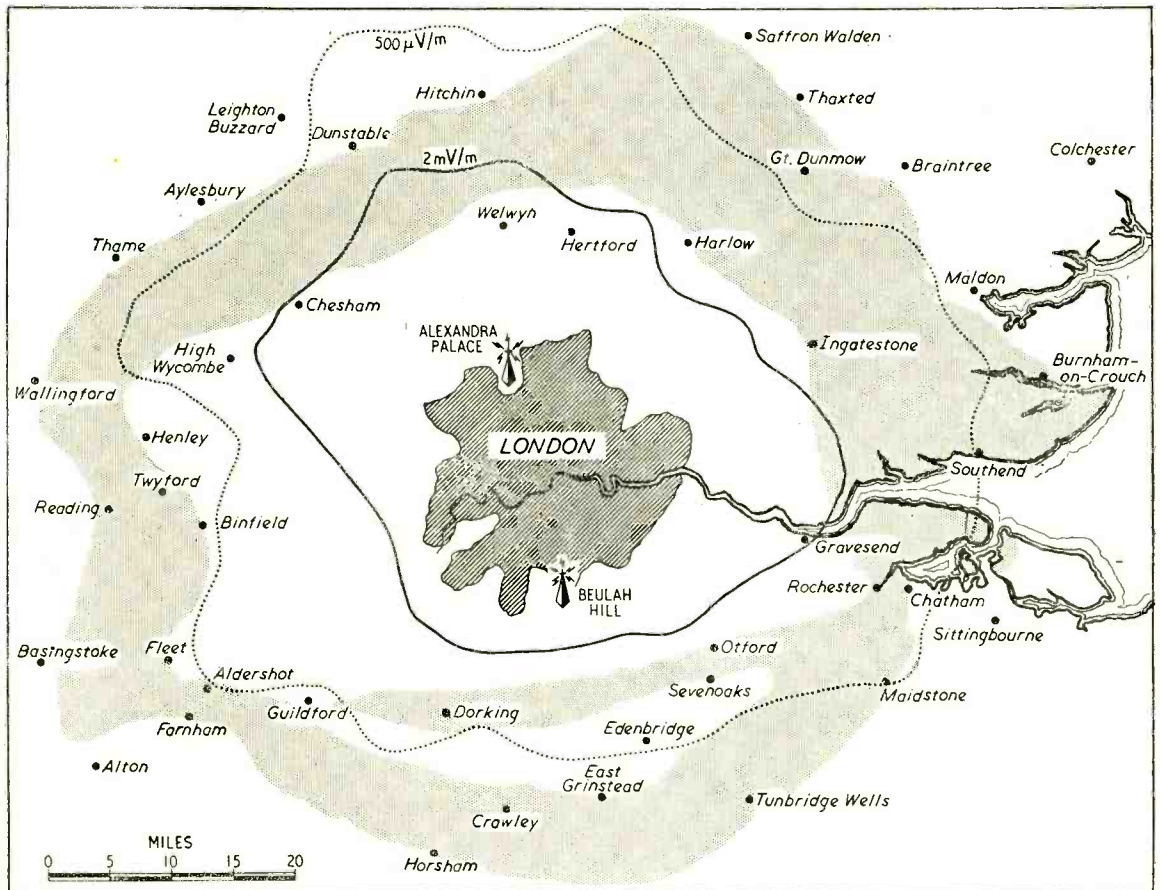
sufficiently to allow the a.c. field to excite the phosphor. Gains of the order of 10 times are claimed, but no figures of the actual screen brightness are available. The second type, developed by General Electric, dispenses with the photo-conducting layer. A direct voltage of the order of 100 volts is applied to a layer of zinc sulphide 10 microns thick on a conducting glass support. Ultra-violet falling on the phosphor excites luminescence, which is enhanced by the applied field. Ten visible quanta are claimed to be emitted for one incident quantum of ultra-violet. Again no figure for the actual screen brightness is quoted.

Both these devices can be made to perform in a similar way to the well-known image convertor. As far as television is concerned, however, they do not appear to hold much promise. There is little to be said for their use in place of the normal viewing screen in projection systems, even allowing for a considerable reduction in the energy of the projected picture. The second type is ruled out on account of its excessive decay time, while the first would demand picture storage from frame to frame in the projection tube, since it would be unable to follow the instantaneous brightness of the normal scanning spot. This is because the upper limit of brightness of an electro-luminescent layer (determined by the dielectric breakdown

strength of the phosphor) is too low. Some measure of storage could perhaps be obtained by allowing feedback of the electroluminescent light to the photo-conductor but this would lead to other practical difficulties.

There is a third device, not yet known to have been demonstrated, which, on paper at least, comes nearer the goal of tubeless television. This uses an electroluminescent layer having electrodes in the form of closely spaced wires stretched vertically on one side and horizontally on the other. The volume of phosphor at the point of intersection of a vertical and a horizontal wire constitutes one picture element, and emits light when an a.c. voltage is applied to those wires. The formidable problems of producing such a screen and devising means for switching to each picture element do not yet appear to have been solved. Owing to the limitation on brightness mentioned above, this device will also require means of storing the signals from frame to frame.

In view of these facts one may conclude that the familiar cathode ray tube will remain with us for some time yet. It may, however, take new forms; for example, the development of a flat, wall-mounted cathode-ray tube approximately 3 inches deep has already been claimed by Willys Motors in America.



**ALTERNATIVE LONDON TELEVISION.** On this recently issued map showing the estimated coverage of the temporary I.T.A. transmitter being erected at Beulah Hill, Croydon, we have superimposed the 2 and 0.5 mV/m contours of the Alexandra Palace transmitter. For the Croydon transmitter the area between the same (estimated) field strength contours is shown shaded. The I.T.A. transmitter will have an e.r.p. of 60 kW whereas the Alexandra Palace transmitter has an e.r.p. of only 34 kW. The height of the aerials above sea level are: Alexandra Palace 600ft, Croydon 550ft. The permanent I.T.A. transmitter will have a much taller mast and an e.r.p. of three or four times that of the temporary station which will be in service for about eighteen months.



# WORLD OF WIRELESS

## Organizational, Personal and Industrial Notes and News

THE FAMILIAR Decca separate half-cheeses for transmission and reception have, in the new Decca 212, given place to a single parabolic cylinder scanner of about 4ft across. As it is intended primarily for small vessels, in which it is essential to reduce top weight, the r.f. unit has been separated from the scanner unit.



### V.H.F. Sound Broadcasting

A REGULAR three-programme service of v.h.f. broadcasting will be introduced by the B.B.C. from Wrotham on May 2nd. The estimated coverage of the station is given on the map on page 161.

The frequencies to be used by Wrotham are 89.1 Mc/s (Light), 91.3 Mc/s (Third) and 93.5 Mc/s (Home). The e.r.p. of each transmitter will be 120 kW and the transmissions will be horizontally polarized.

Wrotham has been in operation experimentally since 1950; first with both a.m. and f.m. transmissions and latterly using f.m. only. It closed down on March 5th for nearly five weeks to permit the installation of a third transmitter, which will radiate the Home Service. This transmitter differs from the two already installed in that it is built as two separate units for parallel operation, and for the first few weeks of the new service only one of these units will be used.

The closing down of the Wrotham station for five weeks just prior to the inauguration of the f.m. service would have been an embarrassment to the industry and the retail trade in London. In response to a request, therefore, from the British Radio Equipment Manufacturers' Association, the B.B.C. is radiating a low-power (1 kW) test transmission from Alexandra Palace on 93.8 Mc/s daily from 9 a.m. to 11 p.m. until Wrotham restarts.

### April Shows

DURING this month three exhibitions are to be held in London—R.E.C.M.F. (19th-21st), Physical Society (25th-28th) and A.P.A.E. (27th-28th). A list of exhibitors at the R.E.C.M.F. components show, which is to be held at Grosvenor House, Park Lane, W.1, is given on page 158.

The Physical Society exhibition of scientific instruments and apparatus is this year being held in the Royal Horticultural Society's New Hall, Westminster, S.W.1. There will be 136 exhibitors, including manufacturers and Government and industrial research organizations. On each of the first three evenings at 6.15 there will be a discourse, the subjects being: "The Free Electron as a Tool in Scientific Research," "Memory Systems in the Brain," and "Recent Developments in Luminescence and its Applications." The exhibition opens at 2.0 on the 25th and at 10.0 on subsequent days. It closes on the first three days at 8.0 and on the last day at 5.0. Admission is by ticket, obtainable on application to the Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

The annual exhibition organized by the Association of Public Address Engineers will be held at the Horseshoe Hotel, Tottenham Court Road, W.1, on April 27th (10.0-8.0) and 28th (10.0-6.0). There will

be 18 exhibitors and there will again be half-hourly demonstrations of equipment throughout each day. Admission is by trade card or on production of this issue of *Wireless World*.

### Interference Suppression

IN July, 1950, the Postmaster General appointed an 18-member committee to investigate interference caused by refrigerators, and twenty months later appointed another committee (of 21 members) to consider the question of interference from small electric motors.

Their recommendations are now embodied in two Statutory Instruments\* laid before Parliament on March 1st by the P.M.G. They prescribe limits of noise voltages and fields which, from September 1st, must be complied with by *manufacturers* of electric refrigerators and by *users* of electric motors. The limits laid down are those given in British Standard 800: 1954. For both motors and refrigerators the noise voltage at the supply line terminals of the equipment must not exceed 1500  $\mu$ V in the 200-1605 kc/s band and 750  $\mu$ V in the 40-70-Mc/s band. The radiated field strength from motors, measured at not less than 33ft, must not exceed 100  $\mu$ V/m and 50  $\mu$ V/m, respectively, in these bands.

The question of making the regulations for small motors apply to manufacturers is to be reviewed during the next two years.

\*"The Wireless Telegraphy (Control of Interference from Electric Motors) Regulations, 1955," No. 291, and "The Wireless Telegraphy (Control of Interference from Refrigerators) Regulations, 1955," No. 292. H.M.S.O.; 6d net each.

### B.S.R.A. Convention and Show

THE ANNUAL convention and exhibition organized by the British Sound Recording Association opens at the Waldorf Hotel, Aldwych, London, W.C.2, on May 20th at 7.0 with a recital of magnetic recordings of film music. The exhibition of recording and reproducing equipment will be held from 10.30 to

7.0 on the 21st and from 10.0 to 6.0 on the 22nd. Admission is by catalogue (1s 6d), obtainable at the door.

## PERSONALITIES

At the annual general meeting of the Parliamentary and Scientific Committee in February, **Dr. S. Whitehead**, M.A., D.Sc., M.I.E.E., F.Inst.P. (director of E.R.A.), was re-elected joint honorary secretary. The committee comprises members of both Houses of Parliament (at present 44 Peers and 119 Members) together with representatives from 94 scientific and technological institutions. It holds lectures and discussions on subjects of national interest with a scientific content, particularly those subjects which may come before the Lords or Commons. Dr. Whitehead is a past-chairman of the international committee on radio interference (C.I.S.P.R.) and has acted as deputy chairman of the P.M.G.'s committees on radio interference from ignition systems and from small motors.

**D. C. Birkinshaw**, M.B.E., M.A., superintendent engineer of B.B.C. television, is going to the United States in company with one of the television drama producers to study television techniques and organization. They leave on March 26th and will be away three weeks.

**W. R. Fletcher**, B.Sc.(Eng.), A.M.I.E.E., who joined the B.B.C. in 1936 as an assistant maintenance engineer at the Lisnagarvey, Northern Ireland, station, has been appointed engineer-in-charge at Brookmans Park. He succeeds **D. Hamilton-Schaschke**, who has become resident engineer, British Far Eastern Broadcasting Service, Singapore. After serving at a number of the Corporation's stations, including the short-wave transmitter at Rampisham, Dorset, where he was senior maintenance engineer, Mr. Fletcher was seconded for two years to the Ceylon Broadcasting Service. In 1951 he was appointed resident engineer of the B.F.E.B.S., Singapore.

**D. H. Ray**, B.Sc., M.I.E.E., the new head of the Engineering Department of the Mid-Essex Technical College, Chelmsford, has been assistant head of the Electrical Engineering Department of the College of Technology, Birmingham, for some years. During the war he was released from the Army to assist in the training of radio mechanics at the College of Technology, where he took a permanent appointment after the war. He is a member of the C. & G. advisory committee on radio and television servicing.

On the death of a cousin the family honours have devolved upon **R. F. Payne-Gallwey**, who becomes the fifth baronet. Sir Reginald is chairman of the Radio Industries Club.

This year's president of the Radio Society of Great Britain is **H. A. Bartlett** (G5QA) who has been a member of the council for the past three or four years. His special interest is long-distance working.

## OUR AUTHORS

**Francis Oakes**, who is with the Ferguson Radio Corporation where he is in charge of transistor applications research, writes on the d.c. stability of transistor circuits in this issue. Educated in Vienna, he came to this country in 1939 and became a naturalized British subject in 1947. Before joining Ferguson's he was assistant chief of the electronics laboratory of the Morgan Crucible Company where he led a team of graduates working on a number of projects, including research into properties of materials, and on the development of carbon resistors.

**M. P. Johnson**, author of the article in this issue describing a method of testing precision oscillators, received the B.A.Sc. degree from the University of Toronto in 1936. He then came to this country and joined the General Electric Company at Coventry as a graduate apprentice. He later went into the transmission laboratory, where he is now in charge of a section dealing primarily with precision master oscillator development and negative feedback amplifiers.

## OBITUARY

**Donald Macadie**, M.B.E., the inventor of the original d.c. multi-range amps-volts-ohms meter, which later became known as the Avometer, has died at the age of 83. After his retirement from the Post Office in 1933 he devoted a considerable part of his time to the activities of the Automatic Coil Winder and Electrical Equipment Company which he helped to form in 1923 to manufacture the Macadie coil winder and the Avometer.

**Cyril H. Ford**, chief engineer of E.M.I. Sales and Service, Ltd., has died at the age of 58. He was originally with Marconi's at Chelmsford and transferred to the Marconiphone Company in 1922. In 1931 he became chief engineer of the Service Department at Hayes on the formation of Electric and Musical Industries, Ltd. He was a member of the exhibition technical committee of the R.I.C.

## IN BRIEF

**Broadcast Receiving Licences** current in the United Kingdom at the end of January totalled 13,903,950, including 4,307,772 for television and 263,741 for car radio. The number of television licences increased during the month by 151,783.

The tenth **Annual Electronics Exhibition** organized by the Northern Division of the Institution of Electronics, will be held at the College of Technology, Sackville Street, Manchester, from July 14th to 20th. On the first day the show will open at 2.0 p.m., but on subsequent days at 10.0 a.m. It will close daily at 10.0 p.m., except on Saturday when it closes at 6.0 p.m. There will be two main sections, one covering scientific and industrial research and the other manufacturers' products. Tickets are obtainable free from the organizing secretary, W. Birtwistle, 78, Shaw Road, Rochdale, Lancs.

In order to meet the increasing demands for **Mobile Radio** in the United States the Federal Communications Commission proposes reducing the channel spacing and making more stringent standards for equipment. According to a report in *Wire and Radio Communications* the spacing in the 25 to 50-Mc/s band is to be reduced from 40 kc/s to 20 kc/s, and in the 152 to 162-Mc/s band from 60 kc/s to 15 kc/s. In this country the spacing is 50 kc/s and 100 kc/s respectively in the 72 to 88 and 156 to 184 Mc/s bands.

**Colour Television Lectures.**—A course of eight lectures on "The Science of Colour Applied to Colour Television" by Professor W. D. Wright will be given on Tuesdays and Thursdays at 4.30 p.m. (from April 26th) in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7. Application for admission to the course, for which the fee is two guineas, should be made to the Registrar, Imperial College, Prince Consort Road, London, S.W.7.

**New Zealand Television.**—Our New Zealand contemporary, *Radio and Electrical Review*, reports that an Australian company (Rola Company Pty., Ltd.) and its New Zealand associate (Loudspeakers, Ltd.) are applying for permission to introduce into Australasia the Zenith system of subscription television—Phonevision.

The twenty-sixth edition of the **Trader Yearbook** (1955) is a veritable mine of information on the radio industry. In its 304 pages it includes directories of trade organizations, manufacturers and trade names, a buyers' guide and a considerable amount of technical information including some 300 valve base diagrams, abridged specifications for current television and sound receivers and a list of i.f.s used in post-war sound receivers. The Yearbook is obtainable by post from the Trader Publishing Company, Dorset House, Stamford Street, London, S.E.1, price 13s.

Sargrove Electronics ask us to point out that the **Direct-Reading Capacitance Meter** illustrated on p. 141 of our March issue was a development version; the final model is unlikely to be in full production for some months.

The Post Office has allocated the call-sign G9AED to the temporary experimental **Band III Television** transmitter which Belling & Lee are erecting on Beulah Hill, South London. The 250-watt transmitter, with its 16-dipole aerial giving an e.r.p. of 1 kW, is planned to be brought into service on April 1st. It will radiate a series of static patterns on 194.75 Mc/s, the vision frequency allocated to the London I.T.A. station.

Further changes in the licensing regulations governing the **Radio Control of Models** have been announced by the Post Office. Licensees will now only be required to check the transmitter frequency as often as may be necessary to ensure that it is operating within the authorized band and, in addition, the equipment may be operated by anyone under the personal supervision of the licensee.

An eight-page programme, giving explanatory notes and full details of the records to be played at the lecture-demonstration on **Sound Reproduction** by G. A. Briggs at the Royal Festival Hall on May 21st, is being produced. Copies, price 1s post free, will be available from Wharfedale Wireless Works, Ltd., Bradford Road, Idle, Bradford, after the middle of April.

The lectures given by Sir Edward Appleton, Professor G. W. O. Howe and Dr. J. Thomson at last year's I.E.E. meeting to celebrate the **Jubilee of the Thermionic Valve** are being published as a book by the Institution. It will also include an appreciation of Sir Ambrose Fleming and Lee de Forest by C. F. Booth (G.P.O. assistant engineer-in-chief). The book, entitled "Thermionic Valves 1904-1954," is available to non-members, price 9s.

The chairman of the new council of the **Technical Publications Association** is C. E. Cunliffe, manager of the Publicity and Publications Department of A. C. Cossor, Ltd.

## INDUSTRIAL NEWS

Associated-Rediffusion, Ltd., the programme contractors who will provide the material for the weekday transmissions from the I.T.A.'s London transmitter, have ordered most of their studio and O.B. equipment from **Marconi's**. The equipment includes complete installations for three 3-camera studios, one 2-camera studio, two 3-camera O.B. vehicles and master control gear. The company has recently acquired Adastral House, Kingsway, London (to be renamed Television House) and have studios at Wembley and a theatre at Walham Green.

What is believed to be the first post-war exhibition of **Imported Electronic Equipment** and components is being organized jointly by Rocke International, Ltd., and B. & K. Laboratories, Ltd. The exhibition, which will be held from April 25th to May 6th at 59, Union Street, London, S.E.1 (near London Bridge station), will include instruments from America and the Continent. Tickets for the display, which is open from 9.0 until 7.30 (Monday to Saturday), are obtainable from Rocke International at the above address.

**Industrial Television Equipment** is to be provided by Marconi's for the Windscale plutonium factory of the U.K. Atomic Energy Authority at Sellafield, Cumberland. It will be used for observing at a safe distance conditions which are dangerous to examine at close quarters.

To extend the radio-telephone service for the county's ambulances the Essex County Council has ordered from **Pye Telecommunications** a fixed station and 45 mobile transmitter-receivers. The fixed transmitter will be installed at Hainault and be remotely controlled by line from the Ilford ambulance depot.

An electro-optical camera, specially designed by **Winston Electronics**, of Hampton Hill, Middlesex, for the United States Government, was amongst the cargo on the first flight of the new transatlantic freight service inaugurated by Airwork, Ltd. The sequential image converter has been designed to enable photographs of 0.1 $\mu$ sec exposure to be taken at 0.5 $\mu$ sec intervals. It will be used at the Aberdeen proving ground—a weapon-testing centre.

The contract for planning the whole of the temporary I.T.A. station at Croydon has been awarded to **Marconi's**, who are supplying the vision and sound transmitters, aerial and 200ft mast. Work has begun on the temporary buildings for the station, which is scheduled to open in September.

**Intercommunications Equipment Company**, of 286-288, Leigh Road, Leigh-on-Sea, Essex, inform us that their marine R/T equipment (HA/66/RTA) has received the G.P.O. Certificate of Type Approval. The 50-watt transmitter operates on eight crystal-controlled frequencies within the band 1.4-8 Mc/s and, in addition to covering the same band, the receiver also covers medium and long waves.

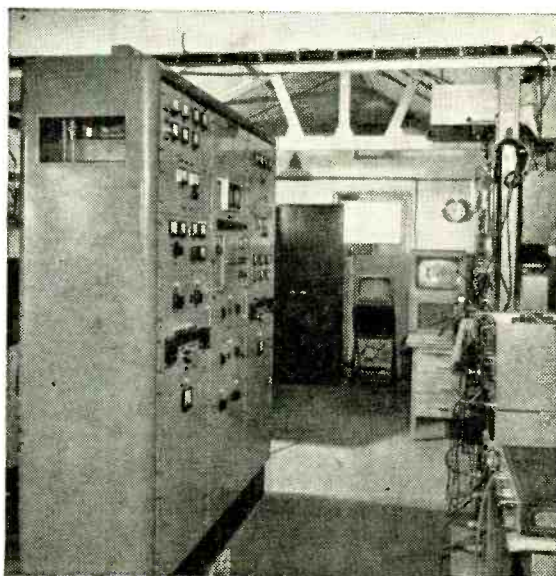
**New Marconi House?**—A new office building is to be erected by the English Electric Company on the site of the old Gaiety Theatre adjacent to Marconi House, Strand, the London office of the Marconi Company, which is in the English Electric group.

**Pye-Polygon Agreement.**—Pye, Ltd., have formed an association with the Polygon Record Company and announce that the business of the Polygon Record Co. (1954), Ltd., will be conducted from 66, Haymarket, London, S.W.1, the address of the Nixa Record Co., Ltd.

The multiplicity of television aerials on the living quarters at the Tower of London have been removed by order of the Ministry of Works and a communal aerial system has been provided. This has been installed by **E.M.I. Sales and Service** and feeds into a four-stage distribution amplifier. The output of 2V r.f. is fed into two "ring mains" of coaxial cable which encircles the whole of the Tower, providing a signal for individual members of the residential staff.

A feature of the **Marconi Marine** equipment installed in the new Grimsby steam trawler *Joseph Knibb* is the recently introduced "Gannet" R/T gear. The receiver has a rotating-loop aerial enabling the set to be used for direction finding as well as for communications.

On behalf of the United States Navy Department the Hazeltine Electronics Corporation has awarded three



THE FIRST of 20 low-power television transmitters ordered from Standard Telephones & Cables by the B.B.C. is being used at the temporary station at Tacolneston, Norwich. The combined sound and vision transmitter is shown on the left in this photograph. The vision transmitter produces a peak-white power of 0.5 kW. All the 20 transmitters are for operation in Band I, some being used at temporary sites and others as standby equipment at permanent stations.

British companies contracts valued at over \$26M for the development and production of **Military Electronic Equipment** for N.A.T.O. countries. The contracts received by B.T.H., G.E.C. and Ferranti are valued at \$11.5M, \$10.5M and \$4.25M, respectively.

Thorn Electrical Industries, Ltd., manufacturers of **Ferguson** sound and television receivers, have purchased ground at Enfield, Middlesex, on which they are erecting another factory. The new site is within a few hundred yards of their present factory.

**Clare Instrument Company**, which was formed twelve months ago by J. de Gruchy, a contributor to *Wireless World* on instrument technology, has moved from Rickmansworth, Herts, to 8, South Street, West Worthing (Tel.: Worthing 3407). The London office remains at 39, Victoria Street, S.W.1 (Tel.: Abbey 1816).

**John Ould, Ltd.**, of 389, Fifth Avenue, New York, 16, U.S.A., has been formed to operate as a sales organization for British electronic and allied equipment. Their appointment as sole concessionaires for the United States was recently announced by W. Bryan Savage, Ltd., and Pamphonic Reproducers, Ltd.

A **Tape-to-Disc** recording service is provided by "Deroy" Sound Services, of Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. Masters and pressings of both 78 r.p.m. and microgroove discs are supplied.

The title of **Hadley Sound Equipments, Ltd.**, of Cape Hill, Smethwick, Staffs, has been changed to **Hadley Telephone and Sound Systems, Ltd.**

The telephone number of **Superior Radio Supplies** in the advertisement pages of this issue, which went to press in advance of this section, should be Elgar 3644.

## COMPONENTS SHOW

THE RECORD number of 142 exhibitors will be participating in the twelfth annual exhibition of components, valves and test gear which opens at Grosvenor House, Park Lane, London, W.1, on April 19th for three days. The show opens at 10.0 each day and closes at 6.0 on the first, and at 9.0 and 5.0 respectively, on the two fol-

lowing days. Admission is restricted to wearers of an official badge obtainable, by engineers and technicians in the "user" industries and the Services, on application to the organizers, the Radio and Electronic Component Manufacturers' Federation, 22, Surrey Street, London, W.C.2. This year's exhibitors are listed below.

|   | Stand No. |   | Stand No.  |   | Stand No. |
|---|-----------|---|------------|---|-----------|
| <b>A.B. Metal Products</b>              | 41        | General Electric Co.                        | 135        | Reslosound                                  | 50        |
| A.K. Fans                               | 123       | Goldring Manufacturing Co.                  | 17         | Rola Celestion                              | 77        |
| Advance Components                      | 30        | Goodmans Industries                         | 47         | Ross, Courtney & Co.                        | 104       |
| Aerialite                               | 85        | Gresham Transformers                        | 70         | <b>Salford Electrical Instruments</b>       | 34        |
| Aero Research                           | 99        | Guest, Keen & Nettlefolds                   | 115        | Sankey, Joseph, & Sons                      | 128       |
| Allan Radio, Richard                    | 8         | <b>Hallam, Sleigh &amp; Cheston</b>         | 117        | Scott, Geo. L., & Co.                       | 118       |
| Antiference                             | 56        | Hassett & Harper                            | 141        | Simmonds Aerocessories                      | 140       |
| Associated Electronic Engineers         | 92        | Hellermann                                  | 89         | Sims, F. D.                                 | 133       |
| Automatic Coil Winder Co.               | 72        | Henley's Telegraph Works Co.                | 136        | Spear Engineering                           | 121       |
| <b>B.I. Callender's Cables</b>          | 57        | Hunt (Capacitors)                           | 23         | Stability Radio Components                  | 51        |
| Bakelite                                | 127       | <b>Igranic Electric Co.</b>                 | 12         | Standard Insulator Co.                      | 142       |
| Belling & Lee                           | 16        | Imhof                                       | 25         | Standard Telephones & Cables                | 5, 62     |
| Bird, Sydney S., & Sons                 | 53        | Insulating Components & Materials           | 122        | Static Condenser Co.                        | 112       |
| Bray, Geo., & Co.                       | 109       | <b>Jackson Bros.</b>                        | 74         | Steatite & Porcelain Products               | 38        |
| British Electric Resistance Co.         | 35        | J-Beam Aerials                              | 80         | Stocko (Metal Works)                        | 131       |
| British Mechanical Productions          | 76        | <b>Langley London</b>                       | 130        | Stratton & Co.                              | 60        |
| British Moulded Plastics                | 2         | London Electrical Co.                       | 36         | Suffix                                      | 48        |
| British Physical Laboratories           | 78        | London Electric Wire Co.                    | 61         | Supply, Ministry of                         | 91        |
| Bulgin & Co.                            | 21        | Long & Hambly                               | 31         | Swift, Levick & Sons                        | 139       |
| Bullers                                 | 1         | <b>Magnetic &amp; Electrical Alloys</b>     | 110        | Symons, H. D., & Co.                        | 113       |
| <b>Carr Fastener Co.</b>                | 75        | Mallory Batteries                           | 97         | <b>Taylor Electrical Instruments</b>        | 19        |
| Clark, H., & Co.                        | 116       | Marconi Instruments                         | 103        | Telcon-Magnetic Cores                       | 111       |
| Collaro                                 | 10        | Marrison & Catherall                        | 132        | Telegraph Condenser Co.                     | 54        |
| Colvern                                 | 55        | McMurdo Instrument Co.                      | 39         | Telegraph Construction & Maintenance Co.    | 66        |
| <i>Communications &amp; Electronics</i> | 93        | Measuring Instruments                       | 102        | Telephone Manufacturing Co.                 | 33        |
| Connollys (Blackley)                    | 9         | Micanite & Insulators Co.                   | 101        | Thermo-Plastics                             | 11        |
| Cosmocord                               | 79        | Minnesota Mining & Mftg. Co.                | 126        | Transradio                                  | 124       |
| Creators                                | 105       | Morganite Resistors                         | 15         | Truvox                                      | 28        |
| <b>Daly</b>                             | 100       | Mullard                                     | 65, 94, 95 | Tucker Eyelet Co.                           | 81        |
| Dawe Instruments                        | 73        | Multicore Solders                           | 69         | Tufnol                                      | 129       |
| De La Rue & Co. (Plastics)              | 83        | Murex                                       | 137        | <b>Vactite Wire Co.</b>                     | 7         |
| "Diamond H" Switches                    | 6         | Mycalex Co.                                 | 3          | Vitavox                                     | 43        |
| Dubilier Condenser Co.                  | 45        | <b>N.S.F.</b>                               | 49         | <b>Walter Instruments</b>                   | 86        |
| Duratube & Wire                         | 52        | Neill, James, & Co.                         | 90         | Wego Condenser Co.                          | 18        |
| <b>Edison Swan Electric Co.</b>         | 42        | <b>Oliver Pell Control</b>                  | 134        | Welwyn Electrical Laboratories              | 63        |
| Egen Electric                           | 37        | <b>Painton &amp; Co.</b>                    | 46         | Weymouth Radio Mftg. Co.                    | 13        |
| Electro Acoustic Industries             | 40        | Parmeko                                     | 27         | Whiteley Electrical Radio Co.               | 14        |
| Electronic Components                   | 108       | Partridge Transformers                      | 24         | Wiggin, Henry & Co.                         | 138       |
| <i>Electronic Engineering</i>           | 98        | Permanoid                                   | 88         | Wimbleton Engineering Co.                   | 87        |
| Electrothermal Engineering              | 120       | Plessey                                     | 67, 68     | Wingrove & Rogers                           | 59        |
| English Electric Co.                    | 106       | Pye   | 96         | Wireless Telephone Co.                      | 71        |
| Enthoven, H. J., & Sons                 | 58        | <b>Radio Instruments</b>                    | 84         | <i>Wireless World and Wireless Engineer</i> | 107       |
| Erg Industrial Corporation              | 119       | Reliance Electrical Wire Co.                | 26         | Woden Transformer Co.                       | 20        |
| Erie Resistor                           | 29        | Reproducers & Amplifiers                    | 32         | Wright & Weaire                             | 82        |
| Ever Ready Co.                          | 125       | <b>Salford Electrical Instruments</b>       | 34         | <b>Zenith Electric Co.</b>                  | 4         |
| <b>Ferranti</b>                         | 44        | Sankey, Joseph, & Sons                      | 128        |   |           |
| Fine Wires                              | 114       | Scott, Geo. L., & Co.                       | 118        |   |           |
| <b>Garrard Engineering Co.</b>          | 64        | Simmonds Aerocessories                      | 140        |   |           |
|   |           | Sims, F. D.                                 | 133        |   |           |
|   |           | Spear Engineering                           | 121        |   |           |
|   |           | Stability Radio Components                  | 51         |   |           |
|   |           | Standard Insulator Co.                      | 142        |   |           |
|   |           | Standard Telephones & Cables                | 5, 62      |   |           |
|   |           | Static Condenser Co.                        | 112        |   |           |
|   |           | Steatite & Porcelain Products               | 38         |   |           |
|   |           | Stocko (Metal Works)                        | 131        |   |           |
|   |           | Stratton & Co.                              | 60         |   |           |
|   |           | Suffix                                      | 48         |   |           |
|   |           | Supply, Ministry of                         | 91         |   |           |
|   |           | Swift, Levick & Sons                        | 139        |   |           |
|   |           | Symons, H. D., & Co.                        | 113        |   |           |
|   |           | <b>Taylor Electrical Instruments</b>        | 19         |   |           |
|   |           | Telcon-Magnetic Cores                       | 111        |   |           |
|   |           | Telegraph Condenser Co.                     | 54         |   |           |
|   |           | Telegraph Construction & Maintenance Co.    | 66         |   |           |
|   |           | Telephone Manufacturing Co.                 | 33         |   |           |
|   |           | Thermo-Plastics                             | 11         |   |           |
|   |           | Transradio                                  | 124        |   |           |
|   |           | Truvox                                      | 28         |   |           |
|   |           | Tucker Eyelet Co.                           | 81         |   |           |
|   |           | Tufnol                                      | 129        |   |           |
|   |           | <b>Vactite Wire Co.</b>                     | 7          |   |           |
|   |           | Vitavox                                     | 43         |   |           |
|   |           | <b>Walter Instruments</b>                   | 86         |   |           |
|   |           | Wego Condenser Co.                          | 18         |   |           |
|   |           | Welwyn Electrical Laboratories              | 63         |   |           |
|   |           | Weymouth Radio Mftg. Co.                    | 13         |   |           |
|   |           | Whiteley Electrical Radio Co.               | 14         |   |           |
|   |           | Wiggin, Henry & Co.                         | 138        |   |           |
|   |           | Wimbleton Engineering Co.                   | 87         |   |           |
|   |           | Wingrove & Rogers                           | 59         |   |           |
|   |           | Wireless Telephone Co.                      | 71         |   |           |
|   |           | <i>Wireless World and Wireless Engineer</i> | 107        |   |           |
|   |           | Woden Transformer Co.                       | 20         |   |           |
|   |           | Wright & Weaire                             | 82         |   |           |
|   |           | <b>Zenith Electric Co.</b>                  | 4          |   |           |

# Design for an F.M. Tuner

## I—Underlying Principles of Receivers for the New B.B.C. Service

By S. W. AMOS,\* B.Sc. (Hons.), A.M.I.E.E., and G. C. JOHNSTONE,\* B.Sc. (Hons.)

**I**N anticipation of the B.B.C. frequency-modulated service, due to start in May with regular programmes initially from Wrotham, the authors have constructed a suitable tuner for feeding high-quality audio amplifiers. The tuner, for which constructional details will be given in next month's issue, includes a built-in mains unit and is designed to use readily available components. Underlying principles and general design features are discussed in the present article.

The B.B.C. proposes initially to employ carrier frequencies spaced at 200 kc/s intervals in the frequency range 88.1-94.5 Mc/s. This range is, however, only part of the range (Band II) allocated by international agreement to v.h.f. sound broadcasting. The full extent of the band is from 87.5 Mc/s to 100 Mc/s, and whilst at present the frequencies in the range 95 Mc/s to 100 Mc/s are used by police and other services, it is quite conceivable that in time frequencies in the upper part of the band will be employed for broadcasting purposes; thus the desirable receiver coverage is 87.5 Mc/s to 100 Mc/s.

The tuner's sensitivity should be such that at any point within the service areas the three local B.B.C. transmissions can be received. As the three transmitters will be of approximately equal power the field strengths at the receiving aerial will be approximately equal. For the purposes of classification the service area of each transmitter is divided by the B.B.C. into two regions; these are the first-class service region (field strength greater than 1 millivolt per metre) and the second-class service region (field strength between 250 microvolts per metre and 1 millivolt per metre). The significant difference between these two regions is that within the latter area some trouble from ignition interference may be experienced.

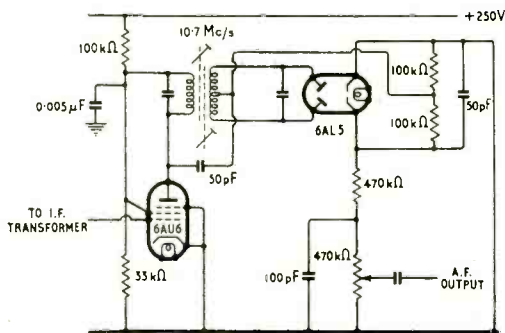
The receiver input voltage  $V$  is related to the field strength  $E$  at the aerial by the expression  $V = \frac{E\lambda}{2\pi}$ ,

where  $\lambda$  is the wavelength. In deducing the expression it was assumed that the aerial is a half-wave dipole, that matching is perfect throughout, and that feeder losses are negligible. For Band II  $\lambda$  is approximately  $\pi$  metres and the above expression may be simplified to  $E/2$ . Thus at the edge of the second-class service area the signal at the receiver terminals will be of the order of 125 microvolts.

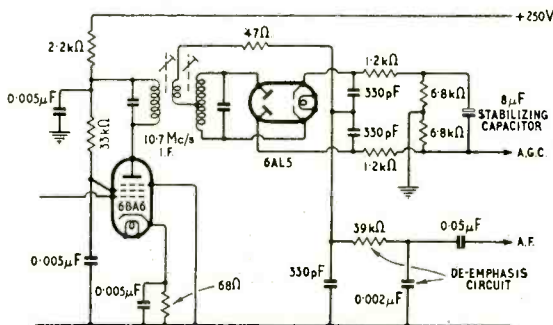
However, this figure cannot be used as a basis for receiver design without some further qualification. The maps published by the B.B.C. give the average field strength at an aerial height of 30 feet. For lower aerials the field strength is less, being approximately proportional to height. Moreover, the field strength within a building is likely to be appreciably below the outdoor value, and tests indicate that this drop under unfavourable conditions may be of the order

of 30 db. Thus at the edge of the second-class service area, with a picture-rail aerial, in a ground-floor room, at the side of a building remote from the transmitter, the signal at the receiver terminals may be as low as  $4 \mu\text{V}$ . With such a small input the signal-to-noise ratio is likely to be barely acceptable, but this figure indicates the order of sensitivity required for a tuner destined for universal use.

Before the general form of the tuner can be considered, it is necessary to decide the type of discriminator to be used. The most popular ones are the Foster-Seeley and the ratio detector. The choice is governed by considerations of linearity and amplitude modulation rejection. The Foster-Seeley discriminator is capable of better linearity than the ratio detector but requires careful design and adjustment to obtain it, whereas the linearity of the ratio detector is not greatly affected by small variations of circuit parameters. As an indication of the distortion of the two, the Foster-Seeley can give less than 1% harmonic distortion at 75-kc/s deviation, whilst the ratio detector for the same deviation may give approximately 3%.



Typical Foster-Seeley discriminator.



The f.m. ratio detector; a de-emphasis circuit is included also in the Foster-Seeley discriminator.

\* B.B.C. Engineering Training Department.

The chief difference between the two detectors is in their amplitude modulation rejection properties. The Foster-Seeley circuit is balanced, and thus gives good amplitude modulation rejection at its centre frequency; elsewhere its response to a.m. is proportional to the difference between the signal and centre frequencies. The ratio detector is also balanced at the centre frequency, but by virtue of the action of the stabilizing capacitor, its response at other frequencies is very much less than that of the Foster-Seeley circuit. For this reason it is usual to precede a Foster-Seeley discriminator by an amplitude limiter. Whilst such a limiter is not essential before a ratio detector, it can be employed to give additional rejection at high signal levels. The limiter used with a Foster-Seeley discriminator requires approximately 1 volt of signal at its *input* for limiting, whereas the ratio detector requires a signal of approximately 1 volt at the diode for limiting. Since the stage preceding a ratio detector may operate at full gain one i.f. stage can sometimes be saved by adopting this detector; in a particular design this may well be the deciding factor. On balance it was decided that the ratio detector was better suited for use in the tuner to be described.

## Receiver Amplification

With a ratio detector the gain required from the aerial terminals to the detector is of the order of  $10^3$ ; with a Foster-Seeley discriminator this is the order of gain required prior to the limiter grid. The major portion of this gain must be obtained from the i.f. amplifier, but there will be a useful contribution from the frequency changer and r.f. amplifier. The necessity for an r.f. amplifier is not immediately obvious, because its gain will be considerably less than that of the same valve used as an i.f. amplifier. In spite of its low gain, the stage is necessary for the following reasons. The noise factor of a mixer stage is almost always considerably larger than that of an r.f. amplifier; since the signal-to-noise ratio of the tuner is determined almost entirely by that of its first stage, it is clear that this stage should be an r.f. amplifier for best signal-to-noise ratio.

Moreover the stage reduces feedback from the local oscillator to the aerial. Such feedback can cause interference to other receivers, and must be held to a low level. It has been suggested that in order to minimise such interference the maximum oscillator voltage appearing at the aerial terminals (loaded by an aerial or dummy load) should be less than 200 microvolts within Band II, and less than 500 microvolts at other frequencies. With the additive type of mixer usually employed at v.h.f. the local oscillator may provide up to 3 or 4 volts output at the grid of the mixer and the reduction of this voltage to the specified limits at the aerial terminals calls for careful design. With the multiplicative type of mixer, this problem is less acute because the input grid is screened from the oscillator grid. Finally, the increased selectivity conferred by the r.f. stage provides increased protection against image channel interference and i.f. break-through.

In order to calculate in detail the gains of the various stages of the tuner we must consider the circuit of each stage in greater detail. Three types of r.f. stage are commonly employed. These are the single pentode, the earthed-grid triode and the cascode (a combination of earthed-cathode and earthed-grid triodes in cas-

cade). The behaviour of the cascode is generally similar to that of a pentode, having an overall mutual conductance equal to that of its constituent triodes. Due to the absence of partition noise, it has, however, a lower noise factor than the corresponding pentode. Except under conditions of extremely low field strength it is doubtful if the better signal-to-noise ratio justifies the employment of a cascode circuit in preference to an r.f. pentode.

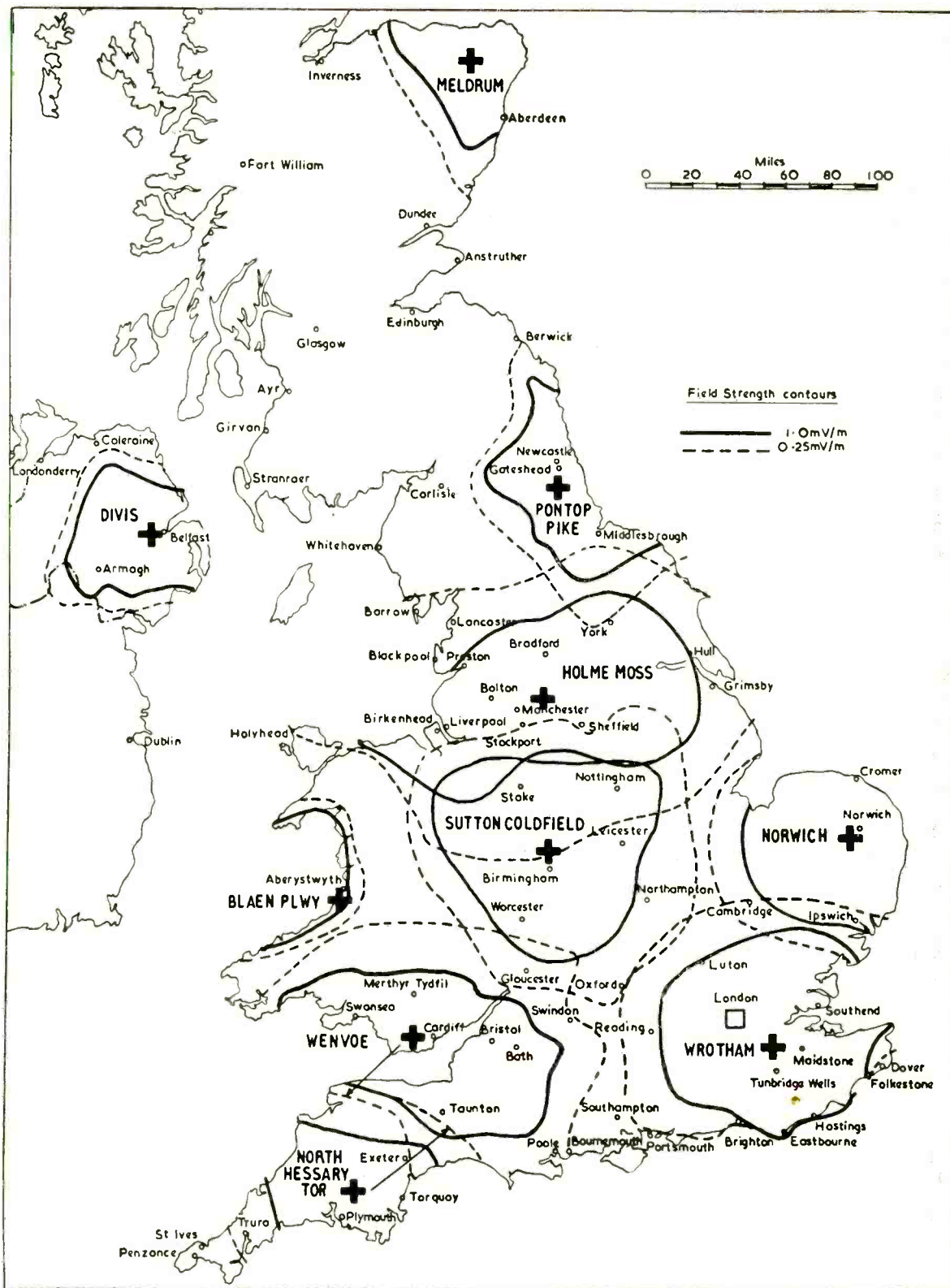
The earthed-grid triode r.f. stage is **not** generally favoured at frequencies as low as 100 Mc/s because it suffers from a number of disadvantages. First, the gain available from the aerial input circuit is low, due to the low input impedance ( $1/g_m$ ); secondly, the noise factor is higher than that of a cascode and comparable with that of the r.f. pentode; thirdly, it offers insufficient protection against oscillator feedback to the aerial, the output and input circuits being linked by the anode a.c. resistance of the valve.

There thus seems little advantage in departing from a simple pentode r.f. stage. In general, because of the damping of the first tuned circuit by the aerial resistance and the input resistance of the r.f. stage, there is no point in having variable tuning in this circuit; it is normally sufficient for the circuit to be resonant at the mid-band frequency. The damping resistance due to the valve will be of the order of 2 to  $6k\Omega$  and is in parallel with the dynamic resistance of the tuned circuit. If we assume a total tuning capacitance of 15 pF (i.e., the sum of the valve input capacitance, strays and a small amount of lumped capacitance) and a Q value of 50, the natural dynamic resistance of the tuned circuit is approximately  $5k\Omega$ . This is reduced by valve damping to 1.5 to  $2k\Omega$  and the aerial feeder impedance must be matched to this resistance to secure maximum voltage transfer and correct feeder impedance termination. With a 75-ohm feeder, the impedance ratio is about 1:25 and the voltage step-up ratio consequently about 5. Thus the total damping resistance from all sources is approximately  $1,000\Omega$ , which, for a tuning capacitance of 15 pF, gives a working Q value of approximately 10. The response is then 3 db down at each end of the band, relative to the response at the mid-band frequency.

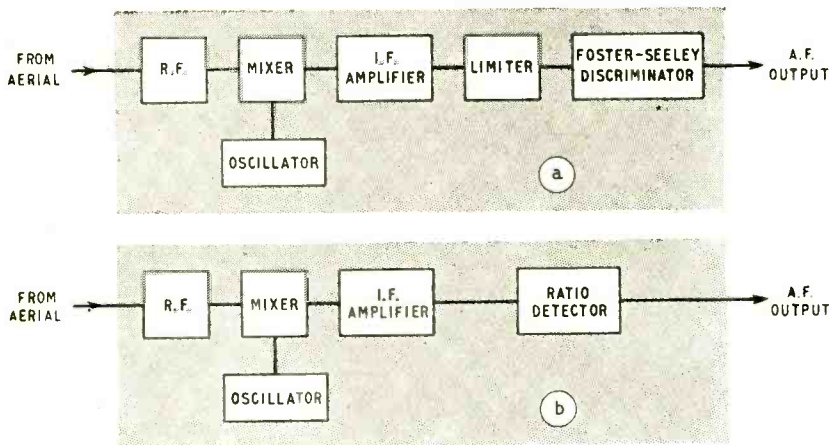
## R.F. Stage

The gain from grid to anode of the r.f. stage, is intimately linked with the input resistance of the mixer stage, which is usually low, of the order of 2 to  $3k\Omega$ . With this value there is some advantage to be gained by having variable tuning for the anode circuit, and with an additive type of mixer, variable tuning is essential to present a relatively constant impedance to the oscillator. The size of the tuning elements is determined largely by the requirements of the oscillator circuit, with which the anode circuit must be ganged. In general, this necessitates a tuning capacitance of the order of 20 to 30 pF, and hence gives a natural dynamic resistance in the region of 2.5 to  $5k\Omega$ . The total load presented to the r.f. stage is thus 1 to  $2k\Omega$ , giving a stage gain of approximately 10 with a valve having a mutual conductance of 6 mA/V. The gain from aerial input to mixer grid is thus about 50, and the gain required from the mixer and i.f. stages is  $2 \times 10^3$ . With a triode mixer, the input resistance is rather difficult to predict, because Miller effect plays a large part in determining it; under certain circumstances it may even be negative.

The combination of oscillator and separate mixer is



Estimated coverage of the first ten f.m. stations to be brought into service is shown on this map reproduced by courtesy of the B.B.C. The frequencies of the three transmitters at each station were given on page 56 of our February issue.



Block diagrams showing the main differences between (a) f.m. receiver with Foster-Seeley discriminator and (b) with a ratio detector.

usually preferred to the multiplicative mixer, because the former gives an appreciably higher conversion conductance (about 2 to 3 mA/V compared with 0.5 to 1.0 mA/V). The oscillator may be a Hartley, Colpitts or Reinartz type but there are two factors which restrict the choice. First, it is desirable that one "pole" of the tuning capacitor should be earthed; this eases ganging problems. Secondly, the cathode of the oscillator should preferably be earthed; with the cathode divorced from earth, the cathode-heater capacitance forms a significant part of the total tuning capacitance, and there is a risk of microphony and hum induction due to movement of the heater with respect to the cathode.

## Receiver Bandwidth

The component values in the oscillator circuit are a compromise between the extremes of a large tuning capacitance, to "swamp" valve capacitance variations, and a small value, to give a high dynamic resistance and hence maximum assistance to the maintenance of oscillation. A reasonable compromise value of tuning capacitance is 30 pF.

The mixer and i.f. amplifier are required to give a voltage gain of approximately  $2 \times 10^3$  and have to satisfy certain selectivity requirements. The channel spacing of 200 kc/s would appear to impose fairly stringent requirements on receiver selectivity to minimize adjacent-channel interference. However, for any given locality the transmitters employing adjacent channels will be remote geographically and it is doubtful if any appreciable adjacent-channel interference will result. The bandwidth of the i.f. amplifier is thus determined largely by the harmonic distortion tolerable, the local-oscillator frequency drift and threshold effect.

The phenomenon of threshold effect is peculiar to all forms of angular modulation and there is no comparable effect in amplitude modulation. In brief, when the amplitude of an interfering signal exceeds that of the wanted signal, there is an abrupt deterioration of the signal-noise ratio. For ignition interference and random noise, the peak value of the noise signal is proportional to the square root of the receiver bandwidth and to preserve the signal-to-noise ratio at the highest possible value, the receiver bandwidth should

be the minimum consistent with adequate bandwidth for the wanted signal. For a signal with a deviation of 75 kc/s, the sidebands extend well beyond the apparent swept limits of  $\pm 75$  kc/s and thus it is usual to assume a minimum bandwidth, between the 3-db loss points, of 180 kc/s. To allow for oscillator frequency drift this is usually increased to between 200 and 250 kc/s.

The r.f. circuits of v.h.f. receivers have bandwidths measured in Mc/s rather than kc/s and the receiver selectivity is almost entirely determined by the bandwidth of the i.f. amplifier. As an indication of

the performance likely to be achieved by a practical i.f. transformer we will assume each winding to have a Q-value of 50 and the coupling factor to be unity ( $kQ = 1$ ). At an operating frequency of approximately 10 Mc/s the response is 0.6 db down at 75 kc/s from resonance and 7 db down at 200 kc/s from resonance. With a coupling factor of unity the response in the passband for Q-values exceeding 50 tends to be unsatisfactory and it is usual to employ coupling factors between 1 and 1.5 which give small "rabbit's ears" and maintain reasonably flat response in the passband.

The overall bandwidth depends on the number of i.f. transformers employed and this, in turn, is determined by the total number and the stage gains. The gain per stage is given by  $g_m R_d n / (1 + n^2)$  where  $n$  is the coupling factor ( $=kQ$ ),  $R_d$  is the dynamic resistance of either tuned circuit alone (assuming both the same) and  $g_m$  is the mutual conductance of the i.f. valve. With  $n$  between 1 and 1.5,  $n/(1 + n^2)$  varies between 0.5 and 0.446. This is a very small variation and thus the stage gain depends almost entirely on  $R_d$  and  $g_m$ .  $R_d$  is given by  $\omega QL$  and, for maximum gain,  $Q$  and  $L$  should be large. An upper limit to the value of  $L$  is set by the minimum value of tuning capacitance which can be employed; whilst it is possible to tune by valve and stray capacitance alone, this is undesirable because valve capacitances vary, particularly when an a.g.c. voltage is applied, causing appreciable change in the shape of the i.f. response curve. In general the lowest minimum value of lumped capacitance is of the order of 15 to 20 pF; even with these values appreciable detuning may occur. Where the highest stage gain is not of prime importance, 50 pF may be taken as a suitable value of lumped tuning capacitance.

The Q-value of the inductor depends upon many factors, amongst which are wire size, coil-former dimensions, and screening-can dimensions. By careful design, Q-values of the order of 100 at 10 Mc/s can be realized; if the lumped tuning capacitance is 20 pF, and valve and stray capacitance total 10 pF, a stage gain of about 200 can be obtained from a valve with a mutual conductance of 8 mA/V. This may be taken as representative of the upper limit of gain per i.f. stage and with such component values instability would probably occur. In practice, Q-values in the region of 70 to 80 are more likely to be obtained and with a tuning capacitance of 50 pF the stage gain is in the region of 70.



With an i.f. transformer of this kind having 50-pF tuning capacitors the gain of an additive-pentode mixer is about 20; the i.f. amplifier is thus required to contribute a gain of about 100 to give the required overall gain. This gain could be obtained from a single i.f. stage but it is preferable to use two stages. Where a ratio detector is employed the last i.f. stage can then be operated as a high-level limiter. This improves a.m. rejection for large inputs whilst giving useful gain for small input signals.

### Oscillator Frequency

The general form of the receiver is determined as described above but there are a number of additional features of an f.m. receiver to which attention must be paid. For example, should the oscillator frequency be above or below that of the signal? The lower value permits better oscillator stability because a larger tuning capacitor can be used; the higher value gives less likelihood of second-channel interference. In order to discuss the choice further, it is necessary now to consider the precise value of the intermediate frequency.

One of the unfortunate features of an f.m. receiver is that harmonics of the intermediate frequency are generated in late i.f. stages and the discriminator; this is due to the pulsating nature of the current in such stages. These harmonics can reach early stages of the receiver and may cause whistles and/or the appearances of "dead" carriers. To minimize this, the i.f. should be so chosen that its harmonics do not lie in the band to be received. Where the band is 88 to 108 Mc/s (as in the U.S.A.) the i.f. must be above 21.6 and below 22 Mc/s to satisfy this requirement. At such frequencies, it is difficult to achieve adequate selectivity. A lower limit to the value of the i.f. is set by the requirement that the frequency shall be greater than half that of the band to be received, to ensure that there are no image signals within the band itself. This minimum value for 88 to 108 Mc/s is 10 Mc/s and a frequency which seems to be favoured as the best compromise is 10.7 Mc/s. This i.f. has the disadvantage that the oscillator frequency can fall within

the received band; for example, when the receiver is tuned to 88 Mc/s, if the oscillator frequency is 98.7 Mc/s, any oscillator radiation can cause interference to local receivers tuned to 98.7 Mc/s. Alternatively if the oscillator frequency is 10.7 Mc/s below the signal frequency and the receiver is tuned to say 98.7 Mc/s interference may be caused to receivers tuned to 88 Mc/s. Interference can thus occur over a range of frequencies at either end of the band, and for the British Band II, this range is 1.7 Mc/s. This difficulty could be overcome by adopting an i.f. of say 12.5 Mc/s, but there remains the problem of image interference and oscillator harmonics falling in this band.

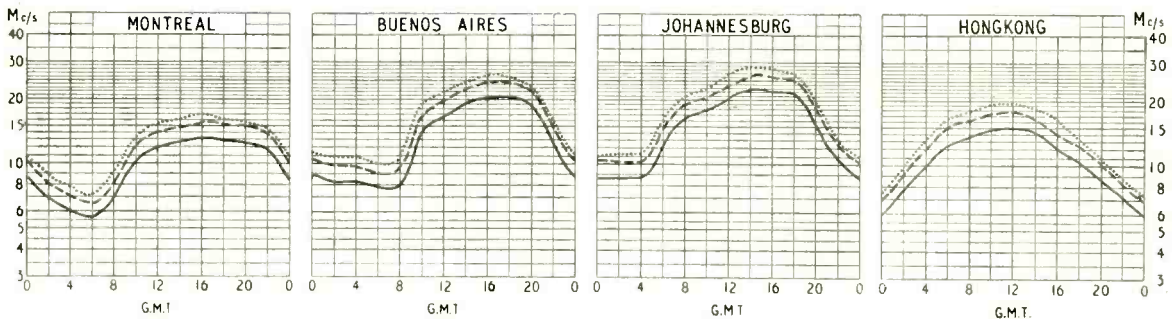
With an intermediate frequency of 10.7 Mc/s, the two image channel bands are 66.1 to 78.6 Mc/s and 108.9 to 121.4 Mc/s. The former band includes the vision carrier of television channel 5 and a number of relatively high-power police and public service transmissions in the band 70 to 80 Mc/s. The band 108.9 to 121.4 Mc/s includes aircraft communication channels, which are less likely to cause interference.

With the oscillator above the signal frequency there is a possibility of the oscillator second harmonic causing interference in Band III; with the oscillator below, the harmonics fall clear of Band III. Summarizing, there is a possibility of interference with Band III television receivers when the oscillator frequency is high, and the possibility of image channel interference when the oscillator frequency is low. Provided these effects are minimized, receivers can be satisfactorily operated with high or low oscillator frequencies. But possibly on balance the choice would be for a higher oscillator frequency.

Oscillator radiation can be a serious problem and can occur in three distinct ways: (a) from the wiring or chassis due to circulating currents (b) from the aerial (c) from the mains lead. For all three classes of interference, limits have been laid down by the B.S.I. for television receivers and doubtless similar limits will be laid down for v.h.f. frequency modulated sound receivers. Clearly the design of any v.h.f. tuner should be such as to conform at least with these limits.

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

- ..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

# D.C. Stability of Transistor Circuits

By FRANCIS OAKES\*, M.Inst.E., A.M.Brit.I.R.E., Assoc. I.E.E.

## Basic Formulæ and Design Data for Junction Types

A TRANSISTOR can be regarded as a combination of two diodes, one of them, biased in the forward direction, representing the emitter-base junction, the other, biased in the reverse direction, representing the base-collector junction. Transistor action, due to minority carrier injection, allows the reverse current of the base-collector junction to be controlled by the forward current through the emitter-base diode. Apart from this conduction by minority carriers, a leakage current flows across the base-collector junction due to impurities in the collector. This current, referred to as  $I_{co}$ , is not controlled by the emitter current, and unfortunately, increases rapidly with rising temperature.

**Direct-current Relationships.**—At any transistor operating point for which the emitter potential is positive, and for which the collector potential is negative with respect to the base, the current  $I_e$  (conventional) flowing into the emitter is equal to the sum of the currents  $I_c$  and  $I_b$  flowing out of the collector and base respectively. This can be expressed in the following forms:

$$I_e = I_c + I_b \quad \dots \quad (1)$$

The collector current, on the other hand, is made up of the flow of minority charge carriers transferring a current  $\alpha I_e$  from the emitter and by the impurity current  $I_{co}$ . The factor  $\alpha$  which is referred to as the emitter direct-current amplification factor is a positive number, somewhat smaller than unity for junction transistors. The impurity current  $I_{co}$  is the current which will flow from the base to the collector when there is zero current flowing into the emitter. These circumstances may be represented in the equation

$$I_c = \alpha I_e + I_{co} \quad \dots \quad (2)$$

Substituting this expression for  $I_c$  into equation (1), the base current can be obtained in terms of  $I_e$  and  $I_{co}$ :

$$I_b = I_e (1 - \alpha) - I_{co} \quad \dots \quad (3)$$

**Influence of  $I_{co}$  upon  $I_b$ ,  $I_c$  and  $I_e$ .**—When interpreting these expressions for application to practical design or to circuit analysis, it is important to realize that  $I_{co}$  is a fixed quantity which is determined by the particular transistor and by the temperature of the collector junction. Furthermore, that of the remaining three currents  $I_b$ ,  $I_c$  and  $I_e$ , only one can be chosen at will, for a given current amplification factor  $\alpha$ . In other words, if an operating point is chosen in a region of the static characteristic plane where  $\alpha$  is of a certain desired value, the circuit must be so designed that suitable current conditions are fulfilled for all three transistor currents. For instance, if the emitter current has been suitably chosen and is supplied by a constant current generator and, because

of bad design, the base current cannot adjust itself to a sufficiently small value as indicated by equation (3), the operating point will be forced into a region of low current amplification. This can be seen in Fig. 1. Operating points for comparatively high base currents are found only in the shaded area. Thus, it is of interest to express each of the direct currents in terms of each of the remaining two, the emitter-to-collector current amplification factor  $\alpha$  and the base-to-collector current amplification factor  $\alpha'$ . The latter is given by:

$$\alpha' = \frac{\alpha}{1 - \alpha} \quad \dots \quad (4)$$

A graph for easy conversion is shown in Fig. 2. Equation (2) immediately yields:

$$I_e = \frac{I_c - I_{co}}{\alpha} \quad \dots \quad (5)$$

From equation (3) it follows that:

$$I_e = \frac{I_b + I_{co}}{1 - \alpha} = (1 + \alpha')(I_b + I_{co}) \quad \dots \quad (6)$$

Substituting  $I_e$  from equation (5) into equation (3), yields:

$$I_b = \frac{I_c (1 - \alpha)}{\alpha} - \frac{I_{co} (1 - \alpha)}{\alpha} - I_{co} \quad \dots \quad (7)$$

Therefore

$$I_b = \frac{I_c}{\alpha'} - \frac{I_{co}}{\alpha} \quad \dots \quad (8)$$

Thus,

$$I_c = \alpha' I_b + \frac{\alpha'}{\alpha} I_{co}$$

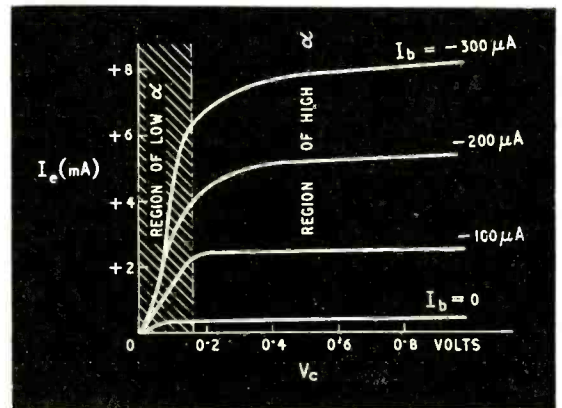


Fig. 1. Emitter currents for constant base currents in a junction transistor.

\*Ferguson Radio Corporation.

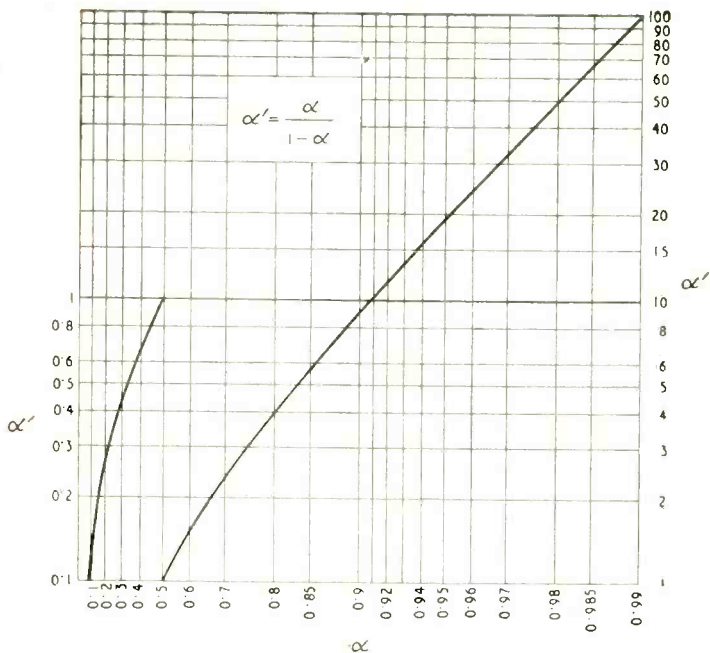


Fig. 2. Correlation curve for transistor current amplification factors

But since:

$$\frac{\alpha'}{\alpha} = \frac{1}{1 - \alpha} = 1 + \alpha' \dots \dots \dots (9)$$

$$I_c = \alpha' I_b + (1 + \alpha') I_{co} \dots \dots \dots (10)$$

or:

$$I_c = \frac{\alpha I_b + I_{co}}{1 - \alpha} \dots \dots \dots (11)$$

These relationships are set out in the table given below.

**Amplified Leakage Current and Collector Current "Run-Away."**—Some important implications follow from these equations. When a transistor is operated in grounded-base connection, the emitter current is simply flowing across the base-collector diode reverse resistance. It therefore appears as a leakage current of magnitude  $I_{co}$ , being a part of the current flowing through the collector. If, however, the transistor is operated with a grounded emitter, the base current controlling the collector current, the portion of the emitter and collector current due to the flow of impurity current is  $(1 + \alpha') I_{co}$ . This means, that with a good transistor giving a large current amplification  $\alpha'$  the leakage current flowing in the emitter and collector paths will be increased

**CURRENT CONVERSION TABLE**

| →     | $I_b$                                | $I_c$   | $I_e$                       |
|-------|--------------------------------------|---|-----------------------------|
| $I_b$ | $I_b$                                | $\frac{I_c}{\alpha'} - \frac{I_{co}}{\alpha}$ | $(1 - \alpha) I_c - I_{co}$ |
| $I_c$ | $\alpha' I_b + (1 + \alpha') I_{co}$ | $I_c$   | $\alpha I_c + I_{co}$       |
| $I_e$ | $(1 + \alpha') (I_b + I_{co})$       | $\frac{1}{\alpha} (I_c - I_{co})$             | $I_e$                       |

very considerably. The same holds good for the grounded collector connection provided that the base current is controlling the other two currents.

An interesting case is that of a transistor connected across a voltage source, emitter positive, collector negative and with the base terminal left disconnected. The base current is thus zero and the emitter and collector currents are identical and equal to:

$$I_c = I_e = \frac{I_{co}}{1 - \alpha} = (1 + \alpha') I_{co} \dots (12)$$

as follows from equations (6) and (10).

This shows that a transistor which will pass a leakage current  $I_{co}$  when connected across a voltage source via its base and collector terminals will take a current  $(1 + \alpha') I_{co}$  when connected via its emitter and collector terminals. Since  $(1 + \alpha')$  can easily be of the order (or in excess) of 30, it can be seen that an  $I_{co}$  of only a small fraction of a milliampere can be responsible for an augmented leakage current capable of destroying the transistor. In amplifier and oscillator circuits, the transistor is often connected in grounded-collector or grounded-emitter configuration, and the base direct current is usually held substantially constant. Under

normal operating conditions, the leakage current  $I_{co}$  is initially quite small, but increases as a result of warming up through normal collector dissipation. The increased  $I_{co}$  in turn raises the collector current by an amount  $(1 + \alpha') I_{co}$  which can now become quite appreciable, and in turn contributes to raise the collector temperature. The process is cumulative and the collector current "runs away" exceeding the safe limit and destroying the transistor.

**Transistor Circuit Stability.**—Since the influence of the impurity current upon the collector current cannot be neglected, it is important to ensure that this influence will not exceed the safe or permissible limits. The intrinsic current can rise to many times its original value for a temperature rise of 20° or 30°C, and for instance, if a transistor is operated near its maximum permissible collector dissipation, any increase in collector current due to the increase in leakage current at raised temperature will have to be held within close limits.

A stability factor can be defined as:

$$S = \frac{\partial I_c}{\partial I_{co}} \dots \dots \dots (13)$$

which is the rate of change of collector current produced by a change of impurity current. For stable operation, S should be as low as possible, and good stability can usually be obtained by suitable circuit design at the expense of power economy.

As can be seen immediately from the current relationships set out in the table, the stability factor for the grounded-base amplifier where the emitter current controls the other currents,

$$S = 1 \dots \dots \dots (14)$$

and for the grounded-emitter amplifier,

$$S = (1 + \alpha') = \frac{1}{1 - \alpha} \dots \dots \dots (15)$$

This indicates that the grounded-emitter amplifier will be more seriously affected by variations in  $I_{co}$

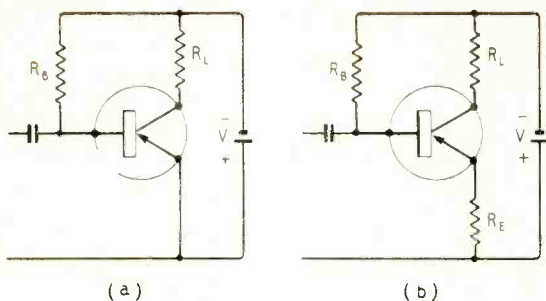


Fig. 3. Simple transistor amplifier (a) without stabilization, (b) with stabilizing resistor

due to temperature changes or other reasons. It is possible however to stabilize the collector current against such effects by the application of negative feedback. In applications where the loss in a.c. gain produced by such feedback would be detrimental, bypass condensers have to be used to reduce the feedback action to a permissible level at the operating frequencies.

A simple practical amplifier circuit is shown in Fig. 3, by way of illustrating the principle of stabilization. Fig. 3(a) does not contain a stabilizing resistor;  $R_B$  represents the base bias resistor,  $R_L$  the load. Under normal operating conditions, the emitter-to-base voltage is so small that it can be neglected, therefore the voltage across the bias resistance  $R_B$  is practically equal to the battery voltage. Hence

$$I_b = \frac{V}{R_B} \dots \dots \dots (16)$$

$$I_c = \alpha' \frac{V}{R_B} + (1 + \alpha')I_{co} \dots \dots \dots (17)$$

and

$$S = \frac{\partial I_c}{\partial I_{co}} = (1 + \alpha') = \frac{1}{(1 - \alpha)} \dots \dots \dots (18)$$

Equation (18) is of course identical with equation (15).

If the stabilizing resistance  $R_E$  is included as shown in Fig. 3(b), the voltage across  $R_B$  is no longer equal to the battery voltage, but equals the difference between this and the voltage drop across  $R_E$ . Thus, an increase in  $I_{co}$  will produce an amplified leakage current through the emitter. This in turn will drop additional voltage across the stabilizing feedback resistor  $R_E$ . This additional voltage reduces the voltage available

across the bias resistor  $R_B$  thereby cutting down bias current and reducing the collector current. In this way, the increase of collector current on account of  $I_{co}$  is reduced.

$$I_b R_B = V - I_e R_E \dots \dots \dots (19)$$

Using the conversion table,  $I_b$  and  $I_e$  can be expressed in terms of  $I_c$ .

$$\left(\frac{I_c}{\alpha'} - \frac{I_{co}}{\alpha}\right) R_B = V - \frac{R_E}{\alpha} (I_c - I_{co})$$

$$I_c \left(\frac{R_B}{\alpha'} + \frac{R_E}{\alpha}\right) = V + I_{co} \left(\frac{R_B}{\alpha} + \frac{R_E}{\alpha}\right)$$

$$I_c \left(\frac{1 - \alpha}{\alpha} + \frac{R_E}{\alpha R_B}\right) = \frac{V}{R_B} + I_{co} \left(\frac{1}{\alpha} + \frac{R_E}{\alpha R_B}\right)$$

$$I_c = \frac{\frac{\alpha V}{R_B} + I_{co} \left(1 + \frac{R_E}{R_B}\right)}{1 - \alpha + \frac{R_E}{R_B}} \dots \dots \dots (20)$$

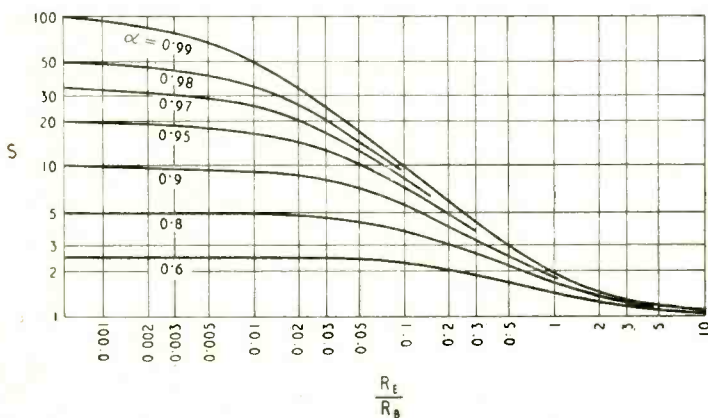
$$S = \frac{\partial I_c}{\partial I_{co}} = \frac{1 + \frac{R_E}{R_B}}{1 - \alpha + \frac{R_E}{R_B}} \dots \dots \dots (21)$$

Equations (20) and (21) show that the collector current is reduced by negative feedback, which depends on the ratio of stabilizing feedback resistance to base bias resistance.

Curves correlating the stability factor with this ratio are shown in Fig. 4. As the ratio  $R_E/R_B$  approaches zero, the stability factor rises towards the value without stabilization expressed in equations (15) and (18). These curves give a good picture of the stabilizing action of the circuit in Fig. 3.

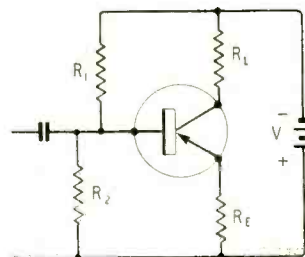
Supposing this amplifier has to operate at a current of 4mA with a collector voltage of 1 volt, and with a load d.c. resistance of 125 ohms, then the circuit could be powered by a 1.5-volt cell without stabilization, i.e. as shown in Fig. 3(a). If the current amplification under these conditions is equal to  $\alpha' = 32$  corresponding to  $\alpha = 0.97$ , a stability factor  $S = 33$  would result. Assuming  $I_{co}$  at room temperature to equal  $5\mu A$ , than a  $20^\circ C$  temperature rise at the junction could raise  $I_{co}$  by about  $50\mu A$ . This would increase the collector current by 1.65mA. If the maximum permissible collector dissipation is 5mW, the margin of safety would then be reduced to half. The load drops 0.7 volts, leaving 0.8 volts at 5.65mA, i.e.

(Continued on page 167).



Left: Fig. 4. Stability factor  $S$  as a function of  $\frac{R_E}{R_B}$  for different values of current amplification factor  $\alpha$ .

Below: Fig. 5. Potentiometer-stabilized amplifier.



4.5mW to be dissipated by the collector, as compared with 4mW at room temperature.

If a second cell is used, raising the battery voltage to 3 volts, a stabilizing feedback resistor  $R_E$  dropping 1.5 volts at room temperature can be inserted. Since the current to be carried is 4 mA, the value of this resistance will be 375 ohms. It will dissipate approximately the same amount of power as the transistor. The feed resistance  $R_B$  has to supply a base current of:—

$$I_b = \frac{I_c}{\alpha} - \frac{I_{co}}{\alpha} = 0.12\text{mA.}$$

Allowing for the voltage drop of 1.5 volts,  $R_B$  has to be 12,500 ohms. The resistance ratio  $R_E/R_B$  therefore equals 0.03. From the curves, the stability factor is found as  $S = 17$ .

Thus, the collector current will change by  $850\mu\text{A}$  for a  $50\mu\text{A}$  change in impurity current. The collector voltage will be reduced by 0.425v., due to the voltage drop across  $R_L$  and  $R_B$  (totalling 500 ohms). The collector will thus operate at 4.85mA with only 0.575 volts—rather a serious reduction—from collector to emitter. The collector dissipation is thus reduced to 2.79mW, i.e. to less than for the cold condition when  $I_{co}$  was negligible. This will be accompanied by a loss in signal-handling capability due to the reduced collector-to-emitter voltage. A better compromise would be possible by a reduction in  $R_E$ , but this would necessitate a value of battery voltage which might prove inconvenient, lying between the steps available by connecting cells in series.

An alternative method of stabilization is therefore illustrated in Fig. 5. Here, improved stabilization is obtained by use of the potentiometer arrangement consisting of the resistors  $R_1$  and  $R_2$ . If the internal resistance of the battery can be neglected, the resistances are effectively in parallel, and the stability factor for

this circuit is therefore again given by equation (21), provided that

$$\frac{1}{R_B} = \frac{1}{R_1} + \frac{1}{R_2} \quad (22)$$

Thus, also

$$S = \frac{1 + R_E \left( \frac{1}{R_1} + \frac{1}{R_2} \right)}{1 - \alpha + R_E \left( \frac{1}{R_1} + \frac{1}{R_2} \right)} \quad (23)$$

Allowing an additional current drain across the potentiometer  $R_1 - R_2$  to dissipate about the same amount of power as the transistor, i.e. 4mW, this would imply a current drain of 1.33mA.  $R_2$  drops 1.5 volts, and therefore equals 1130 ohms.  $R_1$  also drops 1.5 volts, but carries the base current in addition to the 1.33mA, totalling 1.45mA, and therefore equals 1010 ohms. Their parallel value therefore is  $R_B = 540$  ohms,  $R_E/R_B = 0.7$  and therefore, the stability factor  $S = 2.3$ . This is a considerable improvement with an additional 50% power consumption compared with the improvement by the use of  $R_E$  alone, without the potentiometer bias supply.

The temperature change under consideration will raise the impurity current by  $50\mu\text{A}$  as before. This, however, will result in a rise of collector current of only  $115\mu\text{A}$  with additional drop in voltage of 0.0575 volts produced jointly by  $R_E$  and  $R_L$ . The collector dissipation is thus  $(4 + 0.115)(1 - 0.0575) = 3.87\text{mW}$  i.e. less than cold, and with the signal-handling capacity virtually unchanged.

**Conclusions.**—The basic principles outlined above can be applied to the design of more complex circuits. Where transistors are used in tandem, arrangements can be made for a transistor operating at a lower power level to stabilize a transistor operating at a higher power level, and at the same time to provide useful amplification.

## WORLD'S JOURNALS

OVER 160 journals from more than 20 countries are scanned regularly by the compilers of the Abstracts and References section of our sister journal *Wireless Engineer*. Each month abstracts from, and references to, some 300 articles are included in the section, which is compiled by the Radio Research Organization of the Department of Scientific and Industrial Research.

The 60-page annual index to the Abstracts and References, including both subject and author sections, is included with the March issue of *Wireless Engineer*, which is obtainable from our publishers, price 6s.

## New Music

*Designed to generate any tone produced by the human voice or any musical instrument this electronic synthesizer, built under the direction of Dr. Harry F. Olson in the Princeton Research Laboratories of the Radio Corporation of America, also places at the disposal of musicians a medium of expression in which new tones and rhythms can be composed and performed without the intermediary of traditional methods of music making. The photograph, left, shows Dr. Olson at the keyboard.*



# Waveguides as Microwave Links

## POSSIBLE ALTERNATIVE TO RADIO AND LINE COMMUNICATION

**T**HE demand for channels of communication expands so rapidly that the organizations whose duty it is to provide them must continually be ready with new supplies. Hitherto these have always been available by drawing on higher and higher frequencies. Each doubling of the upper frequency limit brings in about as many new channels as all those already in use. But we are now reaching the stage at which such resources will no longer be acceptable. Radio waves of the millimetre order (i.e., above 30,000 Mc/s, or 30 kMc/s) are seriously obstructed by rain, clouds and other kinds of weather. This may be all very well for storm-detecting radar, but not for communication. Even at frequencies several times lower, propagation of radio waves in the open is appreciably affected by such influences. Meanwhile, the alternative of a coaxial line also fails because its attenuation increases fairly steeply with frequency. The same applies to waveguides—with one exception. The Bell Telephone Laboratories have recently published an account of theoretical and experimental exploration of this exception,\* and they conclude that it has interesting possibilities.

A most important characteristic of waveguides is that propagation along them can take place in a number of different modes. These modes are divided into two main classes, according to whether there is a lengthwise component of electric field, in which case they are called E modes (in America, TM), or of magnetic field, when they are called H or TE modes. The two classes are subdivided according to

the numbers of half-cycles of field pattern in two cross-sectional dimensions. Below a certain critical frequency, corresponding to a wavelength of the order of twice one of these dimensions (or a sub-multiple thereof), propagation ceases. The critical frequency for a given cross-section depends to some extent on the mode, and by taking advantage of this fact and by choosing a suitable shape for the guide, it is possible to eliminate all modes but one. This is the usual practice with waveguides as now used for such purposes as connecting a transmitter to its aerial—at most, perhaps, 100ft away. Hitherto, the idea of using waveguides for long-distance transmission has not been favourably considered, because at frequencies low enough for the attenuation not to be excessive the guide has to be so large as to be uneconomic. At 4 kMc/s, for example, the loss in even a theoretically perfect guide is 40db per mile, which is quite useless. At 1 kMc/s the figure is 2db per mile, which would be satisfactory were it not that the guide would have to be more than 6in wide and would be usable only for a narrow band of frequency.

Past theory had indicated that for one exceptional mode (and its multiples of the same type) the attenuation would *decrease* with rising frequency, which, of course, is just what is wanted. At first this seemed too good to be true, and even when the theory was checked it was still reckoned that it would not be so in practice, owing to the necessity for perfect uniformity of cross-section. This particular mode is the  $H_{01}$  (or  $TE_{01}$ ) in a cylindrical guide. The reason for its peculiarity is that the electric lines of force are concentric circles, as shown in Fig. 1(a) and (b), and

\* S. E. Miller. "Waveguide as a Communication Medium," *Bell System Technical Journal*, Nov. 1954, pp. 1209-1265.

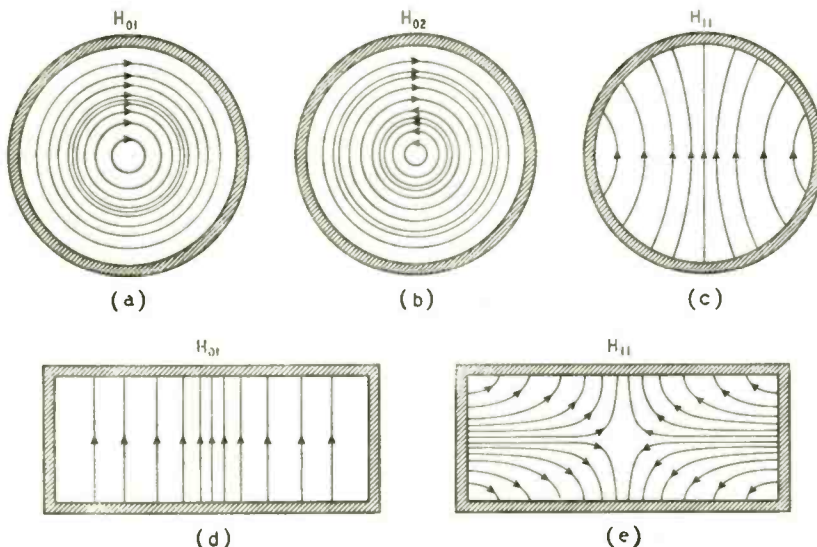


Fig. 1. The  $H_{01}$  mode in a cylindrical waveguide (a), together with its multiples such as  $H_{02}$  (b),  $H_{03}$ , etc., has the unique feature that the lines of electric force (shown in these diagrams) take the form of closed concentric loops, not touching the guide walls as in other modes such as (c), (d) and (e), and consequently loss decreases with increase of frequency. In E modes, the magnetic field patterns are similar to the electric patterns shown here.

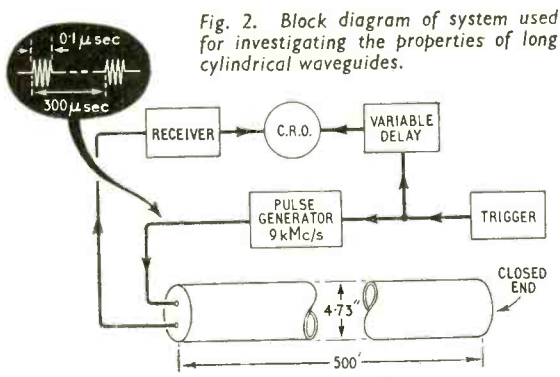


Fig. 2. Block diagram of system used for investigating the properties of long cylindrical waveguides.

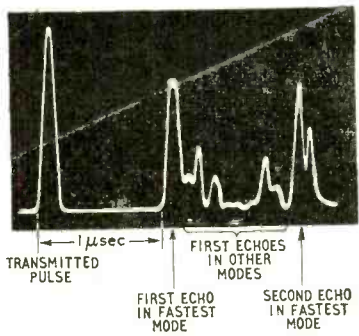


Fig. 3. The first two or three microseconds of the oscilloscope display, showing the transmitted pulse and reflections.

consequently no longitudinal currents are induced in the guide walls as with other modes. The only wall currents are those needed to confine the wave to the interior of the guide, and the loss from that cause decreases with frequency. Taking 2db per mile as a reasonable figure for attenuation and 2in diameter as a reasonable size of pipe, the frequency for these conditions is 50 kMc/s, at which the wavelength is 6 millimetres, and the maximum usable bandwidth about 500 Mc/s.

As already hinted, this attractive prospect is somewhat clouded by practical difficulties. One, the need for generating and dealing with 6-mm waves, can safely be left to development. A less obvious snag is that owing to the wavelength being so much smaller than the diameter of the guide (as is necessary in order to achieve the low loss) propagation is not restricted to this one mode. Energy at 50 kMc/s can in fact travel along a 2-in guide in many different modes. At first sight this might seem to be an advantage, because each mode can be regarded as a separate channel, like a wire in a multi-core cable. But unfortunately even slight curvature or non-uniformity of the guide causes part of the energy in one mode to change to another, which would cause mutual interference between channels working on the same frequency. Seeing, however, that owing to the greater attenuation of the other modes only the  $H_{01}$  would be likely to be employed, it might not appear to matter very much if a small proportion of the  $H_{01}$  energy were lost to other modes, provided it was not enough to add seriously to the 2db per mile. Moreover, the signal energy converted into another mode is always liable to be converted back again farther along. If all modes had the same velocity, this would partly offset the loss. But as it happens they have not, so by the time energy is converted back into the  $H_{01}$  mode it is out of step with the parent signal and so distorts or confuses that signal.

In order to study the practical possibilities the Bell Telephone Laboratories set up a 500-ft straight cylindrical waveguide. The highest frequency for which suitable measuring equipment was then available was 9 kMc/s ( $3\frac{1}{2}$ cm), for which the inside diameter of guide corresponding to a theoretical 2db loss per mile is 4.73in. The guide of this diameter was aligned to within  $\frac{1}{16}$ in of a straight throughout its length, and its cross-section was cylindrical within about 0.008in.

The experimental procedure, indicated in Fig. 2, was to inject short pulses at one end of the guide, and receive echoes from the other end (closed by a metal plate) for oscillographic display on a time base. A variable delay was provided in order to extend the observation to pulses received after a large number of journeys to and fro along the guide. Each pulse, lasting 0.1 microsecond, occupied 100ft of guide while in transit, and the first echo was received 1μsec after the initial blip corresponding to the send-off from the generator. Fig. 3 shows this first stage of events as seen on the screen. The clear space between the pulse received direct from the transmitter and the first echo from the far end shows that the pipe was sufficiently free from imperfections to cause no appreciable reflections from anywhere along its length. The clutter of echoes following on the heels of the first home is made up of modes having lower velocities. There are about 40 possible modes for this guide and frequency, but the resolution of the 0.1μsec pulse is not good enough to allow them all to be picked out.

A continuation of the display, in Fig. 4 (a), shows that most of these modes die out after a few reflections, whereas the mode giving the prominent first echo in Fig. 3 was still going strong enough to be well above noise level after 200 return trips, amounting to 40 miles. The attenuation can easily be measured by comparing amplitudes of blips, and was found to be about 3db per mile. This could only be the  $H_{01}$  mode, for which the theoretical figure in this

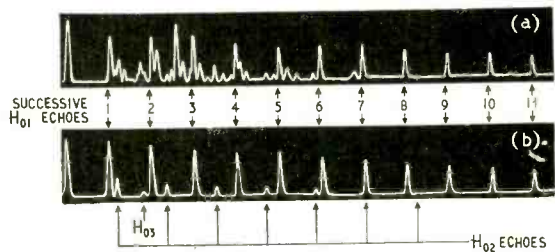


Fig. 4. A more extended view of pulse echoes, (a) without, and (b) with, a mode filter in the experimental waveguide.

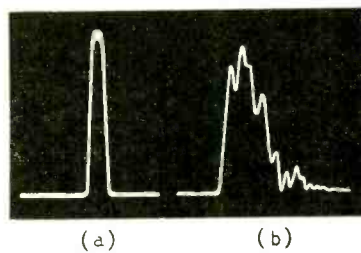


Fig. 5. (a) Shape of pulse as received without distortion, and (b) with distortion due to energy that has been travelling for part of the distance in different modes having lower velocities.

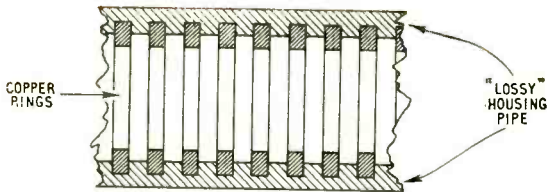


Fig. 6. Spaced-ring waveguide construction, forming a continuous mode filter, especially helpful for reducing curvature losses.

size and material of guide is 1.9db, all the other modes having much greater rates of attenuation. The possibility of transmitting signals over long distances by waveguide was thus demonstrated.

The next experiment was to introduce a mode filter, with the result shown in Fig. 4 (b). The only responses now to be seen, other than the first circular electric of  $H_{01}$  series, are a series of seven identifiable by their velocity as the second circular electric or  $H_{02}$  (Fig. 1 (b)) and one little specimen of the third circular electric or  $H_{03}$ .

So far, matters look very well (except for the practical difficulty of installing a pipe say 40 miles long, dead straight and perfectly cylindrical throughout, within close tolerances). But the results just described, in which even long-distance responses differ little from Fig. 5 (a), are the best of a very mixed bag. Some of the others were more like (b). It was found that varying the length of the guide no more than about a foot, by means of a piston at the far end, could make differences as drastic as these. Further investigation showed that the distortion evident in

Fig. 5 (b) was caused by mode conversion, as already described, and that what the piston did was to vary the distance between conversion and reconversion points, causing either reinforcement or cancellation.

A large proportion of the Bell Telephone report is devoted to a study of this mode conversion problem and what it might be expected to amount to in a 50-kMc/s 2-in guide. An important part of the problem is the effect of bends, which cause energy to be converted from  $H_{01}$  to  $E_{11}$ . One method of preventing this is to use an elliptical pipe for the bend. Another is to devise a guide that attenuates the  $E_{11}$  mode without unduly increasing the loss of  $H_{01}$ . One type of such a guide consists of copper rings held in an insulating pipe, as shown in Fig. 6. In a more easily manufactured variation of this, the conductor is a continuous helix. It must not be imagined that even with these aids the bends can be sharp. The sort of curvature envisaged for the spaced-ring or helical guide is a bending radius of 2,000 feet! This is calculated for a 2-in guide at 48kMc/s, and would double the normal dissipation loss. It appears, however, that there are other methods for negotiating sharp bends, and the author of the report concludes that waveguides have a future as multi-channel links. It is suggested that a 2-in pipe could provide 500-Mc/s channels from 35kMc/s to 75kMc/s, at which the theoretical attenuation per mile is 3db and 1db respectively. The 500-Mc/s bandwidth seems to be somewhere near the maximum: if so, it would presumably exclude present systems of television, especially as even that limitation of bandwidth assumes such an amount of distortion as would make it desirable to use a distortion-tolerant type of modulation, such as pulse-code and regenerative repeaters at 25-mile intervals.

## Commercial Literature

**Low-frequency Transformers** (operating down to 2c/s); hermetically sealed input types with balanced windings, internal screens and Mumetal cases. Note from Avis & Baggs, 11-13, Gosbrook Road, Caversham, Reading, Berks.

**Audio Amplifier** (8-10 watts), with frequency response of  $\pm 0.25$ db between 20c/s and 30kc/s, and associated pre-amplifier and control unit with volume and tone controls, recording compensation, etc. Booklet on the RD Junior from Rogers Development Co., 116, Blackheath Road, Greenwich, London, S.E.10.

**Permanent-bit Soldering Iron**, claimed to last indefinitely and to require no filing. Available with  $\frac{1}{8}$ -in,  $\frac{3}{16}$ -in,  $\frac{1}{4}$ -in and  $\frac{3}{8}$ -in bits. Also permanent tips for fitting as caps to ordinary bits. Leaflets from Light Soldering Developments, 106, George Street, Croydon, Surrey.

**Stabilized H.T. Supply**; dual channel design for giving positive and negative potentials with respect to earth and other facilities. Voltages are variable while current is 0-250 mA per channel. Leaflet from Joyce, Loeb & Co., Vine Lane, Newcastle-upon-Tyne 1.

**Non-corrosive Flux** having a chemical structure with resistance to water and low electrical conductivity. Historical review of development in this field and description of testing methods by Dr. W. Rubin on a leaflet from Multicore Solders, Maylands Avenue, Hemel Hempstead, Herts.

**R.F. Induction Heater** (12kW) with output coupling arrangements enabling it to be used with either fixed or remote work stations. A process timer is included, while the cooling equipment is self-contained. Leaflet from E.M.I. Factories, Hayes, Middlesex.

**Unit Cabinet System** intended for high-quality sound reproduction equipments. Also amplifiers, tuners, loudspeakers, gramophone motors, pickups, tape recording equipment and other accessories. Catalogue from the Classic Electrical Company, 352-364, Lower Addiscombe Road, Croydon, Surrey.

**Information-storage Magnetic Recorder** (Ampex model 306) for industrial and scientific applications. Uses frequency modulated carrier system and has frequency response of 0 to 5 kc/s with tape speed of 30 inches per sec. Equipments with anything from one to 14 tracks. Leaflet from Rocke International, 59, Union Street, London, S.E.1.

**Power Amplifier** with 50 watts output and frequency response at this power of 15c/s to 20kc/s  $\pm 1$ db. Harmonic distortion at 1,000 c/s claimed to be 0.002%. This and four other new instruments made by Krohn-Hite (Cambridge, Mass., U.S.A.) described in a leaflet from Rocke International, 13 East 40th Street, New York 16, N.Y., U.S.A.

**Insulated Resistance Wires** with a new epoxy-based enamel coating called Diamel which is claimed to have durability, high breakdown voltage and resistance to solvents and heat with freedom from pinholes. Details in a booklet "Electrical Resistance Materials" from Johnson Matthey & Company, 78-83, Hatton Garden, London, E.C.1. Also another booklet on precision-drawn seamless tubes.

**Television Frame Output Windings**, complete with laminations ready to clamp into existing shroud; available at present for a certain number of receivers. Note from Direct TV Replacements, 134-136, Lewisham Way, New Cross, London, S.E.14, with a new catalogue containing technical servicing information, price 1s including postage.

**Oscillograph C.R. Tube** (type 4EP1) incorporating post deflection acceleration, giving high deflection sensitivity (about 1mm per volt) with good brightness. The final acceleration voltage of 2kV can be increased to 8kV for high writing speeds. Note from Electronic Tubes, Kingsmead Works, High Wycombe, Bucks.

**Transistor Hearing Aid** operating from a 1.5-volt carbon pen-cell battery (or others) and measuring  $2\frac{1}{2}$ in  $\times$  2in  $\times$   $\frac{1}{4}$ in. Is claimed to run for a year at 8 hours a day on six pen cells. Leaflet from Bonochord, 48, Welbeck Street, London, W.1.



# Propagation on Bands I and III

## Direct Practical Comparison

By F. W. R. STRAFFORD, M.I.E.E., and I. A. DAVIDSON, B.A.

**W**ITH the advent of Band III television transmissions in this country, a large number of problems arise connected with the propagation of television signals at frequencies of the order of 200 Mc/s. If co-siting of the transmitters is adopted, then the strength and variations of the Band III signal must be considered in relation to that of Band I, as in most areas that will have a Band III signal, a Band I signal will also be present.

A preliminary investigation has been made of the relative behaviour of the signals on the two bands, using a transmission of 180.4 Mc/s radiated by the B.B.C. from the Sutton Coldfield mast. The signal was horizontally polarized, and therefore the experiment will not necessarily give an exact picture of propagation with a vertically-polarized signal, which has been chosen for the Band III service. However, useful information was obtained up to a range of about 30 miles from the transmitters. The 180.4-Mc/s transmission was beamed in a south-easterly direction, and all the observations were made within a few degrees of the centre of the beam.

Details of the two transmissions are given in Table 1.

Two receivers were used for the purpose of making the measurements and were installed in a mobile research laboratory. The outputs from the receivers were fed to a pen-recorder, enabling a continuous record to be made on both 61.75 Mc/s and 180.4 Mc/s. The receiver sensitivities were checked throughout by suitable signal generators. Initially the levels were adjusted so that on an open site, free from reflections and within visual range of the mast of the transmitters, the outputs of the two receivers were equal, thus compensating for the differences in the radiated power; i.e., 100/1. The mobile unit then toured through a number of differing types of sites, such as built-up and rural areas, at various distances from the transmitters, and at each site a record was taken with the mobile unit moving slowly. The receiving aerials were at a mean height of 25 feet from the

ground. It was therefore possible both to estimate the relative strengths of the signals at each site, and also to investigate the importance of local variations of the field strength at the two frequencies.

A vertical dipole was used on Band I, and either a horizontal dipole or a horizontal "Yagi" array on Band III. The records show that two distinct types of fluctuations in signal strength are present—rapid and slow.

### Rapid Variations

Fluctuations in the signal received by a dipole aerial when moved over short distances occurred on all the records. These are of a periodic nature, the rate of fluctuation being about three times greater on the Band-III transmission, as would be expected since the fundamental frequencies are similarly related. An example of this type of typical variation is shown in Fig. 1 and is a tracing of a typical pen-recording.

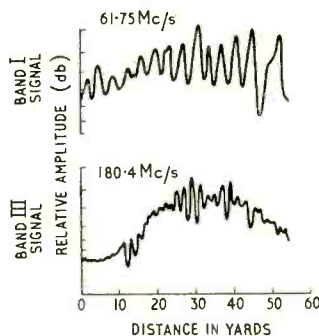


Fig. 1. The rapid fluctuations with distance due to local reflections are shown here. The marks on the decibel scale are 1 db apart, but are unevenly spaced because of the characteristics of the recorder.

In all cases a local reflecting object could be identified as the cause. The periodicity of the variation depended on the relative direction of the transmitting station with respect to the reflecting object, but generally possessed a wavelength of between  $\lambda/2$  and  $\lambda$ ; i.e., 7 ft. 6 in. to 15 ft. on Band I and 2 ft. 6 in. to 5 ft. on Band III. It was further established that these fluctuations were originating from a local reflector. By substituting a directional array in place of the dipole aerial, the fluctuations were completely removed. The distance of the reflecting object was in most cases sufficiently near to the receiver not to cause any noticeable ghost images. This was determined on Band I by viewing the picture, and on Band III by examining the trailing edge of the square modulation pulses.

### Slow Variations

In addition to the rapid variations in the presence of reflecting objects, the signal level on both frequencies showed slow variations, even under open site conditions. These variations were non-periodic, the

Table 1

|                              | Band I                                | Band III    |
|------------------------------|---------------------------------------|-------------|
| Modulation                   | Television waveform                   | Square wave |
| Frequency                    | Vision 61.75 Mc/s<br>Sound 58.25 Mc/s | 180.4 Mc/s  |
| E.R.P.                       | 100 kW                                | 1 kW        |
| Polarization                 | Vertical                              | Horizontal  |
| Aerial height (above ground) | 750 feet                              | 600 feet    |

distances between successive maxima ranging between 15 and 60 yards on both bands. The amplitude was also similar on both bands, but there was no definite correlation between them. Examples of this type of fluctuation are given in Fig. 2 (a) and (b), showing that they are quite random with distance on both bands.

The variations were present both in built-up areas and in open country, and no definite objects, such as trees or buildings, could be found to explain them. Furthermore, the variations were independent of the type of receiving aerial that was used. The most probable explanation is absorption and diffraction of the signal by ground irregularities, quite small changes in ground height or variations in its conductivity, or dielectric constant, being sufficient to explain them.

The effect of these variations is twofold. When considering the service area for a given type of receiving aerial, it is possible to calculate the minimum field strength required, assuming such factors as the forward gain of the aerial and the sensitivity of the receiver. For 90 per cent coverage of a given area, however, because of the slow variations in the signal level, the mean field strength must be greater than the calculated minimum level. From the records it has been calculated that this difference is approximately 6 db for satisfactory reception in 90 per cent of receiver locations. Secondly, in fringe areas, the variations cause large differences in the signal/noise ratio over distances of about 30 feet, and hence between adjacent houses.

### Mean Level

At each site the mean levels of the two signals were determined from the records, the amplitude of the signal being averaged over distances up to  $\frac{1}{4}$  mile. No absolute measurement of the signal was made, since comparison only was required. In each case the

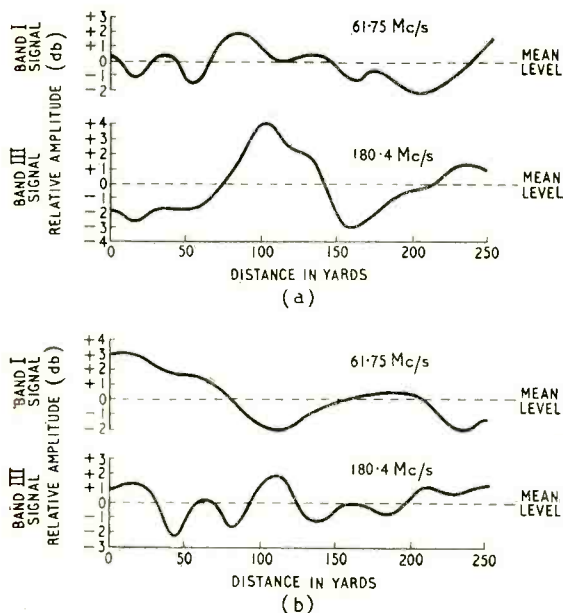


Fig. 2. Two examples (a) and (b) of slow fluctuations are shown here

level was determined relative to the signals obtained on a reflection-free site within visual distance of the transmitting aerial as previously explained. These results are given in Table 2.

Table 2

|   | Distance from Transmitter (miles) | Site          | Field strength relative to that of site "A" |                  |
|---|-----------------------------------|---------------|---|------------------|
|   |                                   |               | Band I (db)                                 | Band III (db)    |
| A | 12                                | Open country  | 0   | 0                |
| B | 19                                | Built up area | -9 } *<br>-16 }                             | -14 } *<br>-21 } |
| C | 19                                | Open country  | -10 } *<br>-5 }                             | -16 } *<br>-15 } |
| D | 34                                | Open country  | -12   | -34              |

\* Taken at two nearby sites in the same area.

It can be seen from this table that, compared with Band I, the Band III signal drops more rapidly as the distance from the transmitter is increased. The measurements at 34 miles correspond to the horizon distance and, at this range, a small hill reduced the Band III signal to the noise level of the receiver.

From the foregoing practical, but admittedly intensive tests, the theoretical prediction of increased propagational losses with increasing frequency has been verified. Workers in various countries have also verified this prediction\*, but their results have invariably been plotted in terms of median field strengths, whereas the television aerial installer is far more interested in the house-to-house problem.

### In Conclusion

Probably the most interesting conclusion which may be drawn is that when one is in a region of weak signal strength in a built-up area, the compulsory requirement of a multi-element directional aerial automatically makes it unnecessary for the site to be "probated" to find the best location for its installation. This is explained under "Rapid Variations." On the other hand, in regions of high average signal strength where a simple non-directional dipole may suffice to provide adequate input to the receiver, it does not matter much whether the aerial is located in a trough of signal field strength due to reflections, since adequate signal is still likely to exist at that point. Of course, it is assumed that no long-distance reflections are present likely to cause a displaced image or ghost, in which case a directional aerial would obviously be required.

The results also show that, in terms of square miles of service area, independent of population considerations, a single Band-III transmission can never be so effective as a similarly located Band-I transmission unless the former is either (a) delivering far more power from its aerial or (b) possesses a much higher mast or, preferably, both.

\* See for example: J. A. Saxton. "Basic ground-wave propagation characteristics in the frequency band 50-800 Mc/s." *Proc. I.E.E.*, Pt. III, July 1954.

# Interference Suppression

## *Techniques for Dealing with Small Commutator Motors*

By R. DAVIDSON,\* B.Sc., A.Inst.P.

As reported elsewhere in this issue, regulations have now been made for the control of interference from domestic and industrial apparatus driven by small electric motors. This article reviews the general principles of suppression and describes some of the latest methods that are being used on such apparatus.

**M**ANY readers will be familiar with the basic principles of interference suppression, but for those who are new to the subject these principles will be briefly re-stated. The supply current to a commutator motor is discontinuous and the discontinuities cause radio-frequency currents to flow in the motor and its associated wiring. These r.f. currents have a wide frequency spectrum and may cause interference to both sound and television reception. The currents and their associated energy may be propagated in several ways, but the majority of interference results either from direct radiation from the motor to the aerial of the receiver or by propagation along the mains wiring and subsequent radiation to the receiver aerial. Interference by direct radiation is usually comparatively local, but interference resulting from propagation along the mains wiring, and subsequent radiation, may occur at considerable distances from the source. Since interference resulting from both these modes of propagation is received via the receiver aerial little can be done to abate interference at the receiver, and suppression measures must be taken at the source. If these measures are concentrated on preventing the flow of radio frequency currents into the mains wiring it is usually found that the direct radiation from the appliance is also reduced to tolerable limits. Interference is suppressed at the source by taking one or more of the following steps.

(i) Fitting capacitors between supply lines and the frame of the appliance to reduce the impedance between these points and thus by-pass the asymmetric component of the radio frequency currents, i.e. the component flowing from the appliance along the lines and back to the appliance via earth. This component is the cause of interference in the majority of cases.

(ii) Connecting capacitors between supply lines to reduce the impedance between lines and thus by-pass the symmetrical component of the radio frequency currents, i.e. the component flowing from the source along one supply line and back to the source via the other supply line.

(iii) Fitting inductors in series with the supply lines to increase the impedance of the lines at radio-frequencies and reduce both asymmetric and symmetrical components.

The types of capacitors or inductors to be used and their positioning relative to the source of interference will depend on the frequency bands over which suppression is required. Here it must be stressed that, except in special cases, components employed for suppression over the low frequency sound broadcast

bands will not be effective at television frequencies, and separate components will be required here. Furthermore, different techniques are used for suppression over the two frequency ranges.

A very wide range of suppressor components is now available both for incorporation into appliances by manufacturers and for fitting to existing appliances by retailers and the general public. Suppression over the sound broadcast frequencies (150 kc/s—1.6 Mc/s) can be achieved by fitting suppressors either within the appliance in the supply lead at the plug, or permanently at the supply point, but due regard must be taken of the safety regulations governing the maximum values of capacitance which may be fitted in the various positions. (These values are fully detailed in the revised British Standard Specification No. 613 which will be published shortly.) Within the appliance it is usual to fit capacitors of  $0.01\mu\text{F}$ – $0.1\mu\text{F}$  across the lines and up to  $0.005\mu\text{F}$  between lines and frame for sound-broadcast suppression. These capacitors are available in paper dielectric as combined units in tubular form or potted in moulded boxes. Separate capacitors are available in paper dielectric or with high permittivity (high "K") ceramic dielectric, the last-mentioned usually in the form of discs. High "K" ceramic capacitors are very compact and have low self inductance, but are subject to considerable changes of capacitance with temperature. Users should, therefore, ascertain that the capacitance value will not rise above the maximum permitted

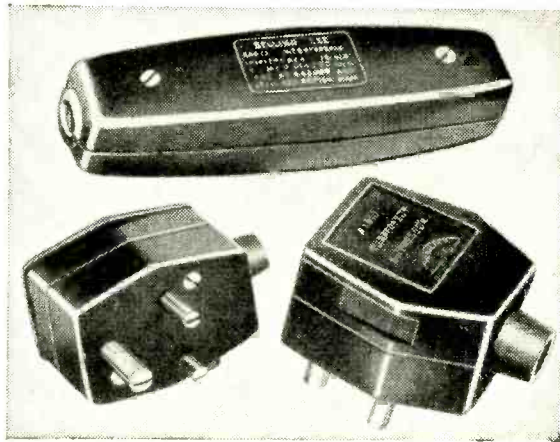


Fig. 1. Cord grip suppressor (top) and (below) plug suppressors. These can be fitted by the user.

\* Dubilier Condenser Company.

value within the temperature range likely to be experienced inside the appliance, nor fall below the minimum capacitance necessary for effective suppression. Radio frequency chokes are available for incorporation inside appliances in wavewound form on iron dust or ferrite cores, as toroids on ferrite cores, or in rectangular form on flaked iron cores. The last-mentioned two types, using closed cores, require few turns on the windings and are especially suited for the heavier current applications.

Two types of radio suppressor which may be conveniently fitted by the user of an appliance are the cord-grip suppressor and the plug suppressor (see Fig. 1). In the cord-grip type capacitance values similar to those which may be fitted within the appliance are used. In the plug suppressor the maximum capacitance values permissible are  $0.005\mu\text{F}$  between line and earth,  $0.1\mu\text{F}$  between line and neutral and  $0.05\mu\text{F}$  between neutral and earth, but it is usual to supply plugs with capacitors only in the last two positions.

For suppression at Band I television frequencies components must be fitted either within the appliance (preferably close to the brushes) or in the supply lead within about 9in of the appliance. Radiation of interference from the lead becomes excessive if suppression is attempted at greater distances from the appliance. Fortunately the components required are very small and can usually be housed within the appliance. Very

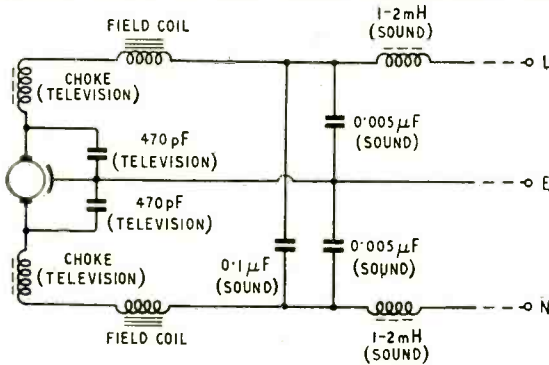


Fig. 2. Full suppression of small motors for sound broadcast and television bands where unsuppressed noise levels are high.

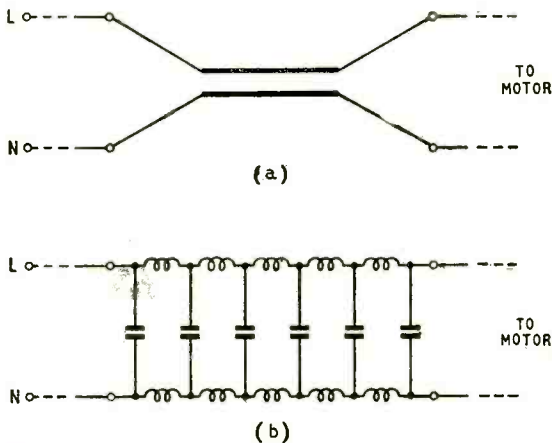


Fig. 3. (a) Four-terminal lead-through capacitor and (b) its equivalent circuit.



Fig. 4. Lead-through capacitor ( $0.005\mu\text{F}$ ) for suppressing interference on Band I from electric drills, etc.

effective suppression is achieved on many commutator motors by fitting 470-pF capacitors from brushes to frame and small self-resonant dust-core inductors in the brush leads or incoming mains leads. For those who wish to fit television suppressors outside the appliance, small cord-grip suppressors incorporating inductors are available for wiring into the mains lead close to the appliance.

The new regulations which have been made call for suppression to within the limits laid down in British Standard Specification No. 800, "Limits of Radio Interference," which covers the frequency bands 200 kc/s—1605 kc/s and 40 Mc/s—70 Mc/s. For motors generating high levels of interference on both sound radio and television bands it may be necessary to fit all the suppressors shown in Fig. 2, which gives typical component values.

Recent developments in the suppressor field, some using novel techniques, have fortunately simplified the suppression problems for certain types of appliances. For wide-band suppression of interference from appliances which have a strong symmetrical component of interference, and this includes at least one type of sewing-machine motor, the four-terminal lead-through capacitor has been introduced.\* In this suppressor the supply leads are connected to the two plates of a rolled paper capacitor at one end of the winding and the appliance leads to the plates at the other end of the winding. It is arranged that the supply current has to traverse the whole of the winding so that good capacitive coupling between lines is achieved over a wide frequency range, and the inductance of the winding is placed in series with the supply leads to aid asymmetric suppression (see Fig. 3). With this construction a comparatively large capacitance can be used to provide suppression at sound frequencies, whilst still being effective at television frequencies, provided the capacitor is fitted close to the source of interference.

Two developments in single-pole lead-through capacitors should be mentioned as they have rendered possible simple high-frequency suppression of two classes of appliance which hitherto were most difficult to suppress—electric drills and similar appliances and low voltage d.c. motors. Most readers will know by now that lead-through capacitors properly fitted are effective up to frequencies well beyond the television Band III and do not suffer from the disadvantages of conventional capacitors† which have appreciable self

\*British Patent No. 727496.

†"R.F. Characteristics of Capacitors." *Wireless World*, August, 1952.

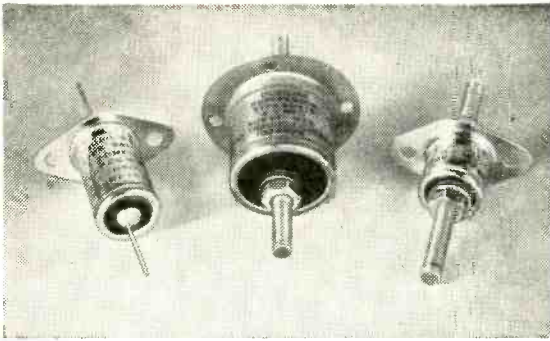


Fig. 5. Group of metallized paper lead-through capacitors suitable for low-voltage d.c. motors (left 2 $\mu$ F, middle 4 $\mu$ F, right 0.5 $\mu$ F).

inductance. A small 0.005- $\mu$ F lead-through capacitor has been introduced which is designed to be particularly effective for suppression of Band I interference from electric drills and similar metal-cased appliances, and measurements show that it will also be effective on Band III. This capacitor is illustrated in Fig. 4.

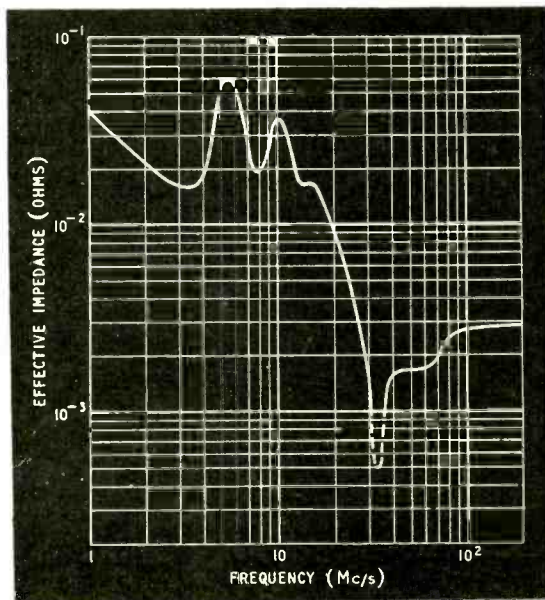
Low voltage d.c. motors usually have low impedance field and armature windings and require high capacitance values to achieve suppression. For suppression at both sound broadcast and television frequencies a lead-through construction is essential, and to meet these two requirements a range of metallized paper capacitors is now available with capacitances up to 4 $\mu$ F at 150 V d.c. working. Some examples of this range are illustrated in Fig. 5. Lead-through capacitors behave as high-attenuation transmission lines and the peaks and troughs in their impedance-frequency characteristic are predictable from the dimensions of the capacitor winding. By using metallized paper the attenuation of the plates is very much increased, and at a certain critical frequency at which, it is believed, all radio-frequency reflections from the equivalent transmission line back on the supply line are completely attenuated, an extremely low effective by-pass impedance is achieved. This effect is illustrated in Fig. 6 which also shows the very low overall impedance obtainable with this type of capacitor. Over the dotted portion of the graph between 30 and 36 Mc/s no signal whatever was detectable on the suppressed line from the capacitor when a signal of 0.25 volt was injected on the line to the capacitor. A receiver capable of measuring 2.5 $\mu$ V input voltage was used for this test.

The use of 470-pF capacitors for tele-

vision suppression of small motors was mentioned earlier. A single unit is now available comprising, in effect, three 470-pF capacitors in delta connection which measures only  $\frac{1}{2}$ in  $\times$   $\frac{1}{2}$ in and has three connecting leads. The two outer leads are connected one to each brush of the motor with the central lead to the frame of the motor. It is simpler to fit than separate capacitors and has been found to give, in many cases, several decibels more suppression than that obtained with separate components. The circuit diagram of this unit, used in conjunction with television inductors on a small motor, is shown in Fig. 7.

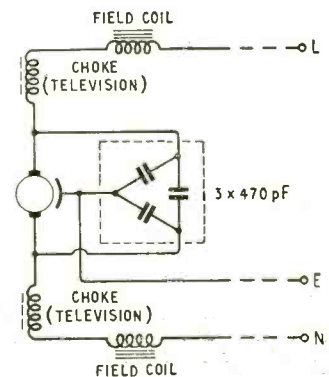
Mention should be made of combined filter units for both sound broadcast and television suppression which, although not novel, have been improved in efficiency and compactness in the last few years. These units are particularly suitable for the larger appliances such as cine-projectors and accounting machines and are usually fitted in the supply leads immediately inside the housing of the appliance.

No review would be complete without strong emphasis being placed on the safety precautions which must be observed when fitting suppressors either within appliances or in the supply lead or the supply plug. The requirements of B.S.613 are such as to ensure that suppressor components used in the various positions are of a sufficiently high grade and have sufficiently high margin of safety at the operating conditions that failure is most unlikely. These requirements must be rigorously observed, especially in positions where component failures may lead to risk of shock to the user of the appliance. For similar reasons the recommended maximum values of capacitance for various circuit positions must equally be observed. For instance the maximum capacitance which may be connected between lines and frame inside a portable appliance not doubly or fully insulated is 0.005 $\mu$ F. Larger capacitances will pass sufficient current at the supply frequency to cause unpleasant shock if the frame of the appliance is unearthed. Many people complain of a sensation of shock from the frame of a correctly suppressed appliance using 0.005- $\mu$ F capacitors and operated with the appliance unearthed. Such people should not blame the suppressor or the manu-



Left:—Fig. 6. Impedance/frequency characteristic of 4 $\mu$ F metallized paper lead-through capacitor (Dubilier type SBN13).

Below:—Fig. 7. Use of three 470-pF capacitances in a single unit for suppression at television frequencies.



facturer who fitted it but should, in their own interests, use the earth lead with which such appliances are provided and connect it to the supply through a properly installed 3-pin plug and socket rather than through a 2-pin one. Space does not permit details of all the safety recommendations for the fitting of suppressors but readers are urged to make sure that suitable components are employed whenever they are installing suppressors and that the wiring is most carefully checked.

There are various sources of expert guidance on suppression problems. The Code of Practice on the general aspects of radio interference abatement (to be published shortly by the British Standards Institution), and the relevant British Standards listed therein, give very great assistance. Manufacturers of suppressor components provide technical data on their suppressors and advice on their use and in many cases are able to carry out interference suppression tests.

## LETTERS TO THE EDITOR

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

### *Frequency Allocation*

I HAVE been reading with great interest your recent editorial comments on the present unsatisfactory state of frequency allocation in this country.

For the past twelve months I have been engaged in negotiations with the G.P.O. on the subject of re-accommodating in the spectrum users of mobile radio who are to be displaced from their present positions by the advent of Band III television. It would, of course, be wrong for me to comment on this work while it is still under discussion, but I have seen enough of the general problem of frequency allocation to enable me heartily to endorse your view that better machinery must be found for the administration of radio frequencies if their immense benefits are to be fully enjoyed by the community in peace, and if we are to have a sound basis of frequency allocation for defence.

I have sought many people's advice on this subject and it seems to me that the best proposal I have so far come across is that the task of allocation should be allotted specifically to one Minister, and to one without departmental responsibilities, such as the Lord Privy Seal. There is a precedent for such an arrangement in that atomic development and radio research are being administered in this way, presumably because the Minister in charge is not departmentally concerned with conflicting interests.

I do not think it would be difficult to conceive of a permanent impartial body working under the Minister which would undertake as its first task an impartial investigation of the present frequency position and the merits of the various conflicting claims being made for space in the spectrum.

It would clearly be essential that the first part of such an examination should be devoted to the relative merits of civil and military claims. I do not see why we should accept the suggestion that military claims for frequencies should be regarded as sacrosanct and not subject to justification. Frequencies, after all, are only a raw material in peace or in war and Service departments should be required, just as much as civil users, to give specific assurances of economic utilization. I cannot accept the proposition that security considerations are any serious bar to satisfying this condition.

A further conclusion I have formed as a layman is that the subject of frequency allocation is not nearly such a difficult one as we have been led to believe.

The Post Office, of course, have a vast fund of experience on interference suppression and are also able to help with advice.

In conclusion some reference must be made to future prospects. This year full-time f.m. broadcasts on Band II and low power television broadcasts on Band III are due to commence. Existing Band-I suppressors will be adequate in most cases for Band II. Until full-power transmissions are available on Band III it is impossible to be dogmatic about interference conditions on this band and it is generally agreed that further work on suppression techniques is required at these frequencies. It can be said, however, that measurements to date on a number of types of domestic appliances fitted with efficient Band-I suppression have shown that radiated and mains-borne noise levels on Band III are sufficiently low that such suppression is also expected to be adequate on this band in many cases.

The problem appears to me to be simply that of dividing a cake and not of cooking it. There have been too many technicians engaged in the task and too few persons skilled in the established arts of arbitration. For this reason I feel that the chairman of the suggested investigating body should be one of Her Majesty's judges.  
House of Commons. L. P. S. ORR.

### *Quality on V.H.F.*

A MOMENT'S thought on the chances of better quality from existing receivers via f.m. shows how masterly was the condensation of facts by Mr. Bishop in his letter in the December, 1954, issue.

The radio industry produces receivers capable of giving the most intelligible listening from the general reception conditions prevailing. These conditions have normally demanded the suppression of more than half of the B.B.C.'s transmitted frequency range on long and medium wavelengths. It is the fault neither of the B.B.C. nor of the set designers that the reproduction of the higher frequencies is inadequately provided for in the majority of radio sets in use today.

Only the complete redesign of the audio amplifiers, speaker units, etc., used in these sets will allow the frequency range available via the f.m. service to be reproduced, and enable us to appreciate to the full the general high standard of transmission by the B.B.C.

F.M. attachments to existing receivers can only provide a silent background, which may expose some frequencies previously masked by interference.

High Cross, nr. Uckfield, Sussex. C. E. WATTS.

### *Diplexers for Reception*

THE use of a filter network for combining the output from two television transmitters operating on sound and vision frequency respectively and conveying it to a radiating system via a single feeder is well known and, of course, is an established practice of the B.B.C.

With the advent of Band III television it will often be necessary to use this selective process in the reverse sense and I see no reason why the term diplexer, which has been used to describe the transmitter combining network, should not equally apply to the receiving counterpart.

For this reason I would like to make an attempt to define a diplexer as follows:—

"A diplexer is a combined low-pass/high-pass filter for

the purpose of conveying energy from two sources of differing frequencies to a common sink impedance such that there is minimum interaction between the individual sources of energy. The linearity of such a system permits that it may be used in the reverse sense."

Putting this in a simplified manner and applying it in the practical sense to Band I/Band III television reception, we may substitute the following definition:—

"A diplexer is a combination of tuned filters designed in such a manner that the output from two aerials operating on differing frequencies (e.g., Band I/Band III) can be connected to a single input (a television receiver) without interaction.

"A diplexer can also be used in reverse; i.e., a single aerial responsive to Band I and Band III can, by a single feeder be connected to a receiver having individual Band I and Band III input connections."

It is interesting to observe that the use of this term appears to be quite common in the United States where such arrangements are already in use for connecting Band IV receiving aerials to existing Band I/III combined aerials.

Perhaps some of your readers may have some better suggestions.

Belling & Lee, Ltd., F. R. W. STRAFFORD  
Enfield.

## As She is Spoke

MR. PAWLEY, in your March issue, asks for a suitable abbreviation for "television recording," and I would like to suggest that what they make is a "replica" or a "reproduction." The programme would then be "transmitted from a reproduction."

Mr. Scroggie, in his letter, finds no justification for the use of a word describing a process, to represent the result; the term "recording" as used above. Tape recorder language is also burdened with this term, for an understandable reason. The public is accustomed to the use of a "record" in relation to gramophones and seems to accept the term as describing a disc carrying a reproducible message; one goes "to buy a record of so-and-so." Were you to describe a tape recorder as capable of making a record, the public may assume it makes discs; by saying it makes a "recording" that possible confusion is ameliorated. But a happier term would be welcome; could one suggest a "magneprint"?

Editorial approval appears to be extended to the proposed E.M.I. use of the term "tape records" for ready-recorded magnetic tapes and with some amusement one recalls that mother used to safeguard the laundry with tape records—strictly embroidered autograph tape.

To avoid confusion is not simple. One need but wonder what youngsters whose school musical instruction was given on the "recorder" think when offered a "recorder" at, say, 100 guineas, and how they may wonder what tape has to do with the English flute.

The growth of language is quite illogical. A magnetic tape recorder makes a "record" by close analogy with, but more directly than, a typewriter; yet we type a "letter," never a "record" and we keep a "duplicate," a "carbon copy" or a "stencil," which last serves a "duplicator" though, in fact, it is a "multiplier."

W. D. ARNOT

Bristol Magnetic Recorder Company,  
Bristol, 3.

I AM afraid I cannot agree with Mr. Scroggie that the use of the word "recording" as a noun constitutes a misuse of the English language.

It is very convenient to refer to the quality of a recording, meaning ambience, frequency response, absence of distortion, etc., and to the quality of a record which would cover surface noise, swinging, and all other mechanical aspects.

Surely a recording is made on tape and is then transferred to disc, and must be referred to as a recording,

whereas a record is something you can pick up and throw into the waste-paper basket if you don't like it.

Wharfedale Wireless Works, Ltd., G. A. BRIGGS.  
Idle, Bradford.

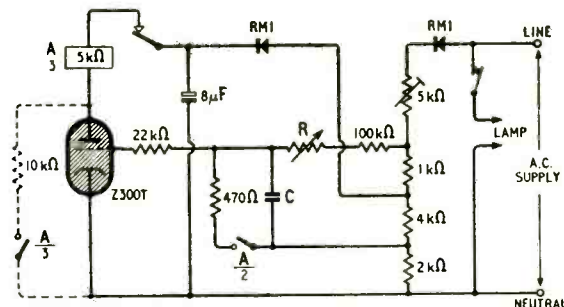
## Neon Timers

I HAVE followed with interest the correspondence on this subject and would like to comment on the observations of N. J. Wadsworth, in the January issue, regarding the design of photographic exposure timers. The actinic intensity of a tungsten filament lamp has been found to vary as the fifth power of the supply voltage and timers have been designed already\* in which the exposure interval is made inversely proportional to the fifth power of the supply voltage.

Cold cathode trigger tubes are considered preferable to neon stabilizers for this application. The trigger tube is cheaper and its striking voltage is likely to be more stable than that of the neon tube.

When compensation is obtained solely by using an un-stabilized condenser-charging voltage, this must be made only a few per cent greater than the striking voltage of the neon or trigger tube. Any variation in the striking voltage then becomes serious. Also, with supply voltages falling below the nominal value by more than about 7 per cent, the timer becomes seriously over-compensated. The cure is then worse than the disease.

These difficulties are overcome by using two forms of voltage-sensitive correction simultaneously. The circuit shown here is based on this principle and is scarcely more



complex than those you have published already. The timing resistor, R, may have any value between 1 and 10 megohms and the timing condenser, C, is conveniently 4 to 20μF. The 5-kΩ preset control must be set to give time intervals equal to 0.6CR at the nominal supply voltage. With supply voltage variations from +15 to -20 per cent of the nominal value, the intensity-time product then changes by no more than ± 5 per cent. Compensated timers of this kind are useful for repetition work, particularly where high-contrast materials are used.

Methods of producing a substantially constant intensity-time product by judicious proportioning of the circuit and valve parameters have been investigated in the laboratories of Ilford, Limited and are the subject of British Patents 656,275 of 1948 and 667,296 of 1949.

Physics Research Laboratory, D. M. NEALE.  
Ilford, Limited, Brentwood, Essex.

\* "Photographic Exposure Timers providing compensation for Supply-Voltage Variations." R. J. Hercocck and D. M. Neale. Proc. I.E.E., Vol. 99, Part II, No. 71, Oct., 1952, pp. 507-515.

## Recovering Hidden Signals

YOUR contributor James Franklin (March issue) speaks of the correlation function as "one of the latest methods of analysing electrical signals—or indeed variations in time of almost any kind." Moreover, "Actually it was invented by G. I. Taylor in 1920, but only recently has it come into prominence and been used in a practical sort of way."

Possibly your contributor does not regard mathe-

mathematical use as "practical," so the fact that this function has been studied and developed by mathematicians since the days of Fourier at latest may leave him cold. The integral involved, the "product by composition" is fundamental to functional analysis, integral equations, transforms and the like and its importance has been recognized for well over a century.

In the more "practical" fields of finance, commerce, meteorology, economics and optics it has been used and taught as a standard instrument for investigating time series, certainly for most of this century.

Perhaps Young (1813) just can be claimed as a candidate for priority in the field of optics and also, much later, Rayleigh. However, Sir Arthur Schuster applied the correlation function to the same problems as your contributor in various papers at the turn of the century. These are well known, in the sense that they are cited in many modern textbooks, including those for communications engineers. One in 1899 dealt with hidden periodicities in meteorological data, others with the coherency of white light. The method was that described by your contributor, using functions of real variable only and therefore confined to the past of the data. The real "latest developments" came after 1930, when Wiener and others extended the method to complex variables.

Your contributor, however, is by the nature of his apparatus concerned only with the real-variable correlation function. If he finds it "the latest method," this is because he, not the function, is the later arrival.

Farnborough, Hants.

R. A. FAIRTHORNE.

### Voltage Multipliers

I READ with interest "Cathode Ray's" article on voltage multipliers (March 1955) and should like to make two comments.

1. The circuit of Fig. 10 can be used as a trebler. All that is necessary is to earth the top end of G, not the bottom end. The rule that can be derived from this is:— If you add any stages of multiplication to a circuit of this type do this always on the supply side (this will obviate the need for reversal). This can also be seen quite clearly in "C.R.'s" Fig. 12. You can, for instance, remove  $C_1$  and  $D_1$ , still taking your output from the right-hand side, and the multiplication factor will be 5 instead of 6. Similarly, you can add a stage between the bottom end of the ladder and G in Fig. 12.

2. Sometimes voltage multipliers are used with a supply of unidirectional pulses of short duration (such as line flyback pulses). In this case  $D_1$  and  $C_2$  in Fig. 10 would produce no step-up of voltage, and  $D_2$  may be replaced with a resistance, a typical value (in a line flyback circuit) being  $1M\Omega$ . The only disadvantage is an increase in source impedance, but the deterioration is generally considered insufficient to warrant the use of a rectifier in place of R.

London, N.W.2.

G. N. E. PASCH.

### Special Quality Valves

THE article in your December issue refers to the use of a wiring jig to hold the contacts of miniature valveholders in their correct positions during chassis wiring. Such a jig is very desirable to ensure mechanical alignment of the contacts but it has been found that this procedure can lead to poor electrical contact between the holder and the valve pin. In certain miniature valveholders which use brass contacts, the heating-cooling cycle caused by soldering (with the jig or valve pin in position) usually results in an appreciable loss of contact pressure. In a limited number of cases this is sufficient to produce a very "noisy" contact. No such difficulties have been found when using beryllium-copper contacts.

Nottingham.

A. T. DENNISON.

### Electronics on the Farm

I CAN assure Mr. Taylor that "the hoary old stager" can be substituted by a unit operating from a wireless battery, but I assume from his letter that he has not tried one of these units. If he will do so I think that he will find that the contact trouble to which he refers will disappear.

Units using neon tubes as a switch and also units using electronic circuits are manufactured, but I believe they are all mains operated and they are also of necessity more expensive.

Line test units are marketed and may be bought independently of the unit, and they are of such design that they can be left permanently connected to the fence line. One particular testing device is so arranged that the actual value of the output from the pulse unit can be measured.

May I suggest to Mr. Taylor that when choosing a pulse unit he should consider output characteristics since some of the types of unit on the market give a large voltage and consequent large spark on open circuit, but when connected to a fence of average insulation resistance they may give a relatively poor shock to an animal having a contact resistance of the order of 10,000 ohms, due to the inherent regulation of the unit.

Orpington.

C. W. ROBSON.

MOST of the electric fences on the market work off a standard 120-volt h.t. battery, and these are fairly big and bulky items to store away, even in so-called "portable units," and are, as far I can find, the highest voltage type on the market.

I have made and operated quite a few fences on the resistance-capacitance principle, and found them very satisfactory and reliable. With neon types, one is up against snags at once. The major one is that the striking voltage is far too high for the standard battery to give any length of service; with the RC type I have still had the fence working with the battery reading 45 volts on load. The ideal is, of course, the cold-cathode trigger type, but I have only used these on mains-operated units, extensive searchings having failed to find a manufacturer who makes one that can strike or be triggered as low as 60 volts.

Incidentally, Mr. Taylor will find that a piece of grass about six inches long (if wearing boots, and shorter if in Wellingtons) will only give a slight tingle in the fingers if held to the fence. Much cheaper than neons or having to walk the full length of a twenty-acre field to see if the unit is on or off.

Truro, Cornwall.

D. A. BOND.

### Viewers' Strike?

I COULD hardly agree more with Mr. Niall (February issue), and wish him every success if he wants to organize a viewers' strike. I assume it is his intention that viewers will cease to view when their licences expire.

I shall then achieve the Four Freedoms. Freedom from timebase harmonics which ruin all B.B.C. reception in TV hours. Freedom from re-transmission of the TV sound programme in the 3.5 Mc/s amateur band. Freedom from various r.f. oscillators on various short-wave broadcast bands. And freedom from rough notes sliding up and down the 14 Mc/s amateur band.

I am in favour of TV suppression—the total suppression of those ill-designed or ill-adjusted models which cause such widespread interference to almost anything except TV.

The possession of a TV set ought not to give one the right—as it seems to do—to moan about interference from others, yet cause interference oneself. Why not try it on the other foot for a change?

"First cast out the beam from thine own eye."

Workshop.

H. S. CHADWICK (G8ON).



# TESTING PRECISION OSCILLATORS

## Automatic Recording of Frequency Stability

By M. P. JOHNSON,\* E.E.(Toronto), A.M.I.E.E.

CARRIER frequencies used in multi-circuit carrier telephone systems must be kept stable if no undue frequency translation of the received audio is to occur. On modern British coaxial cable carrier systems it is usual to derive all carrier frequencies from a master oscillator operating at 124 kc/s. Such an oscillator normally has a frequency drift of less than 2 in  $10^7$  per month and a frequency temperature deviation of less than 2 in  $10^8$  per  $30^\circ\text{C}$ . An extremely precise source of frequency is needed for the development and testing of oscillators of this stability and it is very desirable that the source should be continuously available. An attractive possibility adopted by the author's firm was to measure automatically and record against the National Physical Laboratory transmission on 2.5 Mc/s from station MSF at Rugby. It was ascertained that over the 10 miles from Coventry, where the development was carried out, to the Rugby station MSF ground wave reception was dominant and Doppler effect was negligible.

There are several methods available for displaying the frequency difference between the standard and test sources. For example, needle-like pulses can be produced from the difference frequency and the mean value of these is then proportional to the difference frequency. Alternatively the difference frequency can be passed as a constant current through an inductance and the voltage across the inductance is then proportional to the difference frequency. Another method is to charge a capacitor at a rate corresponding to the cycles of the difference frequency and use suitable linearizing circuitry to produce a voltage proportional to the frequency difference. Circuits dependent upon waveform can, in general, be difficult, especially at low difference frequencies. Those dependent upon pulses developed by differentiating circuits are subject to false operation when noise is present, as is the case with radio signals. Moreover, with some of these

methods long time constants are necessary to obtain a reasonably steady d.c. output to the recording instrument, and this results in a poor response to short-term variations.

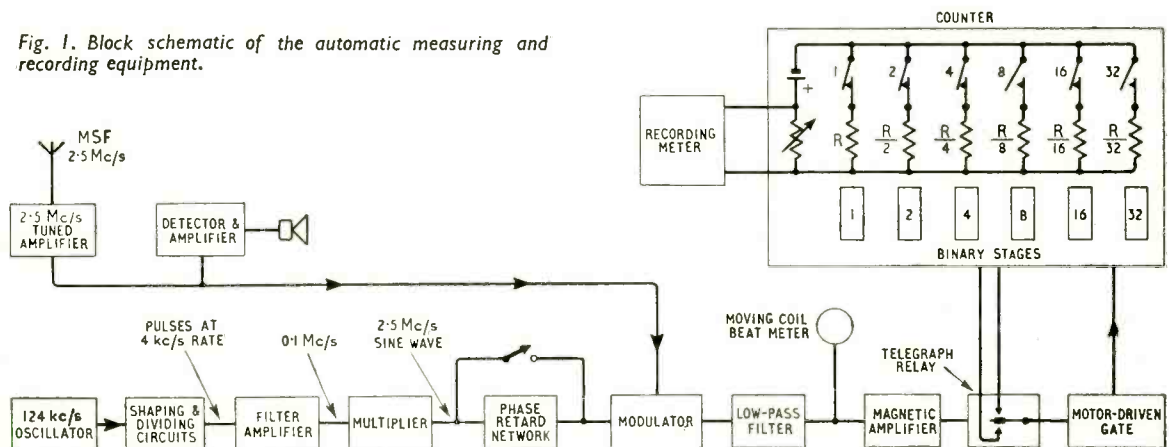
The method we actually chose is free from these difficulties and from linearity problems. A count of the difference frequency is made over regularly recurring gating periods and an output current is obtained that is proportional to the count and hence to the difference frequency. Thus the recorded reading is the average of its own gating period only. This independence of previous readings is not easily obtained with the other methods.

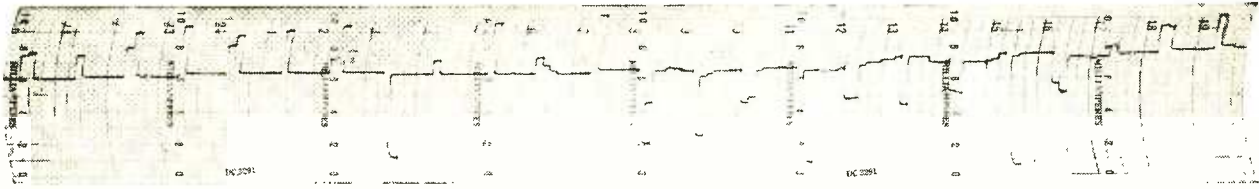
Actually the difference frequency is counted for 116 seconds. The recording meter connected to the counter is arranged to respond linearly to the count and so a linear scale of difference frequency is obtained. A count of 58 causes a full-scale meter deflection. This corresponds to a difference frequency of one cycle per two seconds or 0.5 c/s in 2.5 million c/s, which is a frequency difference of 20 parts in a hundred million, or 20 in  $10^8$ . The meter records the frequency difference at the end of the first count and continues this reading until a different count causes it to change. Four seconds after the first count, the counter commences a second 116-second count without altering the pen recorder reading. At the end of this 116-second count the pen recorder changes, if necessary, to suit the new frequency difference and this process is repeated throughout the normal operation of the equipment. As 58 counts give a full-scale reading, the meter can record any of 58 discrete readings across the paper chart.

The equipment may be set to operate at counting times of 116, 232, or 464 seconds. In each case a count of 58 yields a full-scale reading on the meter.

\* G.E.C. Telephone Works.

Fig. 1. Block schematic of the automatic measuring and recording equipment.





At 116 seconds the full-scale reading corresponds to a frequency difference of 20 parts in  $10^8$ . At 232 seconds it corresponds to 10 in  $10^8$  and at 464 seconds to 5 in  $10^8$ .

The general arrangement of the measuring equipment is shown in Fig. 1. The 124 kc/s master oscillator frequency is translated by division and multiplication to 2.5 Mc/s for comparison with the 2.5 Mc/s radio signal. The two are then combined in a modulator which gives the difference frequency without a d.c. component. This difference frequency is amplified and applied to a telegraph relay, which operates the counter during the counting period, which is controlled by the gate operated from a 50-c/s synchronous motor. This gate actually consists of a telephone relay spring-set mounted on a slotted cam which is driven at 1 revolution per two minutes through a gear train by the motor. The counter (a binary type) contains relays which switch parallel resistors into a circuit supplied with a constant voltage so that a current is obtained in the circuit proportional to the total count in each period. A moving pen recorder then displays this output current. Frequency differences of 5, 10 and 20 parts in  $10^8$  can be displayed with full-scale deflection on the meter by using time intervals of approximately 8, 4 and 2 minutes respectively for the gating period, as already mentioned.

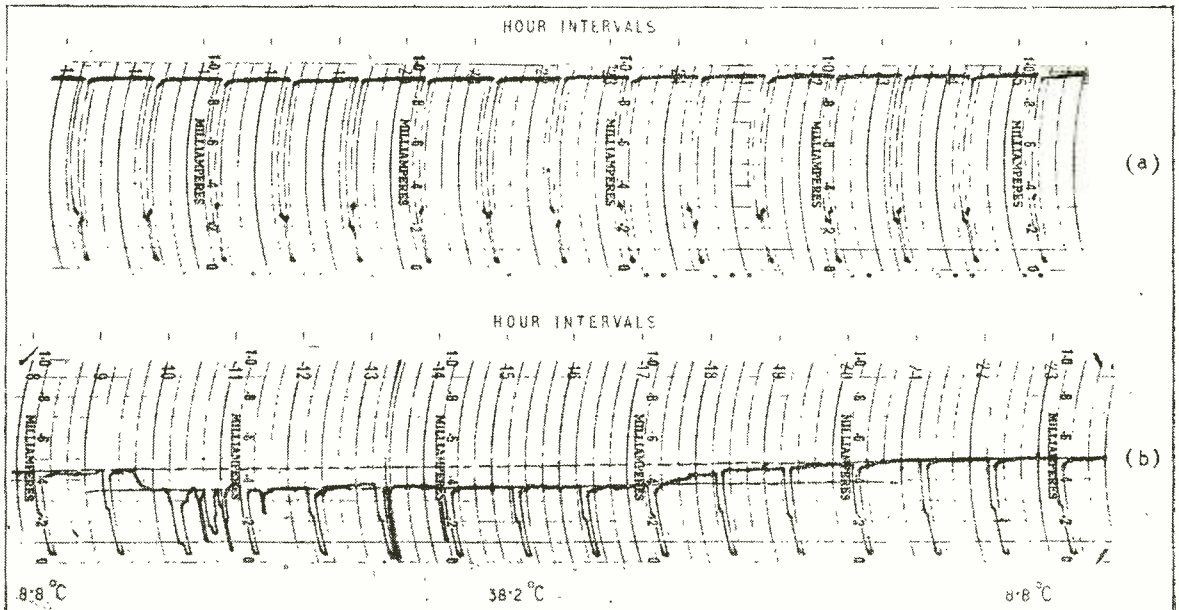
The 2.5-Mc/s receiver comprises five stages, each tuned to 2.5 Mc/s. Audio monitoring for announcements and noise checks is obtained from a detector and amplifier in parallel with the output to the modu-

lator. In the chain associated with the local 124-kc/s oscillator a two-valve tuned multivibrator is used in the first place to perform a division of 124 kc/s to 4 kc/s. It is preceded by a two-stage shaping circuit and also followed by a pulse shaping circuit which gives 4- $\mu$ sec pulses at a repetition rate of 4 kc/s. (This output is, of course, rich in harmonics of 4 kc/s). These pulses are fed into a three-stage filter amplifier which selects the 25th harmonic, namely 100 kc/s. The resulting sinusoidal output is applied to a frequency multiplier, in which an input Class-A stage drives hard a Class-C stage tuned to 2.5 Mc/s. The frequency multiplier is then followed by a two-valve filter amplifier tuned to 2.5 Mc/s to supply the modulator.

The low-pass filter which follows the modulator reduces any signal leakage back to the aerial and thus helps to prevent loop singing. A magnetic amplifier is used to amplify the resulting difference frequency. It has a reasonable zero stability and thus enables a positive drive to be applied to the telegraph relay. The actual difference frequencies for full scale deflection of the recording meter on each of the three ranges are 0.125 c/s, 0.250 c/s and 0.500 c/s. At such frequencies it is not easy to achieve a perfect sine wave free from noise, and for this reason the telegraph relay was chosen, in preference to valve trigger circuits, because it is probably easier to adjust against false operation.

The counter uses cold cathode valves (Osram type CCT5) in six binary stages to give a total count of 63. Of this, 58 counts are used to give full-scale deflection on the recording meter. Each binary stage

Fig. 2. Typical records from the equipment with full-scale reading of 20 parts in  $10^8$ ; (a) drift rate of one oscillator, (b) frequency/temperature performance of another oscillator. Troughs in the traced line are due to 5-minute breaks in the MSF transmission.



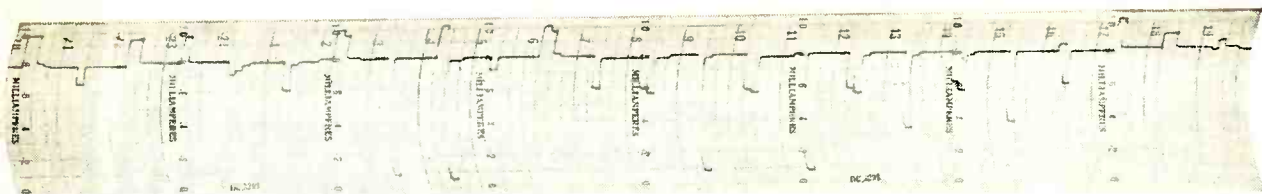


Fig. 3. Record obtained from the equipment over a period of 48 hours. The full-scale reading is 5 parts in  $10^8$ . The five-minute breaks in the MSF signal are again clearly defined while the "pulses" rising above the normal trace are due to interference from a local transmitter during these breaks.

has associated with it a telephone relay and at the end of the first count the appropriate binary stages operate their relays and so give rise to a current which is proportional to the count. For example, in Fig. 1, the relay contacts are shown operated for a count of 23. The relays do not release unless a subsequent count demands it. A switch and two more binary stages enable the normal gating time of 116 seconds to be extended to 232 or 464 seconds. A four-second interval is allowed between readings at the 116-second gating rate.

It is necessary at times to establish whether the oscillator under test is higher or lower in frequency than the standard source. A simple method of doing this is to use a centre-zero moving coil meter to indicate the beat frequency and a phase retarding network connected as shown in Fig. 1. An inductive or phase retard network connected in series with a circuit introduces a phase lag which has at the moment of connection the effect of slowing down the wave applied to it. It appears as if the frequency were momentarily decreased. Thus an oscillator whose frequency is higher than MSF with a difference frequency of a 10-second cycle will appear to have its frequency decreased, and the 10-second swing on the beat meter of Fig. 1 will momentarily, but quite clearly, slow down. If the frequency were below MSF, the difference frequency would be increased and the 10-second cycle would be shortened to give a momentary acceleration of the beat meter.

Of course, there are bound to be certain small inaccuracies in the measurement system, but if a stabilized mains voltage is used and a radio path free from interference is assumed, these are not too serious. The gating or counting period is controlled by the motor which is synchronized with the 50-c/s mains frequency. Variations of the mains frequency will consequently affect the counting time of 116 seconds and multiples of it. This will directly affect the count and, of course, the pen recorder reading. The error due to this cause should not normally exceed 1%, i.e. the count itself would have an error of 1%. Care has been taken with the cutting of the cam and arrangement of the spring-set operation so that the counting-time variations due to these are less than 0.1%. In counting systems such as this where a fixed gating period is used an error of 1 is always possible in the count. At full scale this would be 1/58 or 1.7% and at 10% of full scale it would be 17%. Errors in the recording meter circuit might be 2% resulting from drift in the voltage source and 1% due to resistor tolerances. Excluding inaccuracies in the recording meter, a total error of 6% could occur at full scale and 21% at 10% of full-scale reading. On the range 0-20 in  $10^8$  the 21% error would give an incremental error of 4 in  $10^8$ , which is acceptable.

Fig. 2 shows some typical records obtained from the equipment. The sudden troughs in the line at

hourly intervals are caused by the 5-minute cessation in the MSF transmission at 15 minutes past the hour. Fig. 2(a) shows the drift rate of a particular oscillator under stability investigation. The frequency/temperature performance of another oscillator is displayed in (b). Table I shows the worst errors

Table I

| Manual Reading parts in $10^8$ | Percentage error in pen reading | Actual error parts in $10^8$ |
|--------------------------------|---------------------------------|------------------------------|
| 0.86                           | 30                              | 2.6                          |
| 5.36                           | 3                               | 1.6                          |
| 15.7                           | 1                               | 1.6                          |
| 20.1                           | 0.5                             | 1.0                          |

observed on a chart run for about ten minutes at each of the listed readings. A full-scale sensitivity of 20 parts in  $10^8$  was used. Checks were made by timing with a stopwatch a sufficient number of beats on the beat meter to enable the frequency difference to be determined to an accuracy of better than 0.5%.

The equipment described has now been in operation for about six months. For routine maintenance it is returned at two-weekly intervals. If this is done little trouble is experienced from spurious readings due to faulty adjustment or electrical interference. For example, the chart of Fig. 2(b) was taken at an early stage in the development when spurious readings were more common. In spite of this the performance is reasonably defined. A run of 72 hours with no spurious reading is not unusual. Fig. 3 is representative of the equipment in its present state.

Observations to date have indicated that no deviations that have been observed could be attributed to Doppler effect.

From the charts, the short-term stability and the long-term frequency stability of an oscillator over the preceding 24 hours or longer may be calculated in several minutes. To obtain these results to the same accuracy by manual methods would have required human effort for 24 hours or longer.

It is often necessary to check the frequency/temperature performance of an oscillator before the quartz is fully aged. The frequency deviation due to temperature must be separated from that due to ageing. To do this, a continuous chart run is taken for a sufficient length of time at the initial temperature, then continued while the oscillator is held for a sufficient time at the second temperature, and continued further while the oscillator is returned to, and held again at, the initial temperature. The initial temperature drift lines may be quickly extended on the chart, and their mean distance from the line at the second temperature is the required frequency/temperature deviation. Apart from this simple calculation, it is only necessary

to set the automatic temperature controller to the required temperature after the appropriate time has elapsed. This, too, could of course be made automatic. In contrast, it is a long and tedious process to obtain the frequency/temperature performance by manual methods.

Oscillators of the performance mentioned in the first paragraph of this article may have supply-voltage coefficients of frequency of less than 1 part in  $10^8$ . These coefficients are measured during initial adjustment and, except under fault conditions, require very infrequent checking. Nine combinations of supply voltages are possible. The corresponding nine coefficients of frequency are all measured in a matter of half an hour by obtaining the period of one cycle of the difference frequency at 2.5 Mc/s, by use of a stopwatch or an automatic electronic timer. These methods are preferred for speed and accuracy. If the counting method of Fig. 1 were used, the gating time of 8 minutes would be necessary and this would require at least 72 minutes for measuring the nine coefficients.

The automatic recording method of Fig. 1 is being used for production testing of precision oscillators. Each oscillator under test is sampled in turn and its

frequency difference is printed on a multi-channel recorder.

It would be helpful if a shorter gating time could be used without worsening the accuracy. The following suggestion for obtaining the difference frequency is therefore of interest.

Let the oscillator frequency be  $(124 \times 10^3 + \delta)$  c/s. If this is multiplied by 20 and modulated by 2.5 Mc/s, the frequency  $[2.5 \times 10^6 - 20(124 \times 10^3 + \delta)]$  c/s would result. If this in turn were multiplied by 125 and again modulated by the 2.5 Mc/s signal, the final difference frequency would be  $125 [2.5 \times 10^6 - 20(124 \times 10^3 + \delta)] - 2.5 \times 10^6$  c/s =  $-2500\delta$  c/s. (The negative sign indicates that the final difference frequency is below the standard.) By contrast the signal modulation scheme yields a final frequency difference of

$$\frac{625}{31} (124 \times 10^3 + \delta) \text{ c/s} - 2.5 \times 10^6 \text{ c/s} = \frac{625}{31} \delta \text{ c/s.}$$

The double modulation scheme is therefore  $2500 \div \frac{625}{31} = 124$

times more accurate, and consideration could be given to reducing the gating time.

Finally, the author would like to thank John H. Beesley for his effective paper design of the counter.

## New Valve Voltmeters

### *A Versatile D.C./A.C. Instrument and an Amplifier-type A.C. Millivoltmeter*

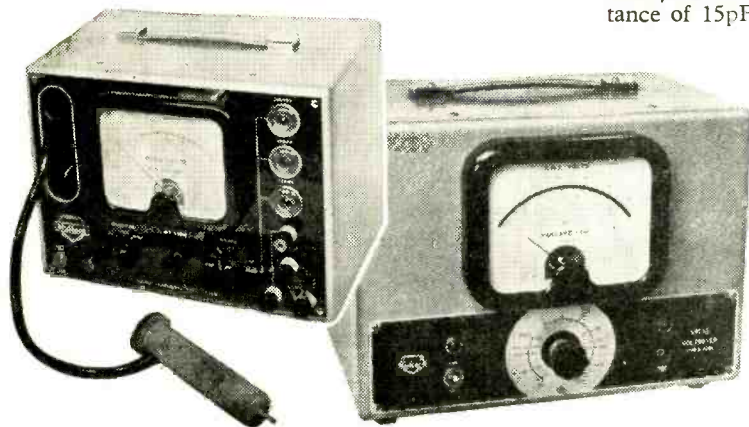
IN the type E7555 valve voltmeter recently developed by Mullard, the d.c. amplifier is designed to be virtually independent of mains fluctuations and valve ageing. The circuit is a balanced type with two EF86s connected as a "long-tailed pair" and directly coupled to two cathode followers. The output from the cathode followers is connected to the grids of the EF86s and gives virtually 100 per cent negative feedback and high stability. Both positive and negative potentials with respect to earth can be measured.

For a.c. inputs a probe unit is provided with a double diode valve, one half for rectification and the other for balancing. A frequency response level from 30 c/s to 100 Mc/s is claimed. On the lowest range

full-scale deflection on the 5-in meter is given by 0.5V peak (a.c. or d.c.). Maximum voltage is 15,000 in type E7555/2 and 500 in E7555/3.

At frequencies up to 50 kc/s the probe input resistance is  $3.5M\Omega$ , falling to  $8.5k\Omega$  at 45 Mc/s. The effective input capacitance is constant at 9pF.

The type E7556 meter incorporates a three-stage feedback amplifier, preceded by a cathode follower. A diode rectifies the amplifier output and the d.c. component is registered on a 5-in mirror scale meter. The limits of measurement of a.c. voltages are 0.5mV to 300V, with a total error less than 4 per cent. The frequency range is 20 c/s to 1 Mc/s. On the lowest range (10mV f.s.d.) the input resistance is  $1.5M\Omega$  at 20 kc/s and  $0.75M\Omega$  at 1 Mc/s, with an input capacitance of 15pF. The corresponding values for ranges of 3V f.s.d. and above are  $1.9M\Omega$ ,  $0.7M\Omega$  and 6pF. A calibrating voltage of 10mV is provided at mains frequency from a bridge circuit with lamp stabilizing elements.



Two new valve voltmeters made by Mullard (Equipment Division). On the left is the type E7555 balanced d.c. meter, with a.c. probe, and on the right the amplifier type a.c. meter (E7556) reading from 0.5mV to 300V.

# Phase-to-Amplitude Modulation

Variable Frequency Transmitter Based on Polyphase Oscillator

By BRYANT D. VIRMANI\*

ONE of the less familiar methods of achieving efficient operation in a transmitter is known as phase-to-amplitude modulation. It was first described by Henri Chireix, a French radio engineer, in 1935† and has since been used in quite a number of transmitters, most of them on the Continent. The principle of operation is based on the fact that when two r.f. carriers of the same frequency and amplitude are phase modulated differentially and then combined the result is an amplitude-modulated carrier. For example, if the modulation causes the two carriers to be 180° out of phase they cancel each other and produce a trough in the a.m. output, and if the modulation causes them to be in phase they add together to produce a maximum in the a.m. wave. Thus, when the phase displacement is varied between 0° and 180° it produces corresponding variations between maximum and zero in the amplitude of the combined carrier wave.

This scheme makes for high efficiency in two principal ways. First of all, the phase modulation is done at low level, which avoids the need for a high-power modulating amplifier. Moreover, this low-level modulation can be used, if desired, with high-efficiency class-C r.f. amplifiers, which normally require high-level anode modulation. Secondly, the valves in the two phase-modulated r.f. channels can be driven to their maximum limits and will remain in that condition all the time, giving the maximum possible efficiency, because there is no variation in carrier amplitude produced by the modulation—only a variation in phase. The result of these two features is that for a given r.f. power output the phase-to-amplitude transmitter is much more economical in its consumption of electrical power than other comparable transmitters. Moreover, it occupies a smaller space and weighs a good deal less. The author, in fact, claims a saving in power consumption and in weight of anything from 40% to 70% and a saving in physical size of 30% to 70%, compared with a conventional class-C anode-modulated telephony transmitter.

Another method of achieving efficient operation which has a certain point of similarity with the

phase-to-amplitude system is a well-known technique for obtaining single-sideband suppressed-carrier transmission. Here the economy results from the fact that no power is wasted in transmitting the redundant carrier and redundant sideband. The point of similarity with the phase-to-amplitude system is the use of two r.f. carrier components with a phase displacement (90° for s.s.b.) between them. (In the output the two sets of sidebands which result from modulating these r.f. carrier components are combined, and the phases are such that one sideband is balanced out and the other is augmented.) In fact, both the phase-to-amplitude system and the single-sideband technique require two r.f. carriers of the same frequency and amplitude with a certain phase displacement between them. In practice these carriers are usually derived from the same source through a phase-shifting network of capacitors and resistors—but the great disadvantage here is that the network is frequency-sensitive and consequently the frequency of the transmitter cannot be varied without changes in the circuit.

This particular disadvantage has been overcome in a 400-watt a.m. transmitter designed by the author which can be operated with either phase-to-amplitude

\* Polyphase Electronics (Toronto, Canada).  
† H. Chireix. "High Power Outphasing Modulation," *Proc. I.R.E.*, November, 1935.

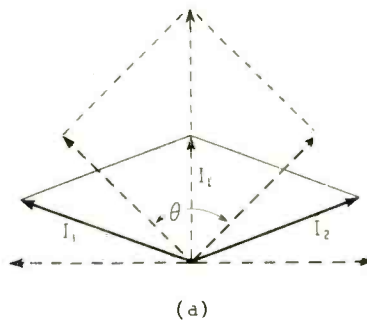
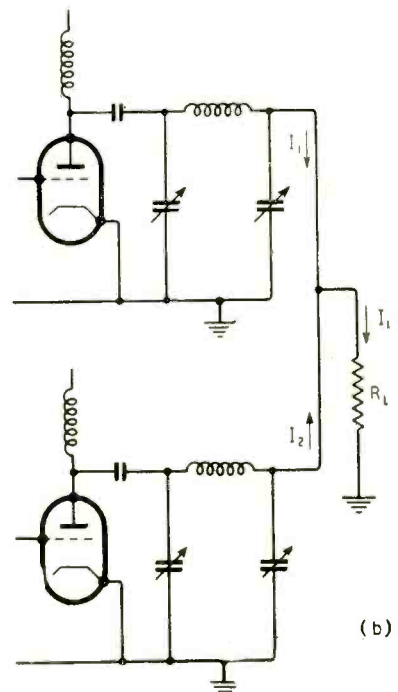


Fig. 1. (a) Vector diagram illustrating the principle of phase-to-amplitude modulation. The two phase-modulated currents  $I_1$  and  $I_2$  are combined to produce an amplitude-modulated current  $I_1$ . (b) Output stage of a phase-to-amplitude modulation transmitter, showing how the phase-modulated components are actually combined in a common load.



modulation or single-sideband suppressed-carrier—and therefore allows the similarity to be exploited to some extent. The conventional oscillator and phase-shifting network has been replaced by a polyphase oscillator, which not only gives the required phase-displaced outputs directly, but retains the correct phase displacement when the frequency of oscillation is varied. The result is possibly the first transmitter in which single-sideband operation has been achieved using a variable frequency oscillator.

Before describing the transmitter in detail it will be as well to look more closely at the phase-to-amplitude system of modulation and at the polyphase oscillator. A fairly recent version of the phase-to-amplitude system was devised by Webster for use in a 5-kW transmitter.\* Here the principle of operation (Fig. 1(a)) is based upon two r.f. vectors,  $I_1$  and  $I_2$ , with a phase difference of  $135^\circ$  in the carrier condition. They are phase modulated up to a maximum limit of  $\pm 22\frac{1}{2}^\circ$  by a push-pull audio amplifier. The resultant phase difference between the two channels could be  $180^\circ$  or  $90^\circ$ , depending upon which channel initially lags or leads the other.

When the two channels are  $180^\circ$  out of phase no voltage will appear across  $R_L$ , the common load shown in the circuit Fig. 1 (b). This condition constitutes, in effect, a short circuit of the output ends of both quarter-wave networks shown in (b). Then, due to the impedance-inverting qualities of the quarter-wave networks, the source ends of these networks appear as very high impedances and very little energy is supplied from the valves.

When phasing conditions are reversed, 100% positive peak modulation is obtained. Each channel then supplies energy to the load  $R_L$ . Owing to the effect of two sources of r.f. power feeding  $R_L$  the resistance "seen" by each channel at the output end of the quarter-wave network varies from zero to four times the load resistance required to obtain the correct carrier power. Then, again due to the impedance-inverting qualities of the quarter-wave networks, the power amplifiers themselves "look" into a load resistance which varies from an extremely high value to approximately one quarter that encountered at the  $135^\circ$  carrier condition. It is impossible to over-modulate because over-modulation will bring the two r.f. channels less than  $180^\circ$  apart, which is the condition for positive modulation.

### Ninety-degrees System

Another version of the principle is due to Perthel† who takes two r.f. channels with a phase difference of  $90^\circ$  in the carrier condition and modulates each channel up to a maximum limit of  $\pm 45^\circ$  by a push-pull audio amplifier. He connects the anodes of the final amplifier valves in push-pull. The phase difference due to modulation at the grids of the final amplifier could be zero or  $180^\circ$ . When the two channels are  $180^\circ$  out of phase full power output is delivered. But when the grids swing to a phase difference of zero degrees, the voltages developed at the anodes cancel out since the anodes are connected in push-pull. If the anodes are connected in parallel instead, the same results are obtained by completely reversing the phasing conditions at the grids.

To obtain two vectors with a phase difference of

\* N. D. Webster, "Economic 5-kW A.M. Transmitter," *Electronics*, May, 1951.

† B. Perthel, "An Unusual Phone Transmitter," *Radio and Television News*, August, 1951.

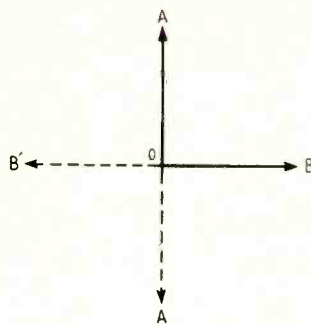


Fig. 2. Vectors illustrating the phase relationships of the four outputs from a four-phase oscillator such as the one in Fig. 3.

either  $135^\circ$  or  $90^\circ$ , phase-splitting circuits are conventionally employed, but, as was mentioned above, these are frequency sensitive. Therefore the systems of Webster and Perthel operate either on a spot frequency or over a very narrow range of frequencies. They are unsuitable for applications requiring a variable frequency oscillator to cover a very wide frequency range of the order of 1:10 or more in several bands.

In Webster's phase-to-amplitude modulation system, the reactance modulator valves operate linearly over a relatively narrow range of phase angles, so frequency multiplication by a factor of three is used to secure the eventual phase swing of  $\pm 22\frac{1}{2}^\circ$ . Moreover, to split an r.f. channel into two component vectors with a phase difference of  $135^\circ$ , using conventional phase-splitting circuits, it is necessary to use special measuring equipment. Furthermore, two quarter-wave networks ganged together are a little more difficult to adjust for best results than the simple push-pull circuit to be described.

The choice of two r.f. channels with a phase difference of  $90^\circ$ , as used by Perthel, is more profitable than Webster's system. The use of  $90^\circ$  vectors places at our disposal two additional types of transmission, namely, single-sideband (as already explained) and phase modulation. The carrier will be phase modulated if the two r.f. channels are swung in the same direction by a single-ended audio amplifier instead of a push-pull one. For c.w. or f.s.k. the modulator grids of the two channels may be driven by a keyed d.c. voltage.

In order to take advantage of the versatility offered by the Perthel system and adapt it for use directly with a variable frequency oscillator, all frequency-sensitive phase-splitting elements must be avoided. The logical solution of the problem lies in the use of a two-phase oscillator to generate two r.f. channels, with a phase difference of  $90^\circ$  as shown by the vectors OA and OB in Fig. 2. Now, in order to phase-modulate OA and OB by a pair of reactance modulator valves two additional channels,  $OB'$  and  $OA'$ , in phase quadrature to OA and OB respectively, must be made available—and the reason for this is as follows. A reactance modulator valve is the equivalent of a capacitance or an inductance shunted across an oscillating tuned circuit. If the value of this shunt element is varied, the phase or frequency of the circuit (depending on the manner in which the reactance valve is connected) will also vary. Now the reactive voltage and current in a capacitance or inductance are in phase quadrature, so in order to make the valve simulate this condition the voltage applied to its grid must cause the anode current to be  $90^\circ$  out of phase with the anode voltage. In other words, the grid and anode voltages must be  $90^\circ$  out of phase. Obviously, then,

to get the required four vectors shown in Fig. 2, we must generate four-phase oscillations with a variable frequency oscillator. Such an oscillator must be very simple to adjust and operate and must be capable of working over a very wide frequency range in a phase locked condition.

### Polyphase Oscillator

A circuit which satisfies these requirements is shown in Fig. 3—that is, the two valves V1 and V2 on the left-hand side. Each of these valves is a separate oscillator, but they both operate on the same frequency and are, in fact, locked together. The coupling between them in the common tuned circuit is such that they both settle down to a "mutual agreement" to differ by 90° in phase. Why is this so? The two inductors  $L_1$  and  $L_2$  are responsible for the coupling and they both carry oscillatory currents of the same frequency and magnitude. According to the laws of electromagnetic induction,  $L_1$  induces a voltage of opposite polarity in  $L_2$  and vice versa. When the sine wave in  $L_1$  is at peak value, it is inducing a maximum voltage of opposite polarity in  $L_2$ , thereby suppressing any sine wave which might normally be building up in the last-mentioned inductor. As the sine wave voltage in  $L_1$  begins to drop below the peak point, the opposing voltage induced in  $L_2$  also begins to drop, so giving  $L_2$  a chance to build up its sine wave voltage, which will reach its peak value when the voltage in  $L_1$  has dropped to zero. In this way

the two similar inductively-coupled oscillators mutually settle down to oscillate with a phase difference of 90°. Thus the output from the pentode anode of V1 is represented by the vector OA in Fig. 2 and the corresponding output from V2 by the vector OB.

The individual oscillators are actually modified versions of the two-terminal oscillator devised by Crosby\* in which the required 360° phase shift round the loop is obtained by two valves instead of one valve and a transformer. In Fig. 3 the two valves of each oscillator are formed by a pentode section, with the screen grid acting as anode, and a triode section; the anode of the pentode being used merely to electron-couple the oscillator to whatever it is feeding (in this case a reactance modulator valve). The oscillators can be varied over a very wide frequency range by the gauged tuning capacitors, and they can be crystal controlled if required by connecting a crystal between the two cathodes of either V1 or V2.

Thus, if the pentode anode of V1 produces an output which can be represented by vector OA in Fig. 2, the cathode of the same pentode will produce the vector OA', which is 180° out of phase. Similarly, if the pentode anode of V2 gives OB in Fig. 2 then the cathode will give OB'. Considering now the phase-modulator section of Fig. 3 (the right-hand side), the voltages represented by OA and OB are fed to the anodes of the reactance valves V3 and V4 respectively

\* M. G. Crosby. "Two-terminal Oscillator," *Electronics*, May, 1946.

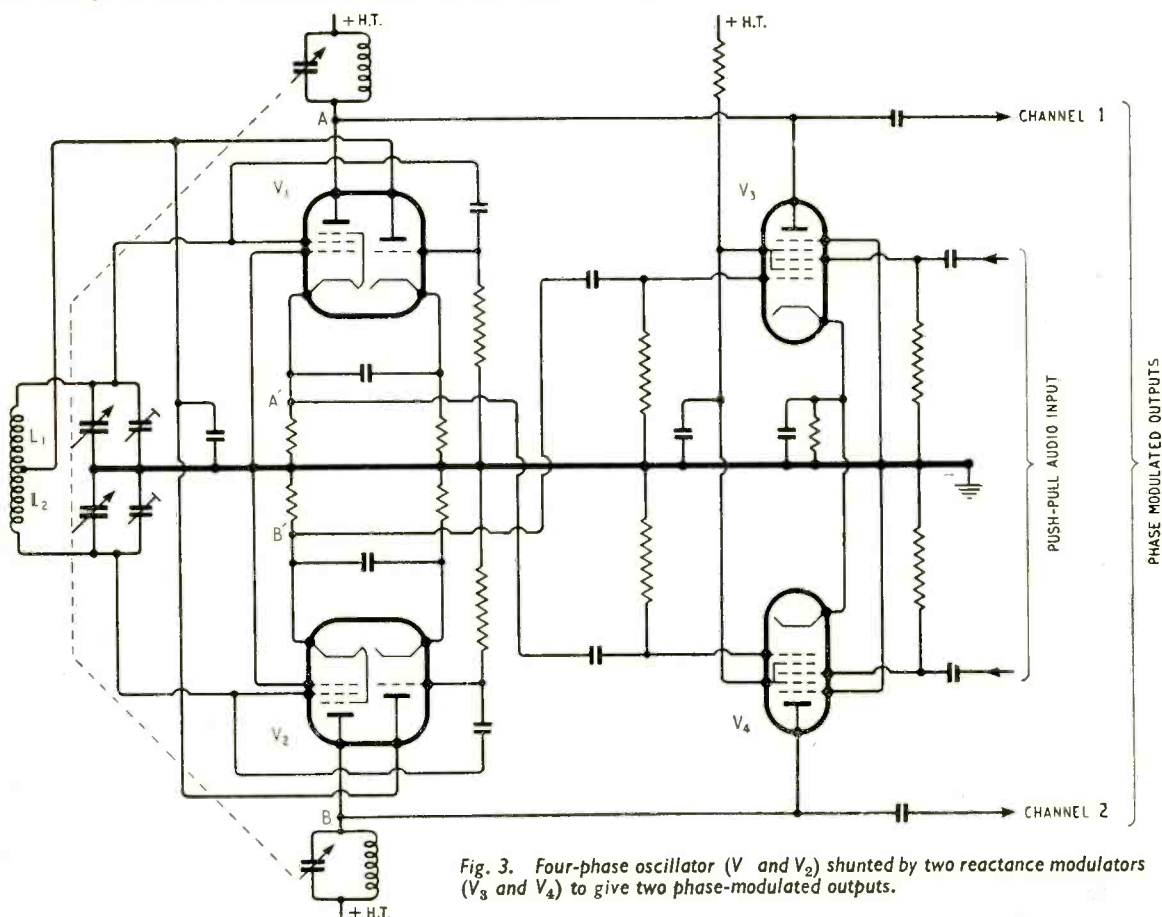


Fig. 3. Four-phase oscillator (V1 and V2) shunted by two reactance modulators (V3 and V4) to give two phase-modulated outputs.

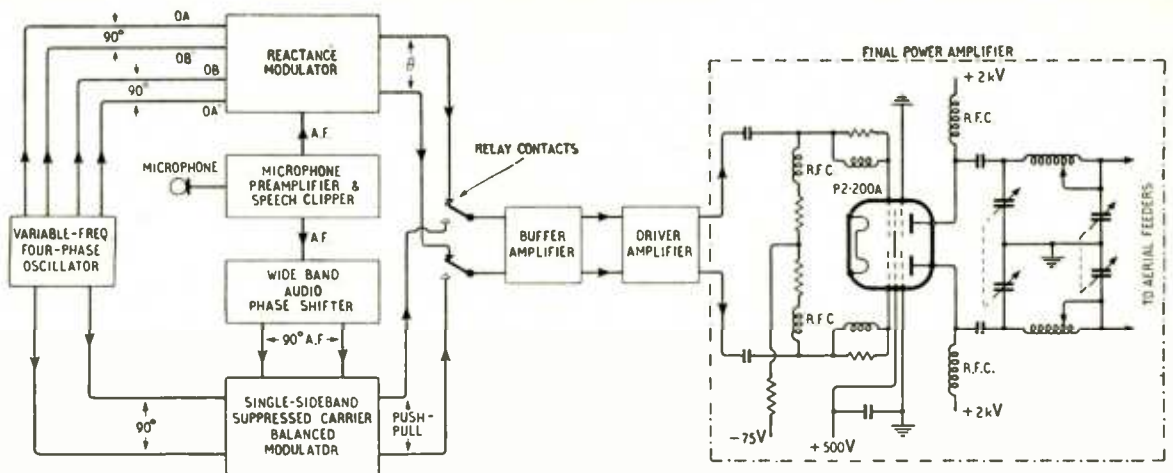


Fig. 4. Schematic (with simplified power amplifier stage) of complete variable-frequency 400-watt transmitter giving a choice of phase-to-amplitude modulation or single-sideband operation.

and the voltages  $OB'$  and  $OA'$  to the respective grids. Thus  $V3$  has a voltage on its anode corresponding to  $OA$ , with an anode current, lagging by  $90^\circ$ , corresponding to  $OB'$ . This is equivalent to a reactance shunted across the tuned-circuit output load of  $V1$  and its effect is to control the phase of the output signal from  $V1$ . De-tuning at the resonance point produces quite a rapid change of phase. The value of the reactance is controlled by the a.f. voltage applied to  $g_2$  of  $V3$  which thereby controls the phase of the oscillator output. Similarly,  $V4$  has  $OB$  on its anode and  $OA'$  on its grid and it operates to vary the phase of the signal coming from  $V2$ .

Thus the conventional frequency sensitive phase-splitting elements have been completely eliminated. The anodes of the two reactance valves and their respective grids remain always in true phase quadrature over the entire tuning range of the oscillator, whatever that may be. The reactance modulators are actually capable of swinging the phase of each r.f. channel linearly  $\pm 90^\circ$ , so that the two channels could be combined to produce a total swing of  $\pm 180^\circ$ .

### Complete Transmitter

The circuit schematic of the complete transmitter is shown in simplified form in Fig. 4. Since the reactance modulators are each capable of swinging the phase linearly  $\pm 90^\circ$  and we need only half of it, no frequency multipliers have been used. The transmitter has been designed to cover in three bands a frequency range of 3.5 to 8, 13 to 30 and 26 to 56 megacycles. The principal application in mind at the time of designing was for the amateurs in Canada and other countries where power output is limited by licence regulations to 500 watts. Since there is no amateur band between 7.5 and 14 Mc/s, no provision was made to cover it.

Fourteen crystals have been provided and they serve as band-edge markers for the seven amateur bands of 80, 40, 20, 15, 11, 10 and 6 metres. As the transmitter was designed to cover a wide frequency range, it was considered highly desirable to provide automatic amplitude control of the oscillations. This was done by means of diodes incorporated in each of the four 6AS8 valves used in the four-phase oscil-

lator. The oscillators operate strictly in class A and generate good sine waves free from harmonics over the entire range of the transmitter.

The reactance modulator valves are triode heptodes type 6AJ8. The anodes of the heptodes are tied in parallel to the anodes of the oscillator valves, which are used for electron coupling as in Fig. 3. The quadrature voltages for the control grids of the heptode sections are obtained from the oscillator cathodes as already described. The triode sections of the 6AJ8s are connected as see-saw push-pull audio amplifiers and the amplified audio voltages at their anodes are fed into the reactance modulators through a transmission selector switch. The first position of this switch is for amplitude modulation, in which case the grids of the heptode reactance modulators are driven in push-pull. The second position is for phase modulation, and here the grids are connected in parallel so that the two r.f. channels swing together in the same direction. In the third position of the switch, the control grid of one of the a.f. amplifier triodes is earthed and therefore no audio signal is applied to the reactance modulators. Consequently the two channels cannot swing in phase. Simultaneously, when the switch is on this position, a relay operates and causes the contacts shown in Fig. 4 to connect the buffer amplifier to the single-sideband push-pull output.

Because of the inherent non-linear characteristics of the phase-to-amplitude system of modulation, it is necessary to pre-distort the audio signal in the interests of high quality transmission. For this purpose germanium diodes are inserted in the grid circuits of the triode a.f. sections of the reactance modulators; the amount of pre-distortion being adjusted by potentiometers which are shunted across them. The audio section is actually built on the unit system, and if the transmitter is needed for short-wave broadcasting the audio amplifier can be replaced in less than two minutes by another one of high quality type suitable for broadcasting purposes. The oscillator tuning coils are also plug-in types and so can be changed if the transmitter is required to cover a different frequency range.

When it is desired to transmit c.w. telegraphy or test the phase swings of the two r.f. channels the



transmission selector switch is set on the second position. Here the third grids of the heptode reactance modulators are connected to a source of d.c. potential through the contacts of the keying relay. When the key is up, and the transmission selector switch is on the first position, the heptode grids are applied with d.c. potentials of polarities which cause the r.f. channels to swing to a phase difference of zero degrees. Then, because the final power amplifier anodes are connected in push-pull, no power output results. When the key is pressed, the polarities on the heptode grids are reversed and the two r.f. channels swing to a phase difference of  $180^\circ$ , in which condition the final power amplifier delivers full power to the aerial. When the selector switch is on the second position, the d.c. potentials swing the r.f. channels in the same direction, resulting in phase excursions which are equivalent to frequency shift keying.

The four valves used in the single-sideband suppressed-carrier balanced modulator circuit are triode heptodes type 6AJ8. The single-sideband output is push-pull and can be connected to the buffer amplifier by the relay contacts as shown in Fig. 4. The grids of the 6AJ8s receive phase quadrature r.f. voltages from the four-phase oscillator. The triode sections of the valves are connected in see-saw phase inverting circuits and the control grids of these triodes receive phase quadrature audio voltages over a frequency range of 130 to 3,600 cycles and  $\pm 1^\circ$  from a wide-band phase shifting circuit (half 12AU7). Upper or lower side-bands can be selected by a switch.

In the audio section, speech from a crystal microphone is passed through a pre-amplifier stage (6AU6) and the output is limited by a cathode-coupled speech clipper stage using a 12AU7 double triode. Since clipping generates harmonics, the clipper stage is followed by a band-pass filter, which is responsive over the speech band only. The filter terminates in two parallel-connected potentiometers. The output (slider) of one is connected through a switch to the reactance modulator. The output of the other potentiometer goes to the grid of an amplifier stage which has a wide-band phase-shifting network connected between its anode and cathode. This provides two audio frequency components with a phase difference of  $90^\circ \pm 1^\circ$  over a frequency range of 130 to 3,600 cycles, which are fed to the single-sideband modulator.

A voice-operated send-receive switch has been added as a refinement for neat and fast two-way communications, and there is also a 1,000-c/s oscillator for testing and adjusting the transmitter and for transmitting tone-modulated telegraph signals.

Returning now to the r.f. section of the transmitter, the buffer amplifier comprises two 6BX6s used as class-A voltage amplifiers and the output of these can be controlled by a potentiometer in the grid circuits. The amplified outputs of the 6BX6s drive the control grids of a dual power tetrode type AX-6360 (QQE03/12), which operates in the class AB<sub>1</sub> condition. The final amplifier valve is a type P2-200A. It is a dual power pentode made by Société Française Radio Electrique of Paris and it operates in the class AB<sub>2</sub> condition with a grid bias voltage of -75 volts and an anode voltage of 2kV in continuous commercial service. It may be loaded to an input of 680/700 watts approximately. The previous valve drives the P2-200A to full output with an ample reserve of driving power. Normally about 400 watts

is taken out of the valve, leaving about 75 watts in reserve. The output tank circuit is of the double  $\pi$  type, which has been designed to match any output impedance from 50 to 1,200 ohms. The anode tuning capacitors are a ganged pair of vacuum types and the rotary inductors are each 10 microhenries. For balancing the feeders a single r.f. ammeter is used with two external thermocouples, one on each feeder, and a double-pole double-throw toggle switch connects the meter to one or the other.

In the whole transmitter there are only three tuning controls: (a) oscillator frequency, (b) final anode tuning, (c) aerial loading. The operation of the transmitter has been reduced to extreme simplicity and it can be fully modulated by a carbon microphone without a pre-amplifier. The complete equipment, including all power supplies, has been packed into a vertical panel space of  $24\frac{1}{2}$  inches on a 19-inch standard width rack, and sits right on the operating desk alongside the communications receiver.

## "CLEAN" VALVES

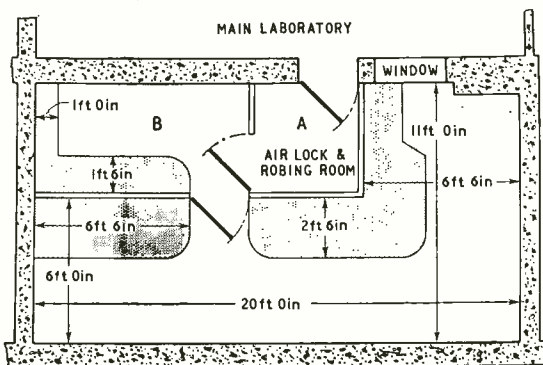
CERTAIN types of receiving valves have grids wound as closely as 500 turns to the inch, with electrode spacings of the order of one-thousandth of an inch. It is not hard to see that the performance and life of such valves can be impaired by the presence in the air, during the assembly process, of particles of dust and other solid impurities. These become attached as whiskers to the electrodes and cannot be removed entirely by any subsequent process. To improve the reliability of certain special valves of the type under consideration, "dust free" assembly shops have been built at the research laboratories of the General Electric Company.

One such assembly shop, shown in the sketch, comprises an area 20ft x 11ft divided into one "L"-shaped room and one smaller rectangular room with a small entrance lobby separated from the working part by an airlock. The lobby serves as a dressing room for the working staff.

Housed in a gallery above the work rooms is a heating and ventilating system which delivers fresh air, warmed when necessary, at the rate of 1,000 cuft per minute and filters out all particles of dust larger than 5 microns in diameter (1 micron = 0.001 mm). A complete change of air is effected every  $2\frac{1}{2}$  min.

To prevent dust and "lint" being carried in by the operator's clothing, close-fitting nylon overalls, caps and special slippers are worn by the working staff and in-and-out traffic is reduced to a minimum.

Provision is made for extra filters to be installed which, should the need arise, would remove all foreign particles in the air over 0.2 micron. It is said that since these special workrooms have been in use a marked improvement has taken place in the quality of the valves assembled under these "clean" conditions.



Plan of the G.E.C. dust-free valve-assembly rooms.

# Geophysical Research

## International Investigation of Phenomena Affecting Radio Transmission

By R. L. SMITH-ROSE,\* C.B.E. D.Sc., Ph.D., F.C.G.I., M.I.E.E.

**M**OST readers of *Wireless World* will be aware of the fact that scientists throughout the world are beginning preparations to participate in the International Geophysical Year, which is the term given to the period from July 1st, 1957, to December 31st, 1958. This will be the third time that physicists interested in the study of the earth and its atmosphere have conducted a detailed programme of world-wide experiments and observations during a "year."

**International Polar Years.**—The first enterprise of this nature was during 1882-83 and was termed an International Polar Year; it was followed 50 years later by a second co-operative effort under the same name. These, as their title indicates, were concerned specifically with investigating the special phenomena associated with the earth and its atmosphere in the polar regions. It was not normally possible to obtain frequent and regular scientific measurements in these regions, so expeditions were organized for conducting extensive observations on the earth's magnetic field, and on atmospheric conditions, including aurora.

During the second Polar Year (1932-33), radio technique was available for investigating conditions in the ionosphere at high latitudes, and a successful expedition was conducted under the auspices of the International Scientific Radio Union (U.R.S.I.), which appointed a Polar Year sub-committee with Sir Edward Appleton as chairman and Sir Robert Watson Watt as secretary.

In addition to the manning of special expeditions of this nature, a large number of countries arranged for detailed studies at observatories not in polar regions on specially selected "international days" as well as generally throughout the year. The British work was carried out in close co-operation with the D.S.I.R. Radio Research Station, and R. Naismith and W. C. Brown, who are still members of the staff of this station, were among those who spent the second Polar Year in Norway observing ionospheric conditions within the Arctic Circle. This particular programme of work gave a major impetus to the development of ionospheric research in Great Britain, and disclosed the close relationship between magnetic storms and abnormal conditions in the ionosphere.

**International Geophysical Year.**—It may now be asked why the title of this international effort has been changed, and why it is being arranged at half the interval between the first two "years." The reduction in the period from fifty to twenty-five years is an indication of the rate at which scientific research is advancing. New methods of investigation have been devised and the older ones considerably improved. The radio technique which was very limited in 1932 has now been extended to automatic methods of sounding the ionosphere and studying the effects of auroral discharges, as well as to techniques for detecting the incidence of meteors in the atmosphere

and for measuring winds in the ionosphere. In 1932 the conditions in the ionosphere were relatively quiet, being associated with a minimum of solar activity; during the 1957-58 period sunspots are expected to be large and to occur frequently. This is important since many solar and terrestrial phenomena depend upon this sunspot activity, as those concerned with radio transmission and reception over long distances are only too well aware.

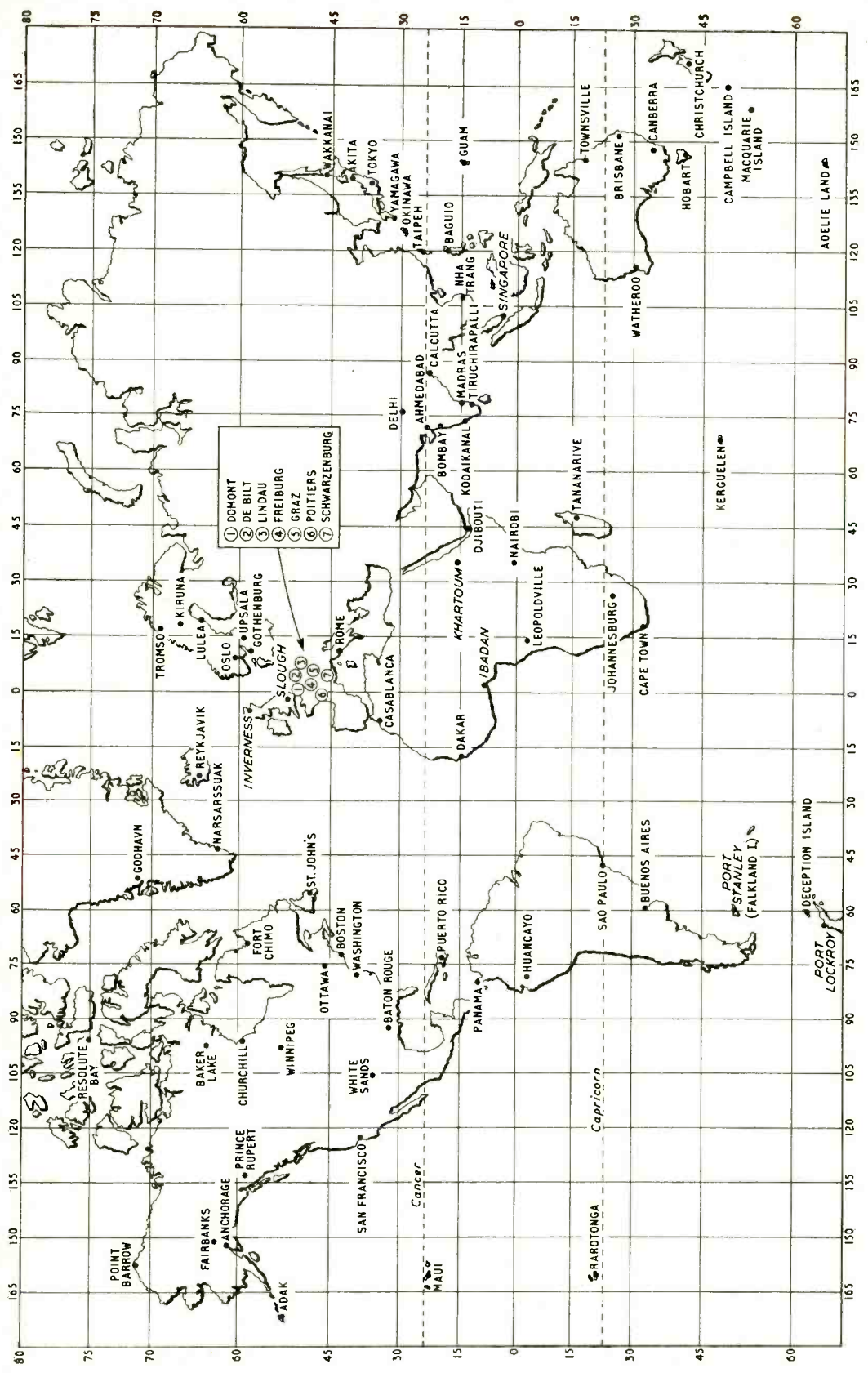
In recent years interesting and unexpected phenomena in the ionosphere have been shown to be associated with the earth's magnetic equator, so that observations are required at low as well as at high latitudes. Furthermore, there appears to be certain differences in the phenomena observed in Arctic and Antarctic regions, so that it is clearly desirable that the new investigation should cover the world as a whole; and this is indicated in the new title. The science of geophysics covers the study of all phenomena associated with the earth's surface and interior and also with its atmosphere. The radio scientist is mainly interested in the latter, since it is the lower atmosphere, or troposphere, which determines the propagation of very short waves over moderate distances, and the upper atmosphere, or ionosphere, which controls the transmission of short radio waves over great distances. The study of the effects of the troposphere and ionosphere on propagation must be conducted in association with research in meteorology, geomagnetism and solar physics. And it is in an active spirit of co-operation that scientific workers in all these fields will be engaged all over the world during the forthcoming international geophysical year.

While some observations will be conducted by automatic recording methods, and are thus virtually continuous, the major portion of the work during the I.G.Y. will be concentrated at certain periods, known as Regular World Days. In addition to these "days" periods of ten consecutive days, to be known as Special World Intervals, will be arranged quarterly at the solstices and equinoxes.

**Radio Investigations.**—Radio research will play a very important part in the general scheme of this international geophysical year. Efforts are being made by various countries to increase the number of stations which use vertical sounding technique for measuring the characteristics of the ionosphere.

As will be seen from the accompanying map, there are about eighty such stations in operation throughout the world. Seven of these are controlled directly or indirectly by the D.S.I.R. Radio Research Organization; they are at Inverness, Slough, Singapore, Khartoum (Sudan), Ibadan (Nigeria), Port Stanley (Falkland Islands), and Port Lockroy (Antarctica). Normally these and most of the other stations take their observations at hourly intervals; but on the World Days described above, this procedure will be intensified to record the ionospheric conditions more frequently and if possible at five-

\* Radio Research Organization, Department of Scientific and Industrial Research.



Disposition of the eighty-odd ionosphere sounding stations which will be participating in investigations conducted during the international geophysical year. The stations which come under the jurisdiction of the Department of Scientific and Industrial Research are shown in italics. Their regular observations will be intensified during the I.G.Y.

minute intervals. The work of these observatories is to measure, mainly by automatic methods, the height and density of ionization of the various regions of the ionosphere. In addition, measurements are made of the amount of absorption of energy suffered by the radio waves in travelling up to the ionosphere and back again to earth. At many of these stations the intensity of the earth's magnetic field is also continuously recorded, as this factor plays an important part in determining the state of the ionosphere for radio transmission.

For correlation with this radio work, all the necessary information on solar activity will naturally be obtained from the astronomical observatories, including the modern installations of the radio astronomers.

Several methods have been developed in recent years for detecting irregularities or disturbances in the ionosphere and the manner in which they travel horizontally and vertically. Observations will be made in this country and elsewhere by direct ionospheric sounding at spaced receiving points. Radio astronomy will also contribute to this investigation. The radiation from radio stars scintillates due to its passage through the upper part of the ionosphere, and observations of this scintillation are to be made in polar and equatorial regions, to provide further information on the irregularities of the ionosphere. Closely associated with this work will be the direct study of meteors, which in their passage through the atmosphere create a trail of ionization detectable by radio-echo technique. Observations on such meteors will be carried out by a chain of stations in the northern and southern hemispheres.

A relatively new technique for investigating conditions in the ionosphere over distant and even inaccessible localities, is that known as "back-scatter." In this method radio waves are transmitted at a low angle of elevation to be reflected by the ionosphere to a distant place on the earth's surface. Some of the energy is scattered from the ground at this place, or travels back over the same path to be received at the point of transmission. By studying the received echo on different frequencies and in different directions, valuable information about the ionosphere is obtained to supplement that from the vertical incidence recordings.

A field in which radio physicists and meteorologists have a common interest is that of atmospheric noise originating in thunderstorms and lightning flashes. A world network of stations measuring the strength of this noise on various radio frequencies has been in operation for some years past and this work will be continued during the international geophysical year. In some countries a group of direction-finding stations is used to locate the sources of these atmospheric disturbances; while in others an investigation is being made into the dependence of the waveforms of atmospherics on the distance and direction of transmission. During the I.G.Y., programmes involving close co-operation will be arranged to ensure the simultaneous observation in various places of special phenomena, such as the "whistler" type of atmospheric.

In collaboration with the meteorologists the radio scientists are seeking a knowledge of the variation with height of the refractive index of the atmosphere. It is proposed that this should be obtained by measurements made on masts up to a few hundred feet, supplemented by observations carried out in balloons, free or captive, up to at least 5,000 and, if possible, up to 30,000 feet.

**Central Planning Control.**—We have so far dealt with the investigations of direct radio interest that will form part of the whole programme of scientific work to be conducted during the year. The general planning of the programme in all fields is being carried out by a committee responsible to the International Council of Scientific Unions, which is the co-ordinating body for the various scientific unions concerned with astronomy, geodesy, magnetism, meteorology and radio. Professor S. Chapman is president of this international committee on which are representatives of the committees in the various countries collaborating in this vast enterprise.

Sir Edward Appleton is chairman of the special committee of the International Scientific Radio Union (U.R.S.I.) set up to advise on the radio work undertaken during the I.G.Y., and J. A. Ratcliffe is chairman of the British National Committee for Scientific Radio which represents this country on U.R.S.I. Among the members of the British committee for the I.G.Y. specially interested in radio research are Dr. W. J. G. Beynon, Professor A. C. B. Lovell, Professor H. S. W. Massey and the writer.

With the co-ordination of scientific effort thus obtained in radio and the allied fields, we may look forward to considerable advances in our knowledge of the various phenomena associated with radio propagation.

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## Club News

**Barnsley.**—At the April meetings of the Barnsley and District Amateur Radio Club, D. Westwood (G8WF) will speak on "The Whys and Wherefores of Q" (15th) and C. T. Malkin (G5IV) will speak on propagation (29th). Meetings are held at 7 p.m. at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33, Woodstock Street, Barnsley, Yorks.

**Chelmsford.**—Meetings of the Chelmsford group of the British Amateur Television Club are held at 10, Baddow Place Avenue, Gt. Baddow, Essex, on the second Thursday of each month. Sec.: M. W. S. Barlow (G3CVO); address above.

**Cleckheaton.**—On April 6th D. Westwood (G8WF) will speak on modulation to members of the Spen Valley and District Radio and Television Society. Meetings are held at 7.30 p.m. at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Yorks.

**Coventry.**—"Civil Communications" is the subject of a talk by G. Brown (G5BJ) to be given at the meeting of the Coventry Amateur Radio Society on April 25th. Lecture meetings are held on alternate Mondays at 7.30 p.m. at 9, Queens Road, Coventry. Sec.: K. G. Lines (G3FOH), 142, Shorncliffe Road, Coventry, Warwicks.

**Romford.**—Weekly meetings of the Romford Radio Society are held on Tuesdays at 8.15 p.m. at R.A.F.A. House, 18, Carlton Road, Romford. On April 12th Louis Varney (G5RV) will deal with the suppression of television interference. Sec.: N. Miller, 55, Kingston Road, Romford, Essex.

**Southend.**—Judging in the annual contests for the Pocock and Hudson Cups for home-constructed gear takes place on April 1st. Sec.: J. H. Barrance (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

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## An Apology

WE regret that due to an unforeseen delay in the despatch department of our printers the publication of our last issue was postponed for a few days.

# DISTORTION

By "CATHODE RAY"

## What Do We Really Mean By It?

IF there had been any doubt about there being a great many people intensely interested in what our American friends call "hi fi," that doubt was dispelled last autumn by Mr. Briggs when he sold the full capacity of the Royal Festival Hall (sitting and standing) in the first four days, on an announcement that he was going to demonstrate loudspeaker reproduction in comparison with direct musical performances. It has been necessary to arrange a second house. And I remember being mightily astonished when the Editor told me how many copies of the Williamson amplifier reprint had been sold. All this being so, there is naturally a demand for some scale of measurement for comparing one piece of sound-producing equipment with another. The advertisement copy writers' "perfect reproduction," "no trace of distortion," "impeccable fidelity," "thrilling tone," etc., cut no ice at all with *Wireless World* readers. They very rightly want some definite figures of performance.

So most of the advertisements nowadays say "distortion at 12 watts output is not more than 0.3%," or whatever it may be. That is certainly an improvement in principle, but we may be forgiven for asking some questions. Is 0.3% good, bad or indifferent? If another make of amplifier distorts 0.3% at 12 watts can its fidelity be assumed to be the same? If it were 0.1% how much better would it sound? And if it were 1%—or 5%—how much worse?

Twenty-five to thirty years ago people were already taking quite a lot of interest in this matter of fidelity of sound reproduction, but the data then consisted of a graph of output against frequency—what is usually called a frequency characteristic. If it was in an advertisement, the scales were chosen so as to make the graph look as nearly as possible like a horizontal line drawn with a ruler. The thing was then described as "distortionless." To the best of my recollection, percentages were not mentioned. "Distortion" was generally understood to mean frequency distortion—the unequal amplification of different frequencies. The reason for this was that the most obvious shortcoming of the very early gear was its frequency

characteristic, which consisted of a violent peak in the middle or upper middle, and very little else.

So far as amplifiers were concerned, it was a fairly easy development to obtain their frequency characteristic curves and to improve their design so as to flatten out the peak into a nearly level plateau extending over the useful frequency range. And so began an era in which high-fidelity enthusiasts vied with one another in smoothing out the last fraction of a decibel (a unit which by then had come into vogue) often regardless of the vastly greater irregularities in the characteristics of the loudspeaker and the room in which it was heard. There is a good reason for aiming at a very level amplifier characteristic, but even now some enthusiasts may not realize that it is not the avoidance of frequency distortion as such (for on that count a peak of the order of one decibel is quite unimportant) but the obtaining of maximum undistorted output. If one narrow band of frequencies is amplified 1db more than others, as shown in Fig. 1, the whole level of output has to be lowered 1db (e.g., from 10 watts to 8 watts) in order to avoid overloading. In other words, moderate frequency distortion is bad, not as frequency distortion but as a potential cause of overloading or non-linearity distortion.

### Non-Linearity

As time went on and gross frequency distortion was eliminated, the possibilities of appreciable improvement of sound by further levelling out of frequency characteristics dwindled. "Distortion" ceased to be frequency distortion and became non-linearity distortion (commonly but illogically called "non-linear distortion"). Now this is where we must be clear about the meanings of terms. "Non-linearity" means lack of straightness or proportionality of a characteristic, expressed as a graph. The particular characteristic understood in this connection is the input/output characteristic of any part of the equipment. Ordinary resistors are linear, because the voltage across them is directly proportional to the

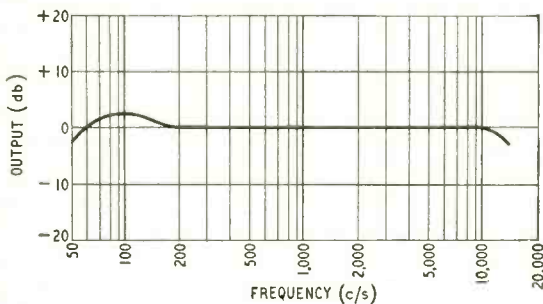


Fig. 1. Example of frequency distortion that is quite negligible as such, but should be avoided if the maximum undistorted power output is desired.

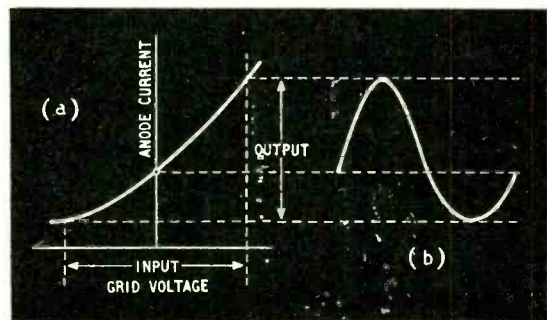


Fig. 2. Typical valve characteristic (a) with the curvature somewhat exaggerated we hope, showing the resulting distortion of a sine wave (b).

current through them; in other words, they obey Ohm's law. Valves and iron-cored coils do not. Fig. 2 (a) shows a typical sample of anode-current/grid-voltage characteristic. If the grid bias is set so that the working point is O, an input signal of sine-wave form will make the voltage swing equally on both sides of O as shown, and obviously the waveform of the output current so caused (b) is distorted, the positive half-cycle being bigger than the negative.

### Harmonic Distortion

This is the effect we are now going to study. It is sometimes called "amplitude distortion," but that term has been allotted to a different effect, which may or may not happen at the same time as waveform distortion. Whereas waveform distortion is a result of non-linearity during each individual cycle, amplitude distortion means that the output level as a whole is not directly proportional to the input level. It is possible with a characteristic of the Fig. 2 (a) type, which obviously distorts the waveform, for the output to be proportionate to the input, the opposite disproportionateness of positive and negative half-cycles cancelling out and resulting in no amplitude distortion.

One of the first things we learn about non-linearity is that it creates harmonics. This has been explained so often that I needn't go into it fully. The usual line is to add together various sine waves whose frequencies are harmonically related (i.e., exact multiples of one particular frequency, the fundamental or first harmonic) and find that the results are distorted waveforms, some of which resemble those obtained by non-linearity. For example, in Fig. 3 a double-frequency or second harmonic (b) is added to a fundamental (a) and the result (c) is very like the output of Fig. 2. That is the synthetic method. Then there is the analytic method of breaking down a distorted wave (graphically or by experiment) into a fundamental and harmonics. It is then explained that the characteristic tone of each musical instrument depends on the amounts of the various harmonics it emits, relative to the fundamental, and that if these proportions are altered, either by frequency distortion or by adding harmonics by non-linearity, the characteristic tone is distorted.

True enough. But by now we are supposed to have got rid of frequency distortion that could drastically alter the proportions of harmonics; such frequency distortion, for example, as poor high-frequency response, which would tend to suppress them. And while such distortion might make a clarinet sound like a flute, it couldn't (even if it took place) account for the appalling sounds that result from severe overloading. The fact that the sounds produced by musical instruments listened to with pleasure contain a generous series of harmonics is evidence of that. An amplifier advertised to give 10% harmonic distortion would hardly find favour with "hi-fi" connoisseurs, yet what is 10% compared with the 50% or more generated by well-regarded pianos? If the only effect of non-linearity were to create harmonics, we should be at a loss to explain how such unpleasant reproduction comes with quite moderate harmonic distortion percentages.

It is now generally agreed that it is *not* the harmonics that are responsible for the worst of the unpleasantness. In *Wireless World* for May 19th, 1938,\* I described a simple experiment for demonstrat-

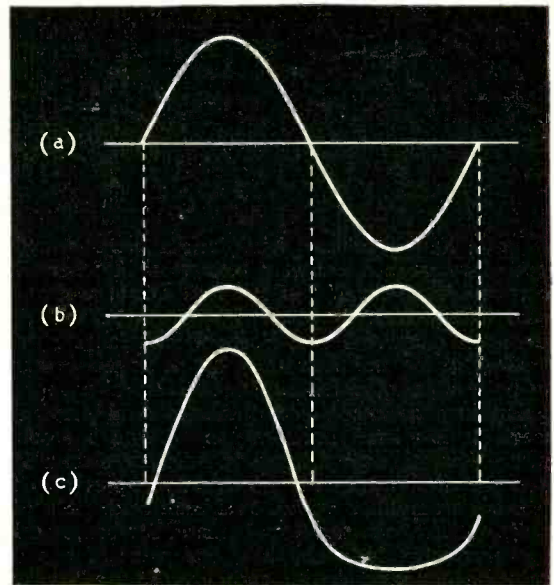


Fig. 3. Showing how the distortion in Fig 2(b) can be made synthetically by adding together a second harmonic to the original (fundamental) waveform.

ing this. On the assumption that copies of that issue may not be lying around to hand, I will briefly recap. A receiver is arranged with two separately-adjustable sine-wave input signals and an output meter. The low frequency, say 100 c/s, is adjusted to be 10 times the voltage (and therefore 100 times the power) of the other signal, say 533 c/s. In spite of this the 533-c/s note sounds about as loud as the 100 c/s, because the ear is so much more sensitive at the higher frequency. At first each signal can be heard as a clear pure note, as it was when alone. But at a certain setting of the main volume control a roughness of tone becomes noticeable; and at a still higher setting the higher note becomes indistinguishable, the whole output degenerating into a harsh rattling kind of hum.

If now the 100 c/s is switched off, the 533-c/s note is heard with perfect clarity. That is only to be expected, because it is weak enough to be well below the point of serious distortion. What might not be expected however is that when the 533 c/s is switched off the 100 c/s becomes quite clear and altogether different from its sound when both signals are on. This is so, notwithstanding that switching the 533 c/s off reduces the output power by only 1%, which by itself is not enough to make an appreciable difference to the amount of distortion. An increase of much more than 1% in the power of the 100 c/s alone has no such devastating effect as switching on the weak 533 c/s.

### Intermodulation

The obvious conclusion is that some kind of distortion is taking place when both signals are being handled together by the amplifier which is not present with only one. Here again we come to a well-worn chapter in radio theory, of which Fig. 4 should be sufficient reminder. (a) is the undistorted two-signal input, and (b), assuming distortion of the kind shown in Fig. 2, is the distorted output. At the positive peaks of the "strong-low" signal the "weak-high" signal is

\* "Debunk'ng Harmonic Distortion."

amplified more than at the working point O, and at the negative peaks it is amplified less. So the weak signal is amplitude-modulated at the frequency of the strong. This can be seen more clearly if the strong signal is taken away (c). The said chapter of radio theory explains how this process introduces new frequencies, not necessarily multiples of either of the input frequencies, but "sum and difference frequencies." The Fig. 2 kind of characteristic, which creates mainly second-harmonic distortion of the low-frequency signal ( $f_1$ , say) causes the high-frequency signal ( $f_2$ ) to wax and wane once per low-frequency cycle, and the frequencies created by modulation are mainly  $f_1 \pm f_2$ , known as the simple sum and difference or second-order intermodulation frequencies. In our experiment they would be  $533 \pm 100 = 433$  and  $633$  c/s.

This distortion is the kind that one gets with a triode output valve, and which a push-pull circuit is used to balance out. If a pentode is used, or the push-pull system is over-driven, both positive and negative peaks tend to be affected in the same way. The result is that the third harmonic is the strongest, and third-order modulation frequencies,  $f_1 \pm 2f_2$ , 333 and 733 c/s in our experiment.

Generally distortion consists of a mixture of second and third, with smaller proportions of higher numbers, but most practical cases fall into one of two main classes, in which either second or third predominates.

### Obvious ?

So far we have talked about the 100 c/s modulating the 533 c/s, but not the other way about. Why? Well, if one man fought another ten times as strong he might inflict something on him, but it would usually be negligible compared with what he received. In

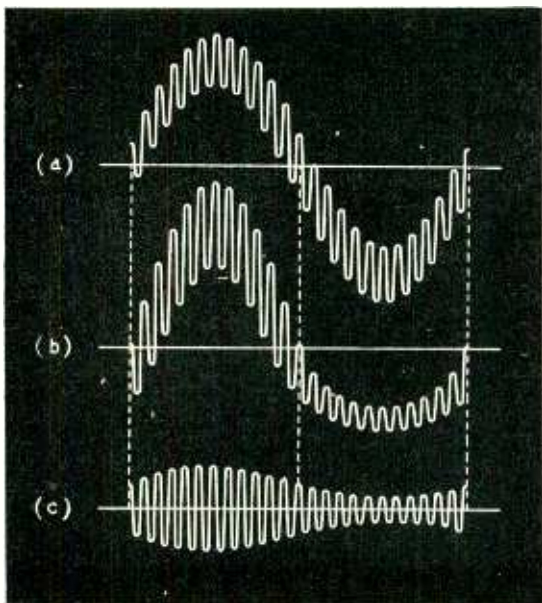


Fig. 4. When a higher-frequency but weaker sine-wave tone is added to the low-frequency signal at the input, the waveform of the combination is as at (a). After suffering distortion of the Fig. 2(a) type it comes out like (b), and by taking away the low frequency the damage to the higher frequency can be seen more clearly (c).

the same way we have neglected the modulation of the strong signal by the weak, though it does exist and is why the process is called *intermodulation*. When two signals going through the mill together are equally strong, each modulates as much as it is modulated.

I said that the experiment made it obvious that intermodulation, not harmonic distortion, is responsible for nearly all the unpleasantness. That conclusion can hardly be doubted so far as the particular conditions of the experiment are concerned. But it is always risky to draw quick conclusions about the connections between physical causes and the resulting impressions on the senses. If a physical force acts on a lifeless object, the effect conforms to a simple equation covering all such events. But the impressions a human being receives as a result of physical causes often seem to bear no predictable or clear relation to them. A race of stone deaf men, though they might master the science of physical sound, could never discover what it was like to hear. Even where there does at first seem to be a clear connection, it may be misleading. For instance, it might seem definite enough that the higher the frequency of a sound the higher the pitch of what is heard. But even there it is not safe to assume that the two things run perfectly parallel, for it is found that the pitch of a note of constant frequency varies slightly with its intensity.

Still less safe is it to draw hard and fast conclusions about the relationship between unpleasantness of sound and the distortion that causes it. Our particular "obvious" conclusion—that intermodulation accounts for nearly all the unpleasantness caused by non-linearity distortion—when I expressed it in 1938 was immediately challenged. And it certainly is unwise to draw such a sweeping conclusion on the basis of one simple experiment. Does it hold for all different combinations of frequencies? And does it hold for typical programmes?

One typical programme is speaking. But speech is an extremely difficult type of sound to study for unpleasantness. Music is much easier, so we shall assume music is our staple diet of listening (whether as the food of love or not is unimportant just now). There do seem to be some clear-cut rules about combinations of musical sounds. One of them is this: that the smaller the whole numbers in which the ratio of the frequencies of two sounds can be expressed, the more harmonious the combination appears to the listener. To take one extreme, the ratio with the smallest possible numbers is 1:1, which means that both sounds have the same frequency, so are heard as one sound, without any disharmony or indeed any distinction at all between them (assuming, of course, that they are coming from the same source). The next simplest ratio is 2:1, which means that the frequency of one note is twice that of the other. Musicians say that it is an octave higher. Although of course the two notes are easily distinguishable when heard separately, they blend so smoothly together that most untrained listeners are unaware that more than one note is being played. People are said to be singing in unison even though the women are singing all their notes twice the frequency of the men. This being so, it should be pretty safe to say that even 100% second-harmonic distortion, if it consisted only of the creation of second-harmonic or octave-higher frequencies, could not cause harshness in the sound. It would certainly make the music sound "brighter" and as this would be different from the original it would have to be classed as "distorted," though to

some ears it might be considered an improvement. The effect on a single sustained note can easily be tried if one has two a.f. signal generators that can be synchronized an octave apart and the higher one brought up from zero level. The effect is identical with that obtained with a single note through an amplifier which can be made to give pure second-harmonic distortion. The same effect on real music can be produced in organs, by bringing in a coupler that adds octaves to all the notes played. This is *not* the same, however, as playing the music through the distorting amplifier, because that adds difference tones as well.

And that, of course, is the crux of the whole matter. But before going into it, let us continue a little longer with our lesson in the theory of harmony. As a non-musician I shall have to be careful; but, on the other hand, musicians themselves seem quite unable to talk our language of frequencies, etc., so fail to tell us clearly what we want to know.

The next simplest ratio might be said to be 3:1. But in music the scale starts all over again at the end of an octave, and so a note 3 times the frequency of another may be regarded as  $1\frac{1}{2}$  times the note an octave higher; consequently our next ratio is really  $1\frac{1}{2}$  or 3:2. And the musicians would agree, I think, that this is the next most important "interval" to the octave, by virtue of which they name it the dominant. The original (lower) note they call the tonic, by the way. And when tonic and dominant are played together, we are conscious of hearing something more complicated than a single note, or even the "brightened" note made up of the 2:1 combination; yet it is undoubtedly "in tune" and harmonious. So is a 3:1 combination, such as a fundamental and third harmonic, because the harmonic lies in this "dominant" relationship to an octave higher than the fundamental, which as we have seen (or rather heard) is almost equivalent to the fundamental.

### Harmonics and Harmony

It would seem, then, that the creation of third harmonics would by itself introduce no harshness or discord, nor perhaps even unpleasantness except to the musical connoisseur who would resent unison passages for flutes being given a harmonic accompaniment. The general effect would be to make the balance of tone still "brighter" and also somewhat "richer" by the addition of the new harmonics. "Nasal" is a description that is sometimes used to refer to the double effect.

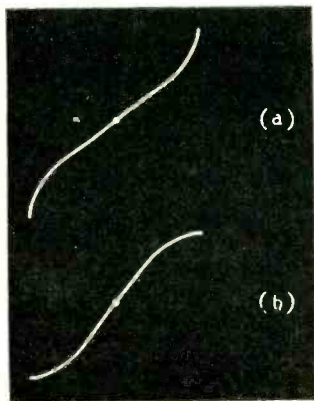


Fig. 5. Here, for comparison with the square-law characteristic of the triode, shown in Fig. 2 (a), are two varieties of the cube-law characteristic, typical of pentode valves and iron-cored coils.

Fourth harmonics are two octaves higher than the fundamental, and as regards harmony are therefore less conspicuous than third harmonics. The only serious effect would be if they were strong enough to make the music sound two octaves higher than it was supposed to be, but in practice this would hardly be so. Any distortion that produces fourth harmonic also produces much stronger second harmonic.

A similar principle holds with the odd harmonics; fifth is accompanied by much stronger third. But how do we expect the fifth to sound in relation to the fundamental? Relative to two octaves above the fundamental, its ratio is 5:4. And I think the musicians would still be with us if we declared that this

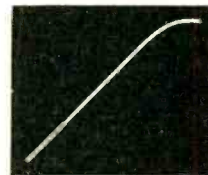


Fig. 6. When the characteristic has a sudden bend, like this, the higher harmonics are created at appreciable strength.

is the next easiest on the ear, after octave and dominant. Sol-fa practitioners identify it as "me" above "doh." If all four notes we have now considered are played together—doh, me, soh, doh—the combination is still harmonious and pleasant. It is, in fact, the "common chord." But I suspect that a musician would consider it a bit thick, in more senses than one, if every single note of his composition were replaced by this four-note combination; which is virtually what would happen if all harmonics up to and including the fifth were added. However, although it would not be a faithful reproduction of the composer's intentions, the non-musical hi-fi expert, without being able to compare it with the original, might (I suggest) be unable to recognize it as "distortion" in his sense of the word.

And so we could go on. Sixth harmonics are like thirds except for being an octave higher. But when we come to the seventh, the ratio to the next lower octave above the fundamental is 7:4. According to my untutored reckoning, this is B flat in relation to C. I don't know how it is rated by the musicians, but it sounds pretty discordant to me, even though my musical taste tends towards the modern. The eighth harmonic is three octaves above the fundamental, so may sound rather squeaky but certainly not discordant. The ninth, which after deducting the whole octaves is like sounding "doh" and "ray" together, is aggressively discordant. As we go higher up the series of *odd* harmonics the numerical ratio becomes more awkward and the musical sound more discordant. The even harmonics are not quite so, because the number can be simplified by dividing by 2, perhaps more than once, and that is musically equivalent to the interval of an octave, which harmonically hardly counts. Take the 12th harmonic; in relation to two octaves above the fundamental its ratio is 12:4, which simplifies to 3:2, and that, as we have seen, is a very easy harmony. But the 14th can only be simplified to 7:1, so it is the lowest discordant even harmonic.

What decides which harmonics are produced, and how much? As one can find out by making the same sort of comparison as Fig. 2 with Fig. 3, using different input/output (or "transfer") characteristics, (Continued on page 195)



or, more elegantly, by mathematics,\* it is the shape of the transfer characteristic that is responsible. The two most important are the square-law, with its smooth one-way bend shown in Fig. 2, which produces second harmonic, and the cube-law, with its S bend (but still smooth) shown in Fig. 5, which produces third harmonic. The sharper and more irregular the bends, the higher the harmonics created. The characteristics of valves worked under reasonable conditions are usually one or other of the first two (though less exaggerated) or a combination of both, and harmonics are therefore nearly all second or third or both. And we have seen that these are not in the least discordant. But if a valve runs into grid current at the signal peaks, or for any other

\* See "Relationships between Amplitudes of Harmonics and Intermodulation Frequencies," by M. V. Callendar and S. Matthews, in *Electronic Engineering*, June, 1951, p. 230, where the results are conveniently tabulated.

reason has a characteristic with an abrupt corner, such as Fig. 6, the resulting harmonics are distributed well up the scale, including perhaps appreciable amounts of the discordant numbers. Incidentally, a practical way of seeing the shape of the transfer characteristic of an amplifier is to connect the input voltage across the X plates of an oscilloscope and the output voltage (phase-shifted if necessary to close the loop) across the Y plates.

It seems that unless the characteristic is so unsuitable that it brings in at least the seventh among the odd harmonics and the 14th in the even series, there should at any rate be no harshness, if harmonics were all that happened. However, there are intermodulation products to be reckoned with. And I am afraid that if we started to reckon with them at all seriously just now it would take up too much space. We shall have to put it off until next month.

# Output Transformer Design

*For Amplifiers Employing Negative Feedback*

By R. F. GIBSON\*

**I**T is relatively easy to design a feedback amplifier with a flat response and good inherent stability to cover a range of 9 octaves. It becomes increasingly difficult, however, as the range is extended another one or two octaves, largely owing to instability troubles caused by the output transformer.

The basic requirements for a.f. transformers for use with negative feedback amplifiers, providing low-distortion power outputs, are well known but may be briefly recapitulated as follows:—

High primary inductance.

Low primary/secondary leakage inductance.

High-frequency resonance at a frequency where the loop gain of the feedback section of amplifier is less than unity.

Some additional considerations of practical importance are:—

Economical design.

Adequate electrical insulation.

Suitable choice of core material.

Moderate  $I^2R$  losses.

Consideration of these requirements will show that the design features must effect as good a compromise as possible between several conflicting requirements, e.g., high primary inductance means a large number of primary turns which necessitates a large  $I^2R$  loss or a large winding space. A large winding space requires a highly sectionalized winding to keep down leakage inductance. This precludes economical design and increases the difficulty of maintaining adequate electrical insulation.

One way of reducing primary turns is to use a high permeability core material, but this solution is often ruled out on the score of cost.

The ordinary grades of silicon iron have a relatively low distortion coefficient but suffer from the disadvantage of very low permeability at low flux densities. This has a serious disadvantage when considered in relation to feedback amplifiers. Briefly, the very low primary inductance at zero signal level necessitates the amplifier designer using otherwise unnecessarily long time constants in his l.f. couplings to keep away from the  $180^\circ$  phase shift associated with a 12-db slope which would result in low-frequency instability. No doubt many readers will have had painful experience of this trouble.

## Instability

One major cause of h.f. instability is resonance "inside" the range of significant loop gain, resulting in a reversal of feedback polarity within the pass band of the amplifier. This is usually produced by the increased leakage inductance associated with a large number of turns in conjunction with high interwinding capacitances.

The foregoing remarks may appear to give a somewhat gloomy picture of the performance of an output transformer in a high-quality feedback amplifier. Fortunately, it is possible, by careful and adequate design, to obtain a performance which, in fact, leaves little to be desired, and some of the basic requirements of such a design will now be discussed.

1. *Core material*: There appears to be no better material at present available than silicon steel. There are, however, several varieties of this material the relative merits of which will be discussed later.

2. *Winding space to core cross-section ratio*: without going into the mathematics of this problem it may be stated that economic considerations inevitably lead

\* R. F. Gibson, Ltd.

to the choice of a small window to core ratio; this choice also helps considerably in easing the problem of obtaining a high resonant frequency and low leakage inductance.

3. *Efficiency*: Once a small window space has been decided upon it will be found that the weight of copper which can be fitted into it is small and therefore it becomes fairly safe to assume that the  $I^2R$  losses will not be unreasonable, providing the primary wire gauge is large enough to handle the r.m.s. value of standing d.c. plus audio-frequency current without overheating and the  $I^2R$  loss ratio between primary and secondary is reasonably near 1 : 1.

4. *Primary Inductance*: An empirical formula which has been found useful in determining the primary inductance is—

$$L = \frac{R_l \times V\beta}{2 \times 10^3} \dots \dots \dots (1)$$

where  $L$  is in henries,  $R_l$  = anode-to-anode load (ohms) and  $V\beta$  is the feedback voltage ratio. In the case of push-pull EL84's with 26 db feedback,

this works out at  $\frac{8000 \times 20}{2 \times 10^3}$

5. *Flux density*: Again a simplified equation—

$$N = \frac{10^3 \sqrt{WR_l}}{KfA} \dots \dots \dots (2)$$

where  $N$  = number of primary turns,  $W$  = V.A input to primary,  $R_l$  = anode-to-anode load in ohms,  $f$  = frequency of bottom distortion limit,  $A$  = cross sectional area of core (sq. in.) and

$K = \begin{matrix} 1.6 \text{ for intermediate grade} \\ 1.7 \text{ for high grade} \\ 3.3 \text{ for "Unidi" material}^\dagger \\ 3.5 \text{ for "C" cores} \end{matrix} \left. \vphantom{\begin{matrix} 1.6 \\ 1.7 \\ 3.3 \\ 3.5 \end{matrix}} \right\} \text{ laminations}$

This formula gives a practical answer for ratings up to 25W if the core area is in the region of  $\frac{\sqrt{W} \times 30}{(0.5 + K) \times f}$

Empirical data plus a consideration of general requirements will then enable a suitable core to be selected.

Going back to a choice of a suitable core material, we have available, intermediate grade silicon steel, high-grade silicon steel and oriented-grain silicon steel, the last mentioned being available in the form of either laminations or "C" cores. "C" cores are expensive and show only a small advantage over "Unidi" laminations both as regards the coefficient in equation (2) and the primary inductance to  $AN^2$  ratio. Oriented grain material does however show a very marked advantage over the other grades of silicon steel and in the case of laminations is reasonably economical provided that it is obtained in the form of "no waste" E and I laminations.

It now remains to select a core size which can be made to satisfy the requirements of equations (1) and (2) and the clause concerning temperature rise. In the case of a 12-watt transformer using push-pull EL84's, the "no waste" size 4, having a 1in. wide core and a  $1\frac{1}{2}$ in.  $\times$   $\frac{3}{4}$ in. window, fits the requirements when built into a square stack.

The simplest winding arrangement which will provide a level response up to 30 kc/s is as shown in Fig. 1. and this provides a d.c. resistance balanced with respect to  $A_1$  to h.t. and  $A_2$  to h.t. The inter-

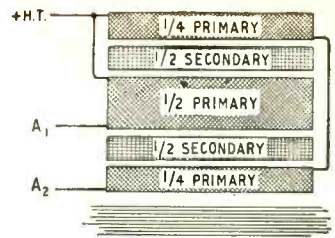


Fig. 1. Simple method of sectionalizing which gives adequate coupling

winding capacities are unbalanced but the overall coupling factor is good enough to take care of this. It should be noted that the winding layout shown is not suitable for a transformer having primary taps for the so-called "ultra-linear" circuit. One way of providing correct screen couplings is to transpose the primary and secondary windings.

Tests carried out on a transformer designed according to the foregoing data show that the expected results are well maintained in practice. The actual readings obtained were:—

Primary d.c. resistance 340Ω; secondary 0.98Ω; leakage inductance 24mH; initial inductance of primary, better than 130 H.

The measured performance is as follows:—  
± 1 db from 25 c/s to 42 kc/s and the distortion limit on a sine wave trace is 28 c/s to 35 kc/s at 12 watts output from secondary, these figures being slightly over 1 octave better than can be obtained on the same size of core with intermediate grade laminations.

## BOOKS RECEIVED

**Television**, by V. K. Zworykin, E.E., Ph.D., and G. A. Morton, Ph.D. Revised second edition covering fundamental physical principles, complete systems for monochrome and colour and details of camera and display tubes. Pp. 1037+xv; Figs. 698. Price 40s. Chapman and Hall, 37, Essex Street, London, W.C.2.

**Radio and Television Engineers' Reference Book**. Edited by E. Molloy and W. E. Pannett, A.M.I.E.E. Compendium of descriptive information, data and servicing hints in all branches of radio communication, contributed by 36 specialists. Includes chapters on sound reproduction and distribution, disc and magnetic tape recording. Pp. 1542+xx; Figs. 1117. Price 70s. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2.

**Ibbetson's Electric Wiring**. Edited by C. R. Urwin, A.C.G.I., A.M.I.E.E.; W. F. Parker, M.I.E.E., and F. G. Thompson, M.Sc. (Eng.), A.M.I.E.E. Ninth edition of this textbook of theory and practice for practical wiremen and students. Pp. 296+viii; Figs. 119. Price 11s 6d E. and F. N. Spon, Ltd., 15, Bedford Street, London, W.C.2.

**Fundamentals of Transistors**, by Leonard M. Krugman. Summary of design procedure and formulæ for the principal transistor circuit configurations, with an introductory chapter on basic semi-conductor physics. Pp.140; Figs. 110. Price 21s. Chapman and Hall, 37 Essex Street, London, W.C.2.

**Radar Pocket Book** by R. S. H. Boulding, B.Sc., M.I.E.E. Basic information on radar systems, components and circuits for the use of operators, installation and maintenance engineers. Pp. 176+viii; Figs. 156. Price 15s. George Newnes, Ltd., Southampton Street, London, W.C.2.

<sup>†</sup> Geo. L. Scott and Co., Ltd.

## APRIL MEETINGS

### Institution of Electrical Engineers

London.—April 5th. "High Speed Electronic-Analogue Computing Techniques" by Dr. D. M. MacKay at 5.30.

April 20th. "A Study of the Long-Term Emission Behaviour of an Oxide Cathode Valve" by Dr. G. H. Metson at 5.30.

April 21st. Kelvin lecture "Transistor Physics" by Dr. W. Shockley at 5.30.

April 22nd. Discussion on "Technical Training in North-West Germany" opened by Dr. K. R. Sturley at 6.0.

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

**Mersey and North Wales Centre.**—April 4th. Annual general meeting followed by "Special Effects for Television Studio Productions" by A. M. Spooner and T. Worswick at 6.30 at the Liverpool Royal Institution, Colquitt Street.

**North-Eastern Radio and Measurements Group.**—April 4th. Annual general meeting followed by "Thermionic Valves of Improved Quality for Government and Industrial Purposes" by E. G. Rowe, P. Welch and W. W. Wright at 6.15 at King's College, Newcastle-upon-Tyne.

**Northern Ireland Centre.**—April 5th. Faraday lecture "Courier to Carrier in Communications" by T. B. D. Terroni at 8.0 at the Sir William Whitla Hall, Queen's University, Belfast.

**South Midland Radio Group.**—April 25th. Annual general meeting followed by "A Transatlantic Telephone Cable" by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey at 6.0 at the James Watt Memorial Institute, Great Charles Street, Birmingham.

**Southern Centre.**—April 1st. "Cold Cathode Valves" by J. R. Acton at 6.30 at the South Dorset Technical College, Weymouth.

### British Sound Recording Association

London.—April 22nd. "Romance and History of the Gramophone" by P. Wilson at 7.0 at the Royal Society of Arts, John Adam Street, W.C.2.

**Portsmouth Centre.**—April 13th. "Tape Recording, 1948-1955" by C. Hardy at 7.15 at the Central Library, Guildhall, Portsmouth.

**South-Western Centre.**—April 13th. "High Fidelity" by P. D. Collings-Wells (Goodmans) at 7.45 at Callard's Café, Torquay.

### Television Society

London.—April 1st. "A Flying-spot (Mechau) Telecine System" by J. L. Bliss (B.B.C.) at 7.0 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, W.C.2.

April 21st. "Progress in Colour Television" by L. C. Jesty (Marconi's) at 7.0 at the C.E.A., 164, Shaftesbury Avenue, W.C.2.

**North-Western Centre.**—April 27th. "Progress in Colour Television" by L. C. Jesty (Marconi's) at 7.30 at the College of Technology, Manchester.

### Society of Instrument Technology

London.—April 26th. "Magnetic Amplifiers as Industrial and Laboratory Aids" by R. J. Russell-Bates at 7.0 at Manson House, Portland Place, W.1.

**Newcastle Section.**—April 20th. "Electronic Computers" by A. St. Johnston (Elliott Bros.) at 7.0 at Stephenson Building, King's College, Newcastle-upon-Tyne.

### British Institution of Radio Engineers

London Section.—April 13th. Discussion on "The B.B.C. v.h.f. Frequency-Modulated Sound Broadcasting Service" opened by Dr. K. R. Sturley and F. T. Lett at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

April 27th. "Suppressed Aerials for the Aircraft h.f. Band" by K. J. Coppin at 6.30 at the London School of Hygiene and Tropical Medicine.

**North-Eastern Section.**—April 13th. Annual general meeting and "The Manchester University Universal Computer" by E. T. Warburton at 6.0 at Neville Hall, Westgate Road, Newcastle-upon-Tyne.

**South Wales Section.**—April 27th. "Some Technical Problems in Sound and Television Broadcasting" by Dr. K. R. Sturley at 6.30 at the Glamorgan Technical College, Treforest.

**Scottish Section.**—April 14th. An evening of films with an exhibition of electronic apparatus at 7.0 at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

### Physical Society

**Acoustics Group.**—April 22nd. "Sound Absorption in Porous Structures and Suspensions" by Professor R. Morse at 5.30 at Imperial College, London, S.W.7.

### Incorporated Practical Radio Engineers

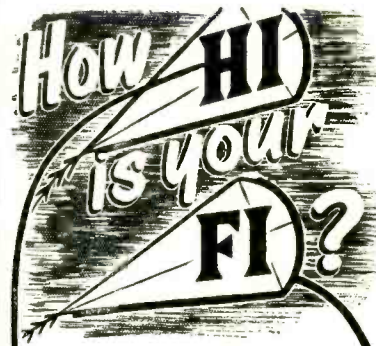
**Midlands Section.**—April 6th. "Projection Television" by R. Lightwood (Phillips) at 7.30 at the Crown Hotel, Broad Street, Birmingham.

## SERVICING EXAMS

REPORTING on last year's servicing examinations organized by the Radio Trades Examination Board and the City & Guilds, the examiners draw attention to the "lack of knowledge of basic principles as they affect servicing." In the intermediate exam. for radio service work (C. & G.) only 129 (19%) of the 659 home candidates obtained a first-class pass and 241 (36%) second-class passes. Of the 244 overseas candidates only six obtained first-class passes and 63 a second-class pass.

Of the 370 candidates who sat for the R.T.E.B. Radio Servicing Certificate examination 144 passed and 96 have to re-enter for the practical test. The many failures in the practical test were said to be due to two main reasons: (1) incorrectly connecting a coaxial cable and (2) dry joints. Incidentally failure in the soldering test fails the candidate in the whole of the practical examination.

Only 104 candidates entered for the R.T.E.B. Television Servicing Certificate exam. Fifty-five passed and 20 have to retake the practical test. Summarizing the results of this examination the examiners state that considering it is the final in the servicing series conducted by the R.T.E.B. the standard of work was not very high.



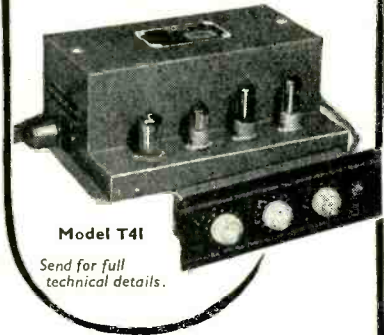
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### STOP PRESS!

Extract from MONTREAL STAR, February 5, 1955. Review of MONTREAL RADIO FAIR

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By "DIALLIST"

## Is "Piping" the Solution?

THE B.B.C.'s scheme for country-wide f.m. transmissions may eventually provide us with interference-free-broadcast reception; but I see no similar way in sight of dealing with the problem of TV interference. Unless some means can be found of suppressing at the source the many different kinds of interference I'm inclined to believe that the only way out is to establish master receiving stations at sites remote from roads, factories, overhead power lines and so on, and to "pipe" the signal to viewers' homes. This is already being done, of course, in quite a number of the larger towns, and it is proving to be a very successful method. I don't see that either manufacturers or dealers need be afraid of it. Were piped TV more generally available, there's no doubt that there'd be a big jump in the number of licences taken out; and that would mean good business. What I have in mind is something like this. The company owning the master receiving station simply delivers a signal of guaranteed quality and strength to the customer's house in return for a weekly or monthly fee. The customer buys the receiver of his choice from his dealer, who installs and subsequently services it. As E. J. Gargini showed in his "Piped Scanning Waveforms" in the February issue of *W.W.*, the receiver can be a very simple affair, which should be much cheaper than the normal set. And that might be the key to the production of receivers of really excellent performance at "popular" prices.

## Putting Up With It

IT'S surprising that non-technical owners of television receivers should so often be content with very poor pictures. A few evenings before this was written I dropped in on some nearby friends and found them looking-in. The very first thing that hit me in the eye was a prominent light vertical line. Yes, the set was ringing heartily; and every dark object had an additional white outline. But that wasn't all: there were dark horizontal bars due to sound-on-vision. They were obviously so delighted with the set's performance that I just hadn't the heart to suggest that anything was amiss. I don't think they even noticed the effects

that shouldn't have been there. Again, I remember seeing in the house of other friends a picture in which everything near the top had a pronounced bend to the left. "It's always been like that," said my host; "but we've got used to it and it doesn't worry us as a rule." He seemed to think that it was just one of those things and was surprised when I told him that any competent service man should be able to put it right without spending much time on the job.

## Indoor Aerial Oddities

WHAT queer effects indoor aerials can produce when used for either sound or television reception. In one room of my home there's a broadcast receiver served by a wire running along the picture rail. Just occasionally it picks up telephone conversations between my house and another not far away. Sometimes, again, there is a noticeable change in the volume when a light in another room is switched on or off, due probably to pick-up and re-radiation by part of the electric wiring. As for indoor aerials for television, there's no saying what they *won't* do. In one house that I know reception is quite good with the aerial in one precise position;

but move it a mere six inches to right or left and both sound and picture almost disappear. The queerest case I've ever come across was that of a building in which the only place an indoor aerial would pick up an adequate signal was the basement. One firm which makes vast quantities of indoor and outdoor TV aerials tell me that they've had more than one similar case.

## Expensive Switching

EVERY TV receiver instruction book ought to contain a warning about the risks taken when a set is switched off and then switched on again before it's had time to cool down. I expect you know people who do it quite often because they've found that it's one way of clearing certain intermittent faults for the time being. If it's switched on when still well warmed up, the set gets the father and mother of an electrical kick in the neck, for the conditions which normally ensure a more-or-less gradual build-up of heater and other voltages are absent.

## The Intermittent Fault

THERE must, I suppose, have been more naughty words used over intermittent faults than over any other shortcomings of broadcast receivers. The most evil of all kinds is that which clears itself so quickly that you've no time to poke round with measuring instruments or an oscilloscope before it's gone. The best



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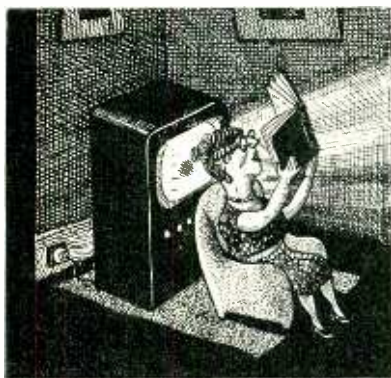
Obtainable from all leading booksellers or from

ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1.

hope in such cases is to think out from the symptoms the only parts of the set in which there could be a fault and to go through them with a fine-toothed comb. As a desperate measure the substitution, one at a time, of components which might be guilty may be tried. The intermittent fault which occurs when the set has warmed up and stays in evidence until it is cooler is less maddening to deal with, though I'm not going to suggest that locating it is always easy. Eliminating, as before, the places where it could not be, you narrow down the field of search and, if you're lucky, you have a good chance of pinning it down sooner or later—it'll probably be later rather than sooner, if my experience goes for anything!

### Alternative TV

VIEWERS in the London and Sutton Coldfield areas have a respectable chance of discovering whether or not they're likely to be able to receive the alternative television programmes, and, if reception seems probable, of discovering what sort of Band III aerial will be needed. A test-signal (of low power, admittedly, but still a test-signal) is going out fairly regularly on 180.4 Mc/s from Sutton Coldfield and, from April 1st, on 194.75 Mc/s from the temporary transmitter set up by Belling & Lee in South London. Much less fortunate are those who live in the north. The only thing the I.T.A. seems so far to have decided for that area is that it isn't going to use the Holme Moss aerial mast. It seems likely that there will be two transmitters, one for the eastern and one for the western part of the area; but where they're going to be hasn't been decided at the time of writing.



"I think we need a new tube, George."

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| L.E.S.14  | 2 x .116" ø @<br>1/16" crs., starting<br>1/8" from Socket<br>centre |
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### LILLIPUT SIGNAL-LAMPS

Designed to accept M.E.S.-cap bulbs (made by Hivac, Philips, Vitality) this compact fitting is ideal for incorporation in equipment where space is at a premium, or in a miniature apparatus. List No. D.675/1 has choice of 5 different translucent lenses, while L.E.S.1/1 has no lens-cap. Full details in Catalogue 194/WW, price 1/- post free.



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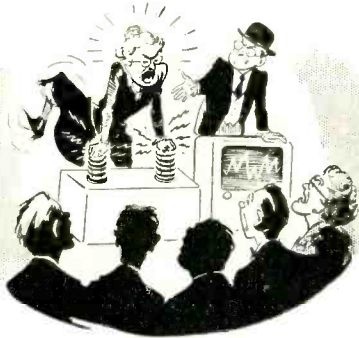
# UNBIASED

By FREE GRID

## Static or Kinetic?

WITH the example of George Washington ever before them, the Americans have always been such sticklers for truth that I cannot imagine how they ever came to use such a misnomer as the word "static" to describe what we always call atmospherics—or Xs if we belong to the older generation.

Surely if the electrical energy—



Certainly not static

be it natural or man-made—which causes noises in our loudspeakers and snowstorms on our television screens were indeed really static or motionless it would cause no trouble. This can quite easily be proved by standing a fully charged capacitor near a sensitive receiver.

This potential energy or static will cause no trouble no matter how great the capacitance of its container or how high the voltage of the charge. But if you convert it to kinetic energy by inviting your mother-in-law to bridge its terminals with her hands you will at once get all the trouble you can cope with, as I once proved to my own satisfaction. Surely then we should speak of man-made kinetic rather than static?

## Connoisseur's Corner

MOST people who have met female film stars face to face after having been accustomed to seeing them on the screen are conscious of bitter disappointment. The reason is that these glamour girls when seen in the flesh don't possess anything that is particularly attention-compelling to distinguish them from their fellow females. In other words, the screen reproduction is a lot better than the original, or at any rate seems so. To use the modern jargon, the operative word here is "seems," for our critical faculties are so drugged by constantly looking at them on the screen that we grow to prefer all

the shallow artificiality there portrayed.

My analogy is not a very good one, I'm afraid, but I find that much the same sort of thing happens when I ask people to listen to my high-fidelity receiver. It is as near perfect in its reproduction as it is possible to get and yet people are so used to the false tones—if that be the correct expression—imparted to speech and music by their ordinary sets that mine sounds disappointing. They are, as it were, drugged by constantly listening to indifferent reproduction and are thus like a confirmed toper who is unable to appreciate the delicate quality of a vintage port when it is set before him.

It looks, therefore, as though people need to be broken in gradually to high quality. I wonder if it would not be advisable for manufacturers to market hi-fi/lo-fi receivers in an effort to raise the rabble to real radio reproduction. A two-way switch should be fitted so that in the "lowbrow" position it would connect a fat capacitor across the loudspeaker and give the musical masses the mellow bellow they have been drugged to love.

## Who'll Take My Money?

NOW that one of our largest recording companies has decided to issue tape records side by side with the conventional disc type I suppose we can look forward to the eventual appearance of radiograms and playing desks fitted with the necessary additional gear. We already have three speeds for discs and it is to be hoped that similar complications will be avoided in tape records.

I shall welcome the appearance of these "tapeograms" as I think it may prove the thin end of the wedge, the other end of which will be the coming of "all-in" 'grams able to record B.B.C. programmes for consumption when desired. At present we have to instal such equipment in untidy bits and pieces.

I am still bothered about the ethics of recording broadcast programmes despite the recent assurances of the Editor regarding the legality. I personally would be willing to pay a small fee to the composers, starving in their miserable garrets, but who'll take my money?

I put this question to some G.P.O. representatives recently when they spent the evening outside my house in one of the new TV detector vans. All I received was a suspicious stare from one of them as he licked his pencil and continued designing an

attenuator from the formulæ given in the reference section of his 1955 W.W. Diary.

## The Curse of Kissing

KISSING is not the sort of thing which one associates with doctors as there can scarcely be a more potent carrier of infection. I was, therefore, somewhat surprised to hear a doctor discuss the matter in a recent B.B.C. talk.

The only thing that interested me in the doctor's talk was his statement that he knew a married couple who caused an electric spark to jump from one to the other each time they kissed. Apparently this is not an isolated phenomenon, for when this statement was published in the Press several letters subsequently appeared which showed it to be quite common.

Quite frankly, however, I was still unconvinced and determined to investigate the matter myself; not by personal experiment—ugh!—but by going to places where couples congregate and taking with me a sensitive portable receiver. No sooner had I slipped on my headphones in the local cinema and switched on than I was startled by a truly appalling spate of interference. From my seat I could see in the dim light several offenders whose osculatory efforts coincided with the bursts of Xs in my phones.

On my way home I took a short cut through the local park and I soon found out the value of the d.f. properties of the frame aerial and had no difficulty in locating my



Potent kisses

quarry. Can any of you learned legal luminaries tell me if the P.M.G. has the power to make regulations to deal with this menace without further legislation. From a technical point of view I don't think it is possible to suppress this interference unless kissing is only permitted in specially screened apartments.

Model 8  
**20,000 ohms  
 per volt** plus  
**AUTOMATIC Overload  
 Protection**



**£23 : 10s.**

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

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 110 V. 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.

**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.

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



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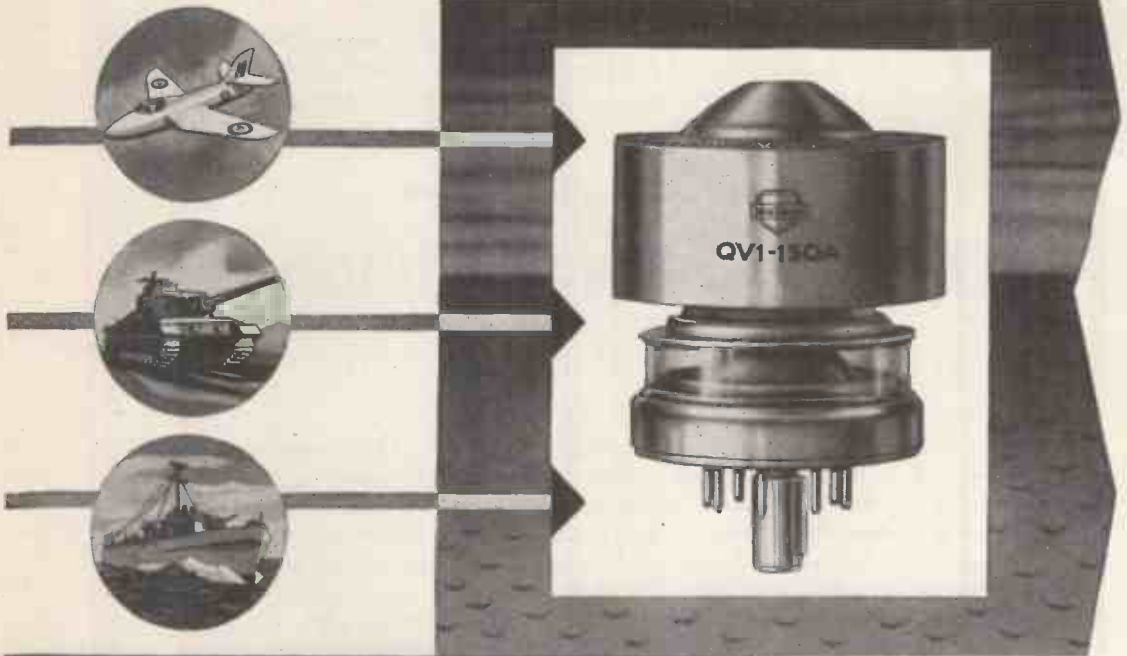
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## QV1-150A POWER TETRODE

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

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

High permissible anode dissipation, high current density and very favourable ratio of mutual con-

ductance to capacitance particularly suit this new tetrode for wide-band applications.

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

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

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

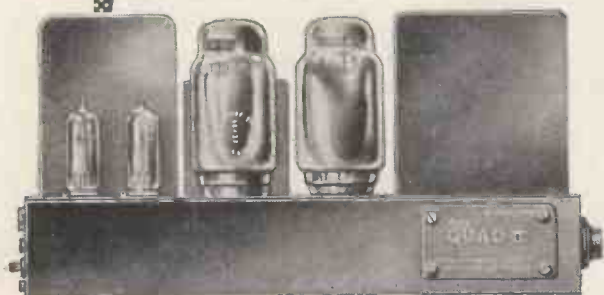
| HEATER |      | LIMITING VALUES |          | BASE |
|--------|------|-----------------|----------|------|
| Vh     | 6.0V | Va max.         | 1.25 kV  | B8F  |
| Ih     | 2.6A | pa max.         | 150 W    |      |
|        |      | Vg2 max.        | 400 V    |      |
|        |      | pg2 max.    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



There are those who consider that there is little to choose in the range of power amplifiers now available—perhaps because the power amplifier is usually considered the “easy” part in the search for audio perfection. Why is it then that leading engineers are so enthusiastic about the QUAD II design?

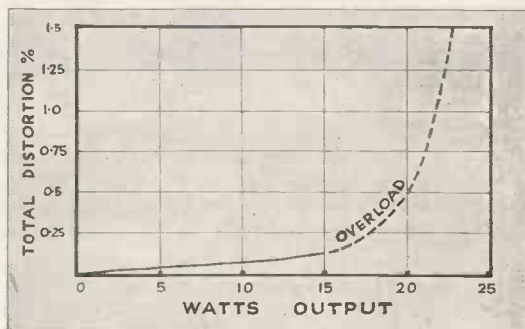
## ... on feedback and linearity

They like the unique integrated feedback to provide complete stability independent of phase changes in the load current . . . the method used for eliminating the loop gain outside the audio range without prejudice to the input signal . . . the way that feedback is again used to provide optimum design stage by stage and to control the effective time constants. They like its use yet again to provide a unique self-balancing phase changer without the usual asymmetry to the H.T. line. They like, too, the fact that the specification is fully met with commercially tested valves without matching or alignment of any kind. They extol the conservative ratings and restoration from overload (several nation-wide broadcasting corporations officially uprate the output to 20 watts, since with this degree of overload, distortion is still well within their acceptance figures).



Good engineering for the best performance\* also results in greater efficiency. Compare the size of the QUAD with any other amplifier of approaching specification. Note the size of the output transformer which results from optimum choice of flux and core material to suit design requirements.

\* The unique output stage design principles are discussed in *Wireless World*, September, 1952.



Linearity and overload of the QUAD II amplifier

The QUAD II power amplifier is primarily designed as part of the complete QUAD II amplifier. The power amplifier is also supplied separately as a quality standard when with a suitable input transformer it can be fed direct from a 600 ohm line.

The QUAD II is available throughout the world. Fully stocked servicing organisations are now operating in Canada, throughout U.S.A., Panama, Canal Zone, Trinidad, Jamaica, Venezuela, Australia, Malaya, Singapore, Japan, Hong Kong, Burma, India, Ceylon, Pakistan, South Africa, Portugal, Italy, France, Switzerland, Belgium, Norway and Sweden.

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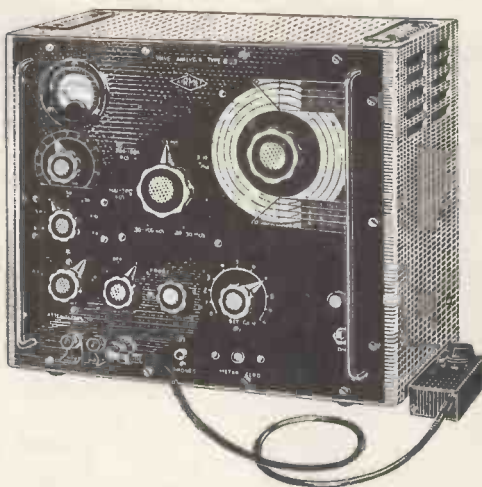
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*(Selective Measuring Set 30 kc/s—30 Mc/s)*

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THIS instrument is a selective measuring set of great versatility operating over the frequency range 30 kc/s—30 Mc/s. It consists essentially of a stable high-gain selective amplifier, operating on the heterodyne principle and incorporating H.F. and L.F. attenuators. The output, in the form of an audio frequency, is applied to a meter circuit and to headphones.



Special features are the high sensitivity (1 microvolt up to 20 Mc/s), wide attenuator range (120 db), high accuracy of attenuation ( $\pm 0.1$  db overall on L.F. attenuator), high selectivity, low noise level and continuous coverage over the whole frequency range.

## SPECIFICATION

**Frequency range:** 30 kc/s—30 Mc/s in 7 ranges.

**Amplitude range:** 30 kc/s—20 Mc/s:  $1\mu\text{V}$  to 120 db above  $1\mu\text{V}$ , 20 Mc/s—30 Mc/s:  $4\mu\text{V}$  to 120 db above  $4\mu\text{V}$ .

**Selectivity:** 3 kc/s bandwidth.

**Harmonic measurement:** 2nd harmonics 70 db down and 3rd harmonics 90 db down can be measured.

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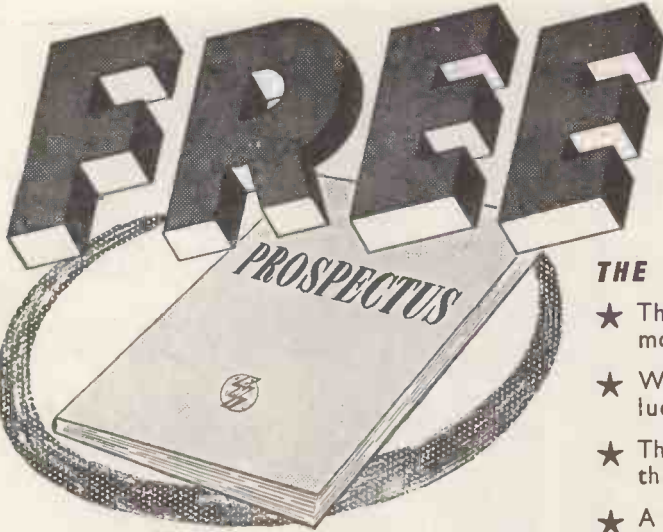
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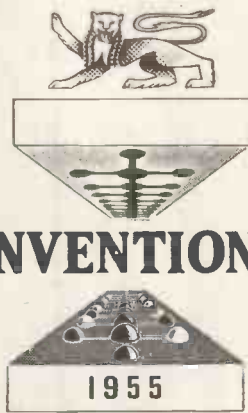
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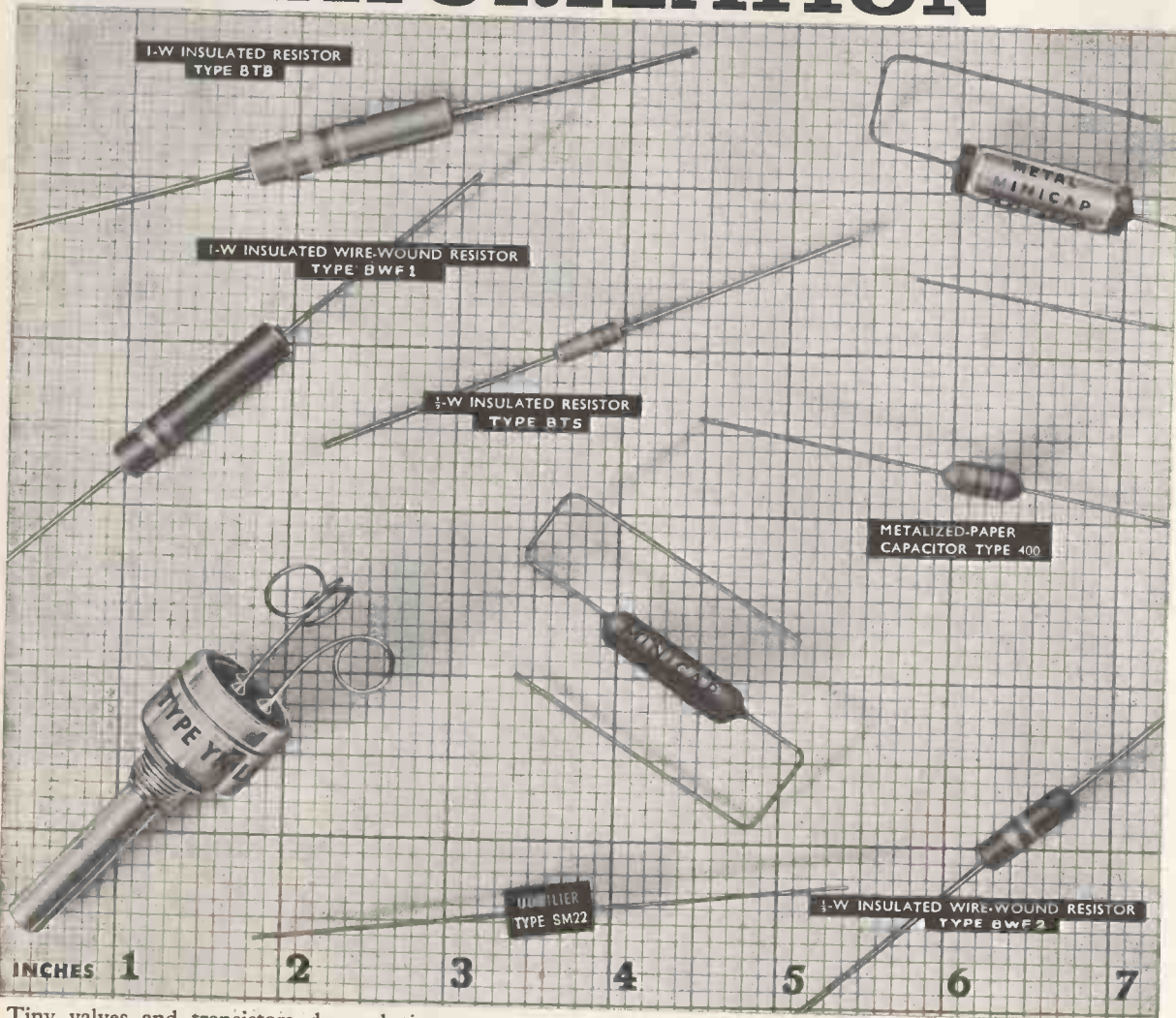
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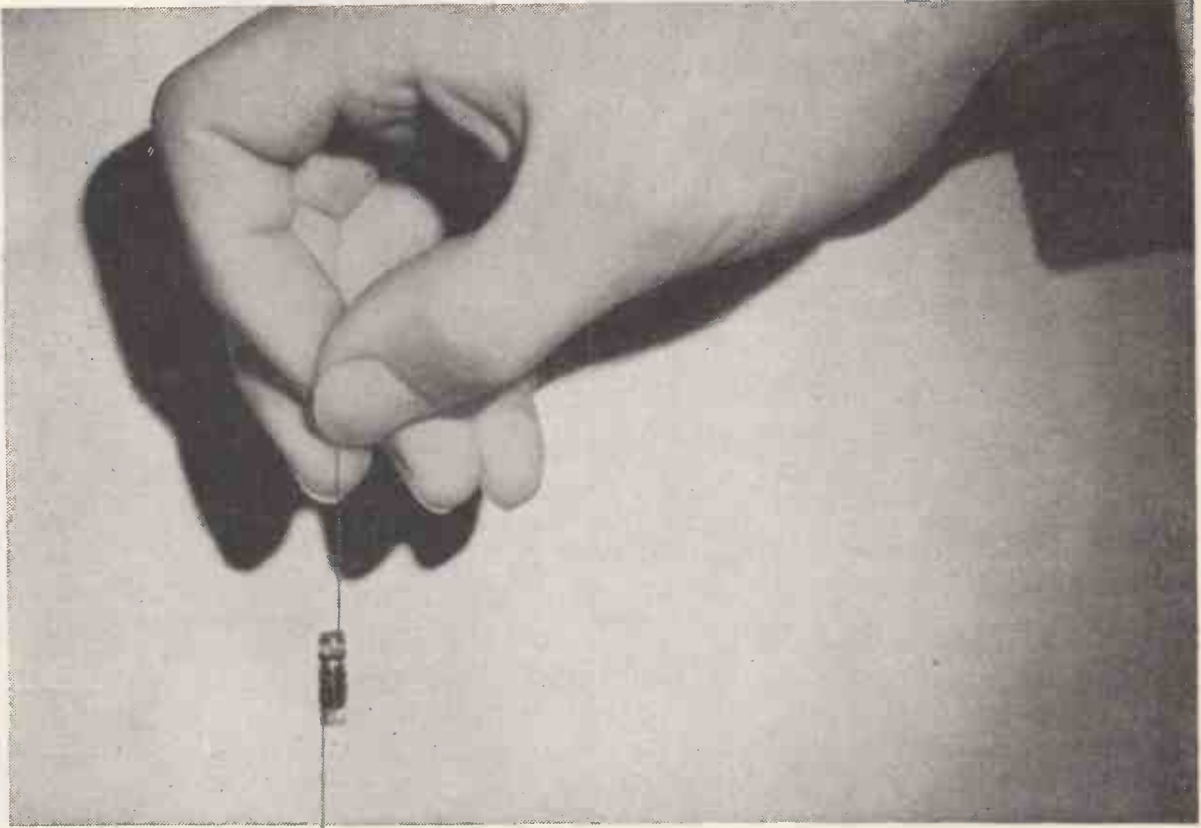
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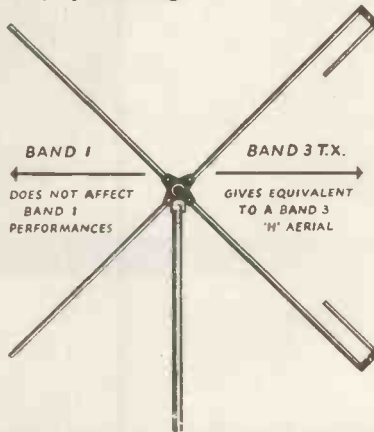
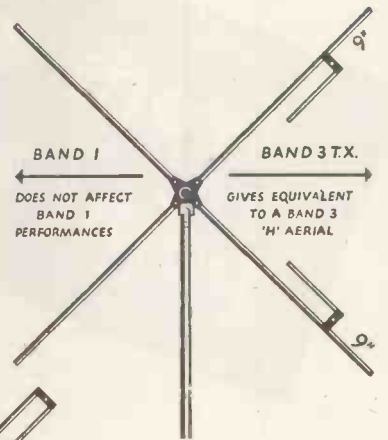


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The above illustration shows the "Antex" array with 2 "Addex" units positioned to receive Channel 1 signals from Band 1 and Band 3 transmitters situated in opposite directions from the receiver.

Right is an illustration of an "Antex" array with 2 "Addex" units fitted at the ends of aerial rods to provide Channel 2 reception for Band 1 and Band 3 transmissions arriving from opposite directions.

STAND No. 56 R.E.C.M.F. EXHIBITION APRIL 19-21

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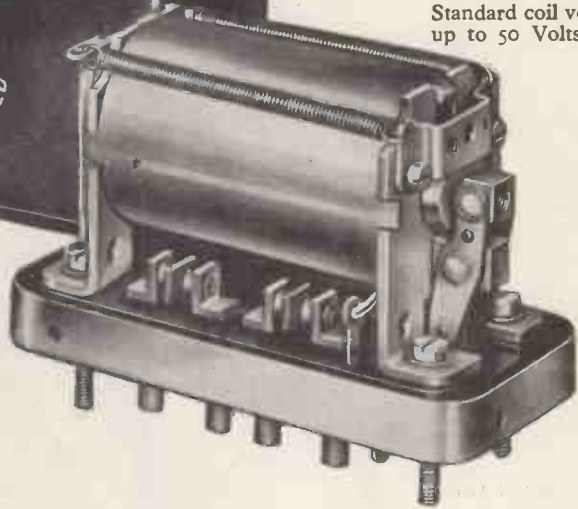
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Standard coil voltages  
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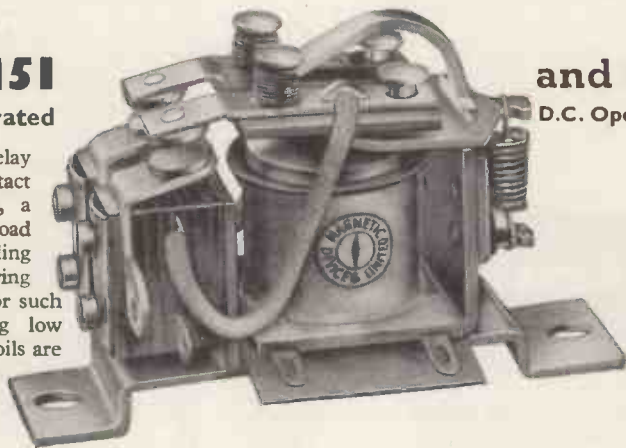


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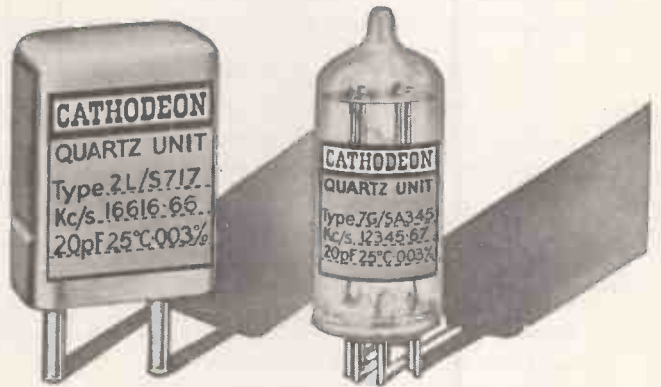
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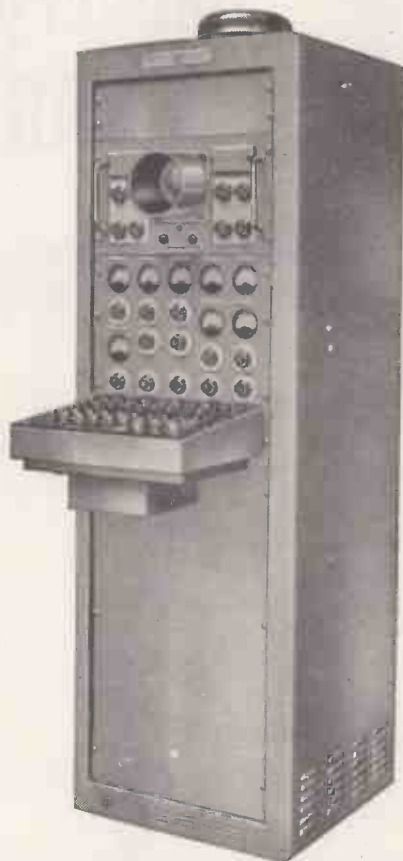
*This equipment displays on a cathode-ray tube a family of  $I_a/V_g$  curves for any receiving type thermionic valve. Eleven curves corresponding to eleven different grid voltages are presented simultaneously and a calibrated graticule permits rapid comparison with published data.*

*Nine standard valve bases are provided, with facilities for connecting others, and the various valve electrodes are connected to the requisite supplies by a multi-button switching board.*

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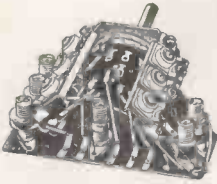
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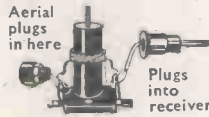
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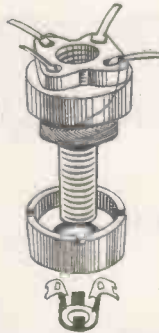
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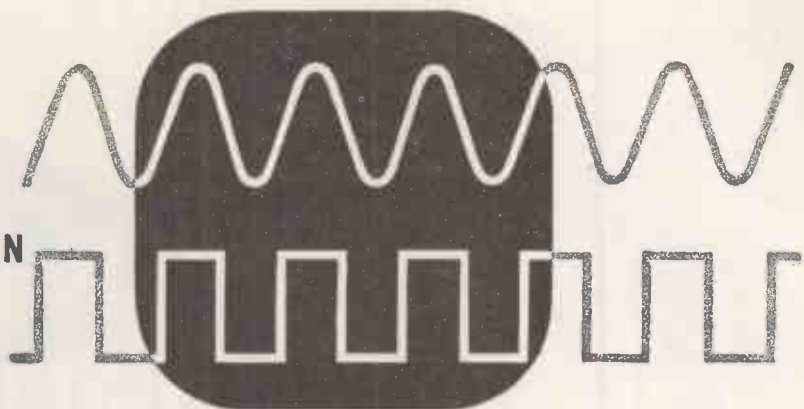
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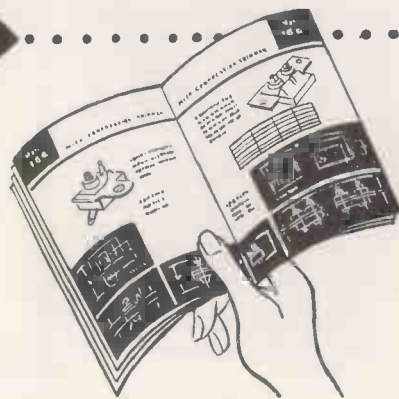
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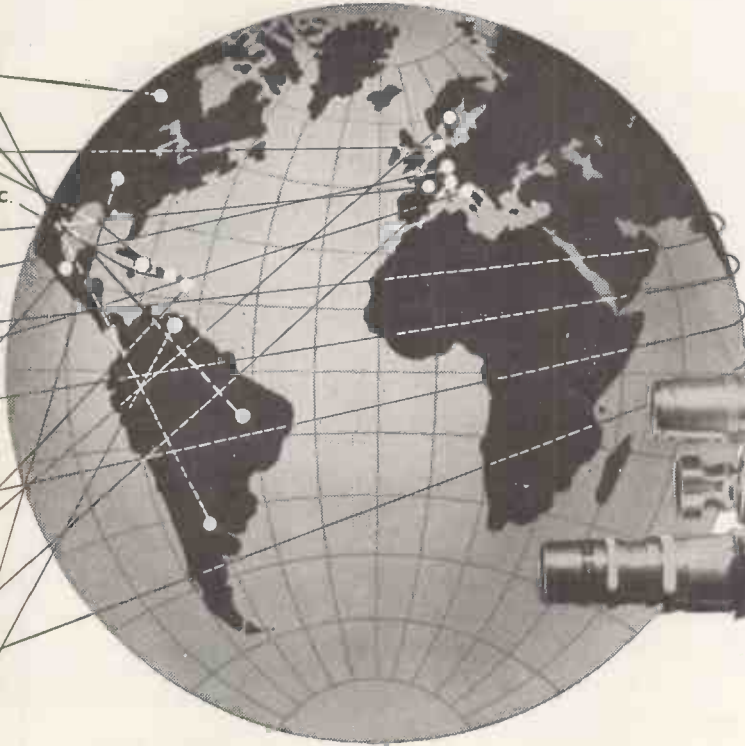
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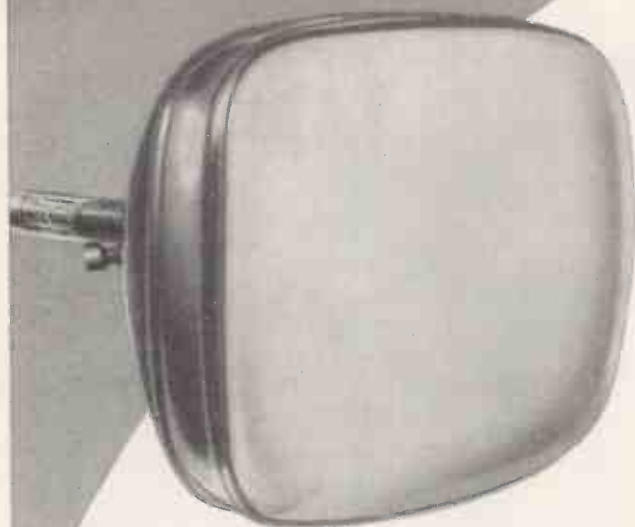
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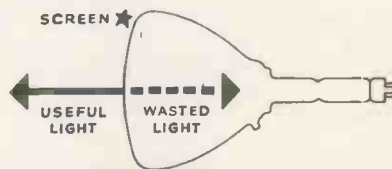
Ediswan production methods, which include the special in-line vacuumizing system, ensure a higher, more uniform standard of lasting efficiency. For complete satisfaction demonstrate and recommend Ediswan Mazda aluminized picture tubes.

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**M A Z D A**

**ALUMINIZED CATHODE RAY TUBES**

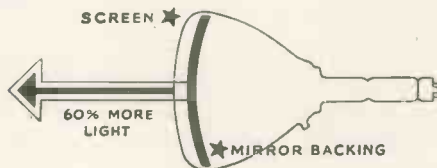
THE EDISON SWAN ELECTRIC COMPANY LIMITED,  
 155 Charing Cross Road, London, W.C.2 and Branches.

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



**WITHOUT ALUMINIZING**

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



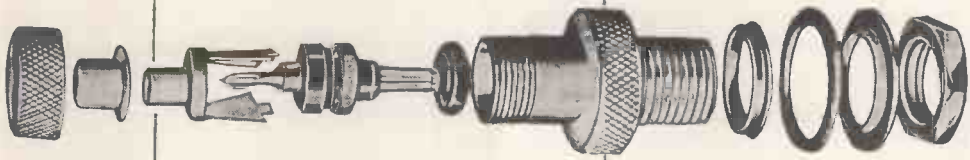
**WITH EDISWAN ALUMINIZING**

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

**NATION WIDE SERVICE**

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

RV9



# MINIATURE

## CO-AXIAL SEALED PLUGS AND SOCKETS

**TYPE APPROVED—  
COMPLYING WITH R.C.S. 322  
PRESSURE SEALED AND  
100% TESTED  
USED WITH UNIRADIO 32  
OR 43 CABLE**



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732561  
732558



732564  
732563



732562  
732559

A.I.D. & A.R.B. - APPROVED

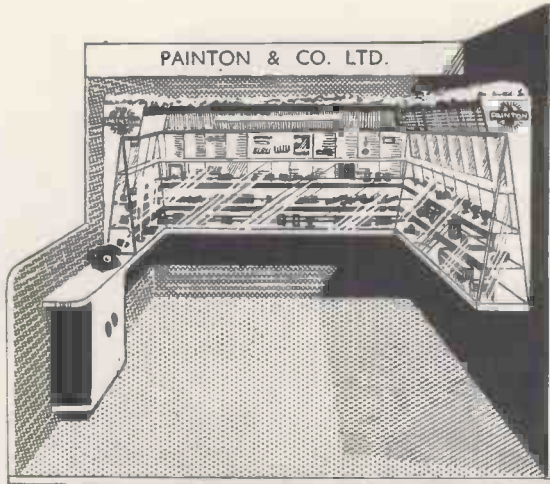
EXNING RD., NEWMARKET

**POWER CONTROLS**  
LIMITED

PHONE: NEW 3181/2/3

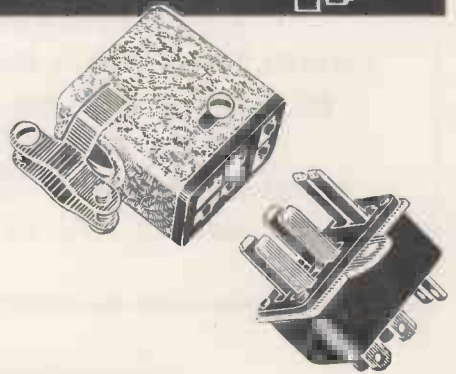
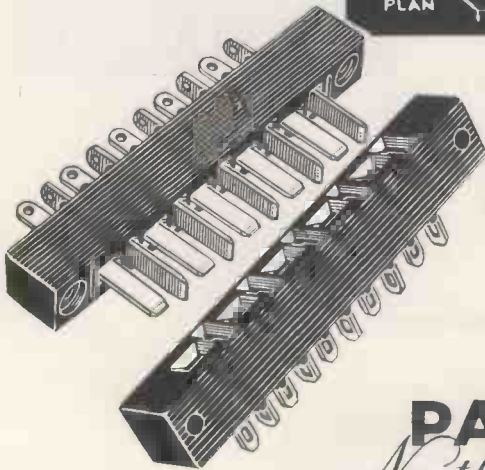
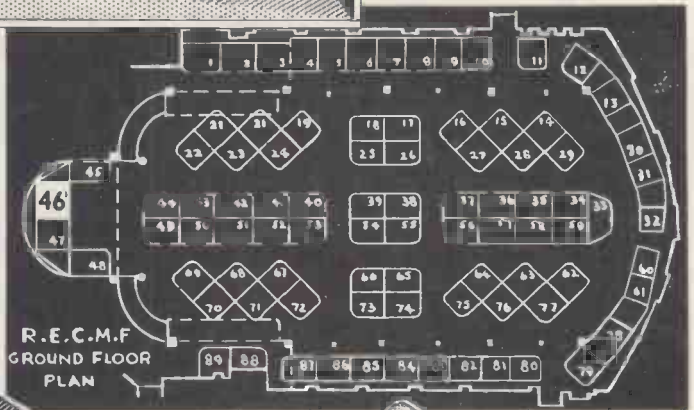


*By Appointment to the Professional Engineer*



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. . . the commercial version of the new PAINTON "MULTICON" SERIES of plugs and sockets and untors, a selection of which are illustrated here.



**PAINTON**  
*Northampton England*



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ATE/TMC Transmission equipment is designed to offer an operating administration the maximum facility in the performance of maintenance routines. Jack-in panel frames fitted with quickly detachable functional units ensure the most rapid form of servicing yet devised. You are invited to apply for a copy of "Unit Construction Practice" which describes the technique employed.

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Radio and Transmission Division, Strowger House, Arundel Street, London, W.C.2. Telephone: TEMple Bar 9262. Cablegrams: Strowgerex London. Manufacturers:—AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., Liverpool and London. TELEPHONE MANUFACTURING Co. LTD., St. Mary Cray, Kent.



# miniature HT RECTIFIERS for domestic RADIO and TELEVISION receivers

## FEATURES

- Withstand overloads such as charging current of deformed electrolytic capacitors
- Instant starting — no warming-up period
- Unlimited instantaneous overload
- Practically indestructible in service.
  - No limit to size of reservoir capacitor
  - Simple wiring — two connectors only.
  - Simple mounting — no valve holder
  - Small size . . . low weight
  - Low heat dissipation
  - Low cost

| TYPE                            | RM0       | RM1       | RM2       | RM3       | RM4       | *RM5      |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Maximum ambient temperature     | 35°C      | 35°C      | 35°C      | 35°C      | 40°C      | 40°C      |
| Maximum output current (mean)   | 30mA      | 60mA      | 100mA     | 120mA     | 250mA     | 300mA     |
| Maximum input voltage (r.m.s.)  | 15mA      | 30mA      | 60mA      | 90mA      | 125mA     | 150mA     |
| Maximum peak inverse voltage    | 350V      | 350V      | 350V      | 350V      | 700V      | 700V      |
| Max. instantaneous peak current | Unlimited | Unlimited | Unlimited | Unlimited | Unlimited | Unlimited |
| Weight                          | 0.82 oz.  | 1 oz.     | 1.4 oz.   | 2 oz.     | 4.5 oz.   | 4.75 oz.  |

\* For use in voltage doubler circuits the peak inverse and maximum input voltages are halved, current output being as for half wave operation.



*Standard Telephones and Cables Limited*  
Registered Office: Connaught House, Aldwych, London, W.C.2  
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# Record Today...

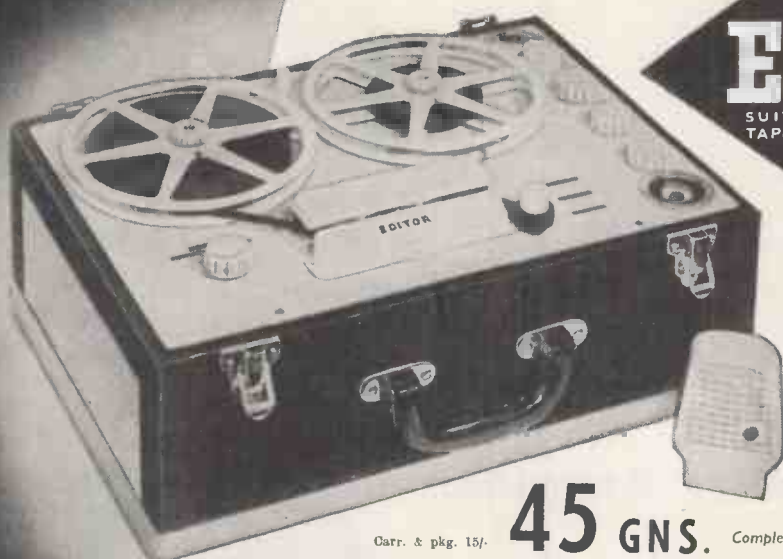
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# Editor

SUITCASE  
TAPE RECORDER

### TWO-SPEED TAPE RECORDER

Easy to carry—easy to look at. Suitable for pre-recorded tapes. The "Editor" is the smallest mains operated fully automatic two speed portable tape recorder with 7in. spools on the market. Twin track heads; INDEPENDENT BASS AND TREBLE CONTROLS FOR RECORDING AND PLAYBACK. For A.C. mains 200-250 v.



Carr. & pkg. 15/-

## 45 GNS.

Complete with High Fidelity microphone and 1,200ft. spool of tape.

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Complete with High Fidelity microphone and 1,200ft. spool of tape.

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Or supplied complete and ready for use with High Fidelity Crystal Microphone and One Hour spool of tape for £31.4.6.

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## 26 GNS.

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The smallest lowest-priced tape recorder giving a full hour's playing time. Completely self-contained for recording: PLAYS BACK THROUGH ANY RADIO OR AMPLIFIER, making possible Hi-Fi reproduction through your own favourite system.

Single knob control for all functions. High fidelity twin track recording heads. Powered by specially designed motor. Frequency response between 60/9,000 c/s. Overall size 12½in. x 10in. x 4½in. For A.C. mains 220/250 v.



# The most successful amplifier design of the year... The **Osram** 'nine - one - two'

**High Quality Amplifier  
and Reproducer**



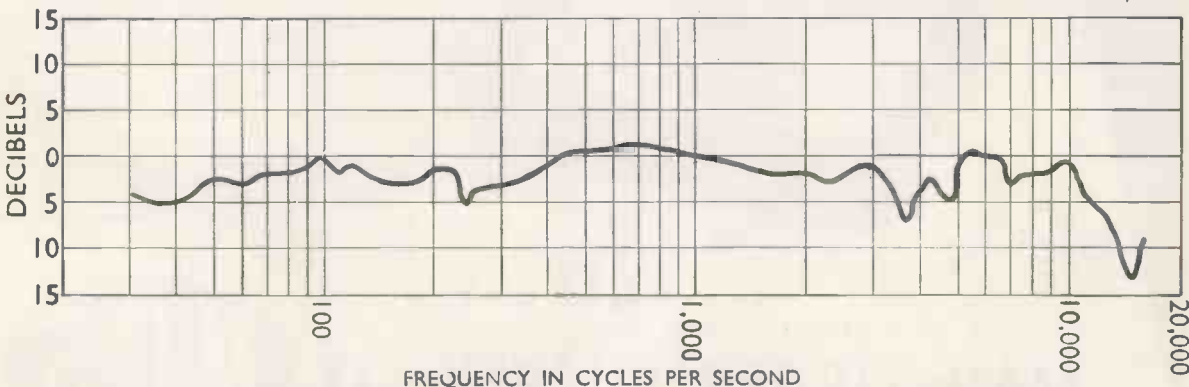
Hailed with enthusiasm by home constructors and music lovers throughout the country. Designed to do full justice to the best of modern L.P. recordings, the Osram '912' sets a startlingly new standard of realism in domestic sound reproduction. The versatile tone control system with its variable treble slope also enables old and worn, but often treasured, records to be played with the maximum of musical enjoyment.

## How to build the Osram '912'

Osram '912', 9 octaves, 12 watts, ultra-linear output stage, base and treble tone controls, variable treble slope, stage-by-stage wiring instructions.

**PRICE 3/6**

From your dealer or by post 3d. extra from Osram Valve and Electronics Department.



Overall frequency response of the complete equipment, comprising L.P. record, specified pick-up, Osram 912 amplifier and G.E.C. Metal Cone Loudspeaker in octagonal loaded-port cabinet.

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Before the age of electronics this (we are told) was how the gentleman of leisure often enjoyed himself. From this elevated position he could spin along the quiet lanes and byways drinking in the pure fresh air and the delights of nature spread before him.



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Traffic conditions today make it very difficult to find pleasure in travel for its own sake. Electronics has given us a new way in which to enjoy our leisure—by drinking in the pure delight of good music, faithfully reproduced on High Fidelity equipment supplied by Classic.

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May we point out that we at Classic have very little leisure to enjoy. We often find that we spend twenty-four hours a day (at least!) keeping other people happy—so many enthusiasts turn to Classic because they can get everything they want from our comprehensive range of high-fidelity equipment.

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**75 ohm. T.V. DOWNLEAD CABLE**  
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Plastic Extrusion**



THE  
*Concertone*



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★ perfection ★

and

★ fidelity ★

in

**TAPE RECORDERS**



**48 GNS.**  
COMPLETE

TRADE  
ENQUIRIES  
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MAGNETIC RECORDER

Meticulously recording every *tonal facet* with *complete mastery*, the "Concertone" tape recorder will give you the *ultimate listening pleasure* that comes from superb music *faultlessly* recorded and reproduced.

The "Concertone" will re-create, in the home, the *true image of the original performance*. Whether it be Solo Violin, or Oboe, or a Full Organ with its demanding power and range, the "Concertone" with its *wide frequency response*, and *extended dynamic range*, will satisfy the *connoisseur* of fine music.

Simple, absolutely reliable, rugged, compact, lightweight, and easily portable, the "Concertone" will, wherever there are sounds to be recorded, *serve faithfully*, earning, justly, *unqualified praise* for its *faultless performance*.

Manufactured by the company in its own precision machine shop, the tape mechanism employs three motors and a special design servomatic brake. The brake not only locks the spools *securely* during transit but, of greater importance, it is *completely free from fade*, being *self-compensating* for wear. Unique is the provision of a *mechanical interlock* which prevents faulty operation.

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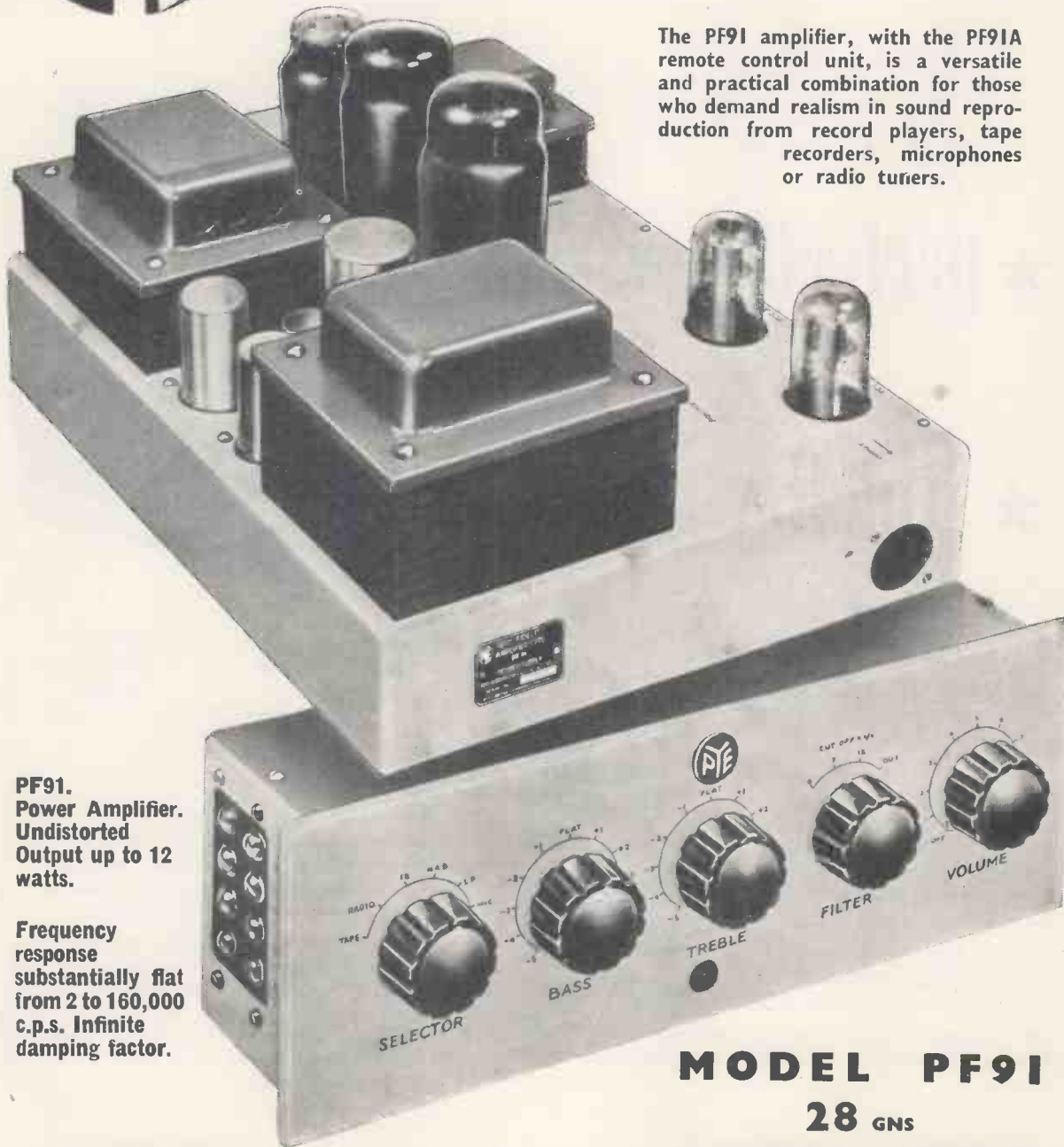
Entirely Manufactured by  
**FISHER ELECTRONICS COMPANY LTD.**

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# Hi Fi HIGH FIDELITY AMPLIFIER

The PF91 amplifier, with the PF91A remote control unit, is a versatile and practical combination for those who demand realism in sound reproduction from record players, tape recorders, microphones or radio tuners.



**PF91.**  
Power Amplifier.  
Undistorted  
Output up to 12  
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Frequency  
response  
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from 2 to 160,000  
c.p.s. Infinite  
damping factor.

Demonstrations of the PF91 can be arranged through Pye Hi-Fi agents. Please write for a fully illustrated booklet to Pye Limited, Box 49, Cambridge.

**MODEL PF91**  
28 GNS  
**MODEL PF91A**  
12 GNS

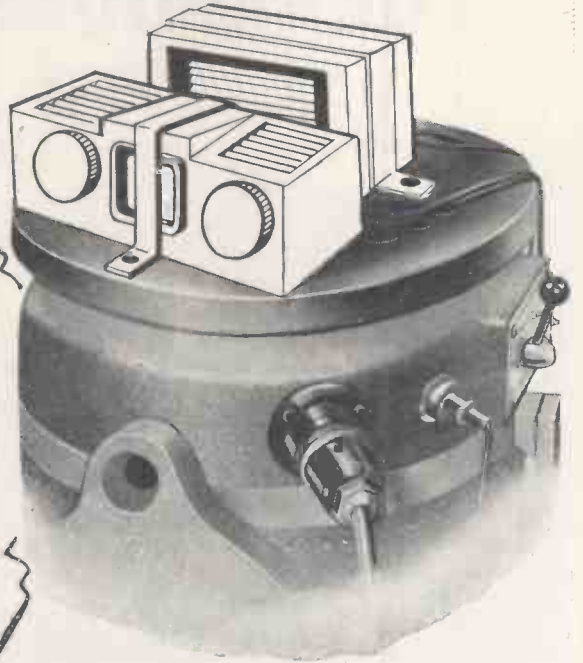


# SHAKING OUT the facts!

## ... the story of a PROTOTYPE CAR RADIO

A new product—a car radio! How to be sure—absolutely certain—that its laboratory performance would always be duplicated on the road? Would vibration mar its performance, or shorten its life? Goodmans Vibration Generators, which accurately simulate vibratory forces of variable frequency and amplitude, find the answers—in the prototype stage! Recently a wise radio manufacturer sought Goodmans advice and a series of pre-production tests were carried out to vibrate the equipment from 10 c/s. to 500 c/s. at various amplitudes. The results, some of which are enumerated on the right, enabled positive design and constructional modification to be made, ensuring perfect, long-life peak performance of every production model.

*Just one example of the service rendered to Industry by Goodmans Vibration Generators.*



at

75 c/s

Pronounced vibration mode in main chassis, bending of base and movement of components.

150 c/s

Spurious noises from loudspeaker, microphony in amplifier, and instability in output components.

220 c/s

Tuner cover in resonance, setting up audio radiations.

310 c/s

Phase-splitter Valve and Screening Can vibrating, causing peaking at this frequency with consequent audio distortion.

375 c/s

Vibration mode evident, smaller "between-wiring" components and connecting leads flapping freely.

~10 c/s

Protecting cover of power pack in resonance, generating objectionable sound energy.

Now ANY PRODUCTION MODEL IS READY FOR THE WORST THAT THE ROAD CAN OFFER

Thanks to VIBRATION INVESTIGATION

with

**GOODMANS**

Vibration Generators

*If you have a vibration problem, whether it is fatigue testing, torsional vibration testing, flexure testing or structural investigation—consult Goodmans first—you may save many, many pounds on research and production costs. The Goodmans range of Vibrators extends from a model developing ± 300 lb. to a midget with a force output of approximately ± 2lb.*

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GOODMANS INDUSTRIES LTD., AXIOM WORKS, WEMBLEY, MIDD.

Telephone: WEMbley 1200 (8 lines)

# And NOW—a range of 'CERAMICAPS' for your

## LAB Storage Unit!



The LAB Continuous Storage Unit is widely acknowledged as the most efficient and convenient method of storing and selecting resistors. Now its usefulness is still further extended with the introduction of LAB pak'd 'Ceramicaps'.

With the LAB Unit, research and experimental laboratories and small production groups have to hand immediately, a complete range of resistors and 'Ceramicaps', easily selected with card index simplicity from some 700 sorted and carded components. Empty cards are merely replaced with full ones from stock.

The LAB unit is supplied FREE with initial purchase to your specification. Standard assortments available. Each LAB Unit can be used to store one type of component exclusively, or quantities of the complete range of resistors and 'Ceramicaps'. Full details and illustrated list will be sent on application.

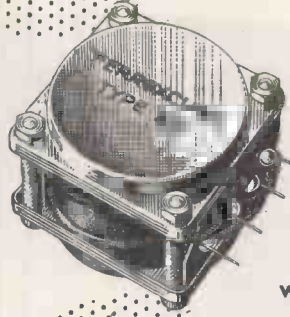
## THE LAB CONTINUOUS STORAGE UNIT

| RESISTORS                         |        |                          |            |                       |             |
|-----------------------------------|--------|--------------------------|------------|-----------------------|-------------|
| Ref.                              | Type   | Loading                  | Max. Volts | Range                 | Dimensions  |
| T                                 | ½ watt | ½ watt                   | 250        | 10 ohms to 10 megohms | ¾" x ½"     |
| R                                 | ½ watt | 1 watt                   | 500        | 10 ohms to 10 megohms | ¾" x ¾"     |
| Tolerance available ±20%, 10%, 5% |        |                          |            |                       |             |
| HIGH STABILITY RESISTORS          |        |                          |            |                       |             |
| HS3                               | ½ watt | ½ watt                   | 750        | 1 ohm to 500 megohms  | 1.1" x 0.1" |
| Tolerance available ±5%, 2%, 1%   |        |                          |            |                       |             |
| WIREWOUND RESISTORS               |        |                          |            |                       |             |
| 5 ohms to 100K ohms — 5-10 watts  |        |                          |            |                       |             |
| 'CERAMICAPS'                      |        |                          |            |                       |             |
| Tubulars 3 - 470 pf               |        | Tolerances ±2%, 10% Hi-K |            |                       |             |

The Lab Continuous Storage Units are available from your normal source of supply, but more detailed information can be obtained from

- ★ Continuous Storage for Resistors and 'Ceramicaps'
- ★ Values separately carded
- ★ Finger-tip Selection

**THE RADIO RESISTOR COMPANY LTD**  
50, ABBEY GARDENS · LONDON · N.W.8 · Telephone: Maida Vale 5522



## High Q inductance coils

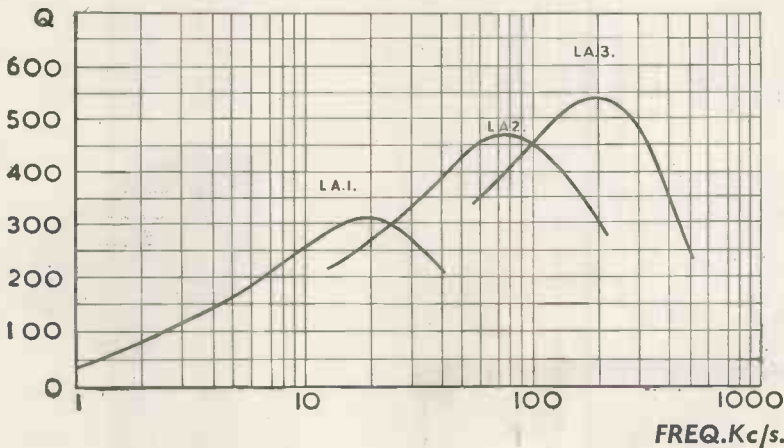
wound on Ferroxcube cores

DESIGNERS of compact and efficient tuned circuits and wave filters are making ever-increasing use of Mullard high Q inductance coils.

Based on Ferroxcube, the world's most advanced magnetic core material, these coils combine small size with an inductance of up to 30 henries over a wide frequency range. Furthermore, their convenient shape and self screening properties facilitate either individual mounting or stacking.

Full details of these and other high grade components now available from Mullard will be gladly supplied on request.

### TYPICAL Q VALUES



### Special Features

- Small size
- Low hysteresis loss factor
- High value of inductance
- Low self capacitance
- Controllable air gap facilitating inductance adjustment
- Self screening
- Controlled temperature coefficient
- Operation over a wide frequency range
- Easily mounted

# Mullard



'Ticonal' permanent magnets,  
'Magnadur' ceramic magnets,  
Ferroxcube magnetic cores.



**RECMF  
EXHIBITION  
STAND  
NO: 28**

Pre-recorded tapes can now be replayed  
on the proved

**TRUVOX**

**TAPE DECK NEW MODEL MK. III/TR2U**  
Incorporates BSS sense of tracking.

Price Still Remains at  
**22 GNS.**



Manufactured in Gt. Britain by

**TRUVOX LTD**

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Tech & Service Depts.: 328 The Broadway, Station Rd., Harrow, Middx.  
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The popular TRUVOX  
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used with Grundig and  
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Recorders for listening to  
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Programmes.

Model TA7 (with Con-  
tinental Plug).

Model TA3 (BSS Model)  
£2/10/- + 18/4 P.T.



The Light Programme can  
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RADIO JACK which adds  
the 1500 m. wavelength to  
the two Medium Wave  
stations.  
Model TA.8 (BSS Plug).  
Model TA.9 (Metric Plug),  
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Recorders.

£3/9/6 + £1/5/5 P.T.

# AND A FOURTH ONE



The new Truvox Corner Diffuson Speaker for Hi-Fidelity reproduction, particularly of the pre-recorded tapes played back on Tape Recorders. Increases the pleasure of listening, at the same time a beautiful addition to any home.

12 watts, 10,000 lines, 5 or 15 ohms.  
Cabinet only (Patts. Apd. for) £26 8 6  
Special Speaker to match £3 0 0  
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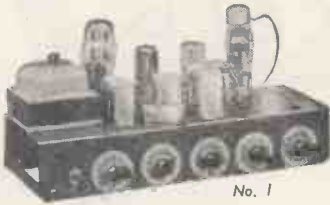
# REAL HIGH FIDELITY at modest cost . . .

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

We are now specialising in the supply of units for making up high-fidelity Radio and Record-reproducing Equipments for use in the Home, small Halls, Schools and Gramophone Societies and single items for replacing in existing equipments and radiograms. Our Chief Engineer, who is operating a Technical

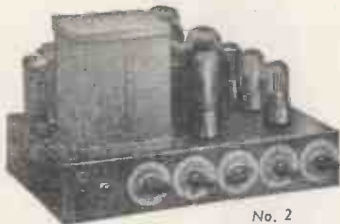
Guidance Service, is available daily, including Saturdays, from 10 a.m. to 6 p.m., or will deal with enquiries by return of post. Our new Illustrated Catalogue and Supplement will be a great boon to those desiring high quality equipment for modest expenditure. Send two 2½d. stamps for your copy now. It may well save you pounds.

Treble Baffle Optional Extra



No. 1

**No. 1 "SYMPHONY" AMPLIFIER** is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is far more important than mere nominal linear response of the amplifier, as the pick-up, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78's to new L.P.'s. Input is for all types of pick-up of 0.1 v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price: 10 gns. (carriage 5/-). Fitted in portable Steel Cabinet, 35/- extra.



No. 2

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



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

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

**CURRENT GARRARD PRODUCTS AVAILABLE FOR IMMEDIATE DELIVERY FROM STOCK AT PRESENT.**

**MODEL TA** 3-speed unit, but with plug-in turnover head Type G.C.2, £10/16/-, or with Acos HGP 33 or 37 heads, £10/14/-, or with two separate high fidelity Acos HGP35 heads, £12/17/- . Unit less heads, £8/11/- . post 2/6. Heads, 42/3 each, post 1/-.

**MODEL TB** as above, but with long pickup arm. Less heads, £8/11/-, post 2/6.

Heads to fit this unit: Decca XMS, 5/6, Decca Crystal, 33/-, Garrard Standard Magnetic, 28/-, miniature magnetic low impedance, 28/-, miniature magnetic high impedance, 38/- . Post on heads 1/- . Unit can be supplied with any combination of above heads and is carefully adjusted for stylus pressure on despatch.

**MODEL RC80M**, less heads, £15/5/-, with new turnover head, £17/9/6, with two separate Acos HGP35 heads, £19/9/-, carriage 5/-.

**COLLARO PICKUPS AND HEADS.** Studio Pickup Arm, 13/10. Studio Pickup head type "O" or "P," £3/0/9. Pickup complete £3/14/7. Studio Transcription Pickup Arm with Studio "P" head, £4/15/9. Ditto with Transcription head, £5/2/5.

**TRANSCRIPTION MOTORS IN STOCK.**

**NEW CONNOISSEUR** variable speed on all 3 speeds £25/15/5.

**GARRARD Model 301** £25/3/6.

Cabinets available to house either of the above motors together with pick-up, price £3/7/6. Carriage 5/-.

## SNIP NO. 1

**GARRARD LATEST MODEL RC80M AUTO-CHANGER.** Fitted with full-length Pick-up Arm to take 3-pin plug-in heads, manufactured end of Oct. 1954. PRICE LESS HEADS, £15/5/-, carriage paid. These extraordinarily versatile units can be supplied fitted with the following combinations of Pickup Heads at the following prices:

With two Decca XMS ferr Magnetic Heads, £20/15/-.

With two Decca Crystal Heads, £18/10/-.

With Decca Crystal for L.P. and Garrard Miniature Mag. for Std. Takes miniature fibre or steel needles. £18/13/-.

With adaptor and two Acos HGP39-1 Heads, £20/5/-.

With adaptor and one Acos HGP39-1 Head for L.P. and Garrard Miniature Mag. High Impedance for Std. Takes miniature fibre or steel needles. £19/17/-.

The above combinations of heads are matched for output and the stylus pressure is carefully adjusted before despatch. Carriage paid.

Above mounted in Portable Cabinet 90/- extra IMMEDIATE DELIVERY from STOCK *Guaranteed*.

## SNIP NO. 2

Very latest Model "MONARCH" 3 speed **AUTO-CHANGER** fitted with latest ACOS HGP37 turnover Pickup Head for Std. and L.P. Plays 12in., 10in., and 7in. records mixed in any order. Capacity 10 records. Operates on 100/125 and 200/250 v. A.C. 50 c/s. Unit plate measures 12½in. x 10½in. Height above plate required 5½in.; depth below required 2½in. PRICE COMPLETE £13/10/- . Carriage 5/- . IMMEDIATE DELIVERY. Leaflet 2½d. Above mounted in Portable Cabinet, 16 gns., plus carriage 7/6.

## "SYMPHONY" BASS REFLEX CABINET KITS.

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

## HIRE PURCHASE FACILITIES

NOW AVAILABLE on orders of £15 or over.

Send one-third deposit with order, balance over 6 or 12 monthly instalments. State which required.

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Tubes: Swiss Cottage and Chalk Farm.

Buses: 2, 13, 31, 113, 187.



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



**CONSOLE AMPLIFIER CABINETS** (above), 33in. high, lift-up lid with piano hinge, take Tape Deck, Gram Unit or Auto-changer, Amplifier, Pre-Amplifier, and Radio Feeder Unit, finished medium walnut veneer. De Luxe version, price 10 gns. Oak or Mahogany veneers 10/- extra. Special finishes to order. Carriage according to area, we will quote.

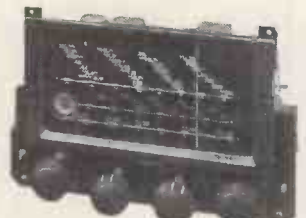
# Northern Radio Services (CONTD.)

## "SYMPHONY" RADIO FEEDER UNITS



**NO. 1 "SYMPHONY" TUNER.** A T.R.F. model designed for the quality reception of local stations. Quality is adequate for amplifiers of the highest fidelity class. Infinite impedance detection. Controls: gain, wave-change and radio/gram switch. Illuminated engraved glass dial. Latest miniature valves. Overall dimensions: 9in. wide x 6in. deep x 6in. high. Power required: 6.3 v. at 1 amp. and 250/500 v. at 16 m/a. Price £7-7-0. Carr. & pkg. 5/-.

**NO. 2 "SYMPHONY" SUPERHET TUNER.** Three wave-bands, advanced circuit, very newest valve types, floodlit glass dial with bronze escutcheon provided. Suitable for use with the best amplifiers. Overall dimensions: 12in. wide x 8 1/2in. high x 7in. deep. Controls: on/off/gain, radio/gram, wave-change and tuning. Dial cut-out: 8in. x 4 1/2in. reading horizontally or vertically (state which required). Tuner can be readily mounted at any angle. Requires 6.3 v. at 1.5 amp. and 250/300 v. at 20 m/a. Price £11-11-0. Carr. & pkg. 5/-.



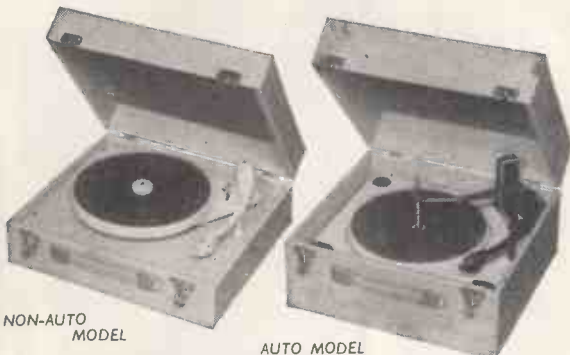
**NO. 2VS "SYMPHONY" SUPERHET TUNER.** As No. 2 but incorporating on the wave-change switch an extra position for radio, thus making two radio positions. One is the standard one with 9 kc. separation and the extra one providing virtually T.R.F. band-width and quality on local stations. Price £13-13-0. Carr. & pkg. 5/-.

All above tuners are made to plug in to any of our "Symphony" Amplifiers in a matter of seconds by means of the octal plug fitted at the end of a flexible multi-cable. They are ideal for providing in conjunction with our "Symphony" Amplifiers, the same high quality on radio as is obtained from these amplifiers on gramophone, but they are equally suitable for use with other high fidelity amplifiers. And where the output circuit requires modification to match a given amplifier this can be carried out free of charge. Either of the two Superhet models can be fitted with a magic eye tuning indicator for £2-2-0 extra. Furthermore, they can be fitted with a pre-amplifying stage to match the Decca Magnetic Pickups or the Collaro Studio type "P" pickup head for use with amplifiers which would not otherwise have enough gain for these comparatively low output pickup heads. In these cases, two separate correction circuits—one for standard and one for LP as recommended by the pickup manufacturers—are incorporated in the radio/gram switch. Please send for our catalogue giving further details.

## TAPE DECKS AND AMPLIFIERS

**TRUVOX TAPE DECK MARK III.** TR2/U. Latest version to take pre-recorded tapes. Price 22 gns. Illustrated leaflet 2 1/2d.  
**TAPE AMPLIFIER TYPE C,** expressly designed by Truvox to work perfectly with their Deck, 3 valves plus rectifier and Magic Eye level indicator. Price 16 gns.

## NEW MODEL PORTABLE RECORD PLAYERS



We are pleased to announce the entry on to the market of two "Symphony" Record Players designed to represent the greatest value in this line ever offered. Model No. 1 contains the Collaro 3-speed single record playing unit AC3/554 and model No. 2 contains the Collaro Autochanger RC54. They are available with either Type "O" insert, "P" insert or transcription insert. Prices (in attractive rexine case), No. 1 £10-19-6, No. 2 £14-19-6. Carr. 7/6. Transcription insert 6/9 extra. Fully illustrated leaflets on the units 2 1/2d.

**GOODMANS CORNER CABINETS** (right) for the AXIOM 150 Mark 2 manufactured by us to Messrs. Goodmans' specification and approved by Messrs. Goodmans. Height, 44in. Price: complete kit in plain board with lin. thick felt, 8 gns. Price: ready built, 10 gns. Finished in figured walnut, 16 gns. Other veneers to order. Carriage extra according to area.



# BE SURE OF SUCCESS IN RECEIVING F.M. PROGRAMMES BY BUILDING THE "MAXI-Q" F.M. FEEDER UNIT.

Full constructional details, Point to Point wiring diagram and alignment instructions are given in our Technical Bulletin DTB.8, price 1/6. The guaranteed components described below have been acclaimed by thousands as the finest obtainable.

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**RATIO DISCRIMINATOR TRANSFORMER 10.7 Mc/s. Ref. RDT.1.**

A 10.7 mc/s. transformer for use in ratio discriminator type circuits. Can size 1 1/2in. square x 2 1/2in. high. Secondary winding of bifilar construction. Iron dust core tuning, polystyrene former and silver mica condensers. Price 12/6 each.

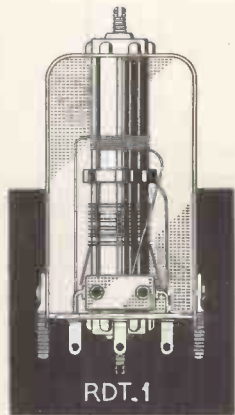
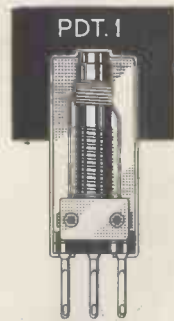
**PHASE DISCRIMINATOR TRANSFORMER 10.7 mc/s. Ref. PDT.1.**

A miniature 10.7 mc/s. transformer for use in frequency modulation detector circuits where the limiter/Foster-Seeley type of circuit is employed. Designed for carrier deviation of ±75 kc/s. Qk = 1.5. Wound on black Bakelite former, complete with iron dust slugs and two 6 B.A. threaded fixing holes on .532in. centres. Screening can 1 1/2in. x 1 3/16in. square. Price 9/- each.

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 A miniature I.F. Transformer of nominal frequency 10.7 Mc/s. The transformer is primarily intended for the I.F. stages of frequency modulation receivers and converters. The Q of each winding is 90 and the coupling critical. Construction and dimensions as PDT.1. Price 6/- each.

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Illustrated are a few signal lamps taken from our wide range. The insulation of every Arcoelectric signal lamp will resist a flash test of 1,500 volts A.C.

The S.L.90 illustrated here is a typical Arcoelectric low voltage signal lampholder. It is designed to accept popular M.E.S. bulbs. The bulb is accessible from front or rear of panel. The domed plastic lens surrounded by a polished chrome bezel gives a most attractive panel appearance. This holder can be fixed in a single  $\frac{3}{4}$ " hole.

The mains voltage signal lamp S.L.88/N is supplied complete with an M.E.S. neon tube and a suitable series resistance.

Write for Catalogue No. 128

**ARCOLECTRIC**  
SWITCHES LTD



S.L.88/N

S.L.90

S.L.86

S.L.82

S.L.92

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





# Component Bridge

THE WAYNE KERR MODEL B.121

A MODERATELY PRICED self-contained instrument, capable of a wide range of accurate measurements.

In addition to giving direct readings of resistance, capacitance, and inductance, it will measure the impedance between any pair of terminals in a three-terminal network, and it can also be used for in situ measurements of component values.

Two individually calibrated dials give simultaneous readings of parallel combinations of resistive and reactive components, with independent scale multiplying of R and C values. The mains supply constitutes the source, and a selective amplifier with sensitive "magic eye" is used for null indication.

## Specification

**RESISTANCE RANGE:** 3 ohms to 1,000 megohms, using six ranges and 3 multipliers of 0.1, 1 and 10.

**CAPACITANCE RANGE:** 1.0 pF to 1,000  $\mu$ F, using six ranges and 3 multipliers of 0.1, 1 and 10.

**INDUCTANCE RANGE:** 100 mH to 10,000 H in five ranges.

**ACCURACY:** 2% on all ranges over the major part of the scale. If higher accuracy is required, the instrument can be supplied hand-calibrated.

**POWER SUPPLY:** 110/115 V. or 200/250 V. at 50 c/s — 10 W. approx.

**DIMENSIONS:** 17 $\frac{1}{2}$ "  $\times$  10 $\frac{1}{2}$ "  $\times$  10" high.

**WEIGHT:** 15 lb. approximately. **PRICE** £60 NETT Immediate Delivery





# Home Constructors

## MAKE A SOUND JOB OF IT WITH . . . HUNTS CAPACITORS



### APPROVED CAPACITOR KIT FOR THE OSRAM 912 HI-FI Amplifier

| Ref. | Capacitance     | Volts D.C. Wkg. | List No. | List Price s. d.  |
|------|-----------------|-----------------|----------|-------------------|
| C 1  | 0.005 $\mu$ F   | 1000            | B 402    | 2 0               |
| C 2  | 25 $\mu$ F      | 25              | JD 52T   | 2 6               |
| C 3  | 0.1 $\mu$ F     | 350             | B 406    | 2 3               |
| C 4  | 0.05 $\mu$ F    | 500             | B 405    | 2 3               |
| C 5  | 8 + 16 $\mu$ F  | 450             | JE 561   | 7 6               |
| C 6  | 470pF $\pm$ 5%  | 350             | L 433    | 1 6               |
| C 7  | 1000pF $\pm$ 5% | 350             | L 435    | 1 9               |
| C 8  | 2000pF $\pm$ 5% | 350             | L 435    | 2 4 $\frac{1}{2}$ |
| C 9  | 0.02 $\mu$ F    | 750             | B 404    | 2 1 $\frac{1}{2}$ |
| C 10 | 22pF $\pm$ 5%   | 350             | L 430    | 1 6               |
| C 11 | 220pF $\pm$ 5%  | 350             | L 433    | 1 6               |
| C 12 | 470pF $\pm$ 5%  | 350             | L 433    | 1 6               |
| C 13 | 25 $\mu$ F      | 25              | JD 52T   | 2 6               |
| C 14 | 0.1 $\mu$ F     | 150             | B 500    | 2 0               |
| C 15 | 2 $\mu$ F       | 150             | B 504    | 5 6               |
| C 16 | 0.01 $\mu$ F    | 350             | B 810    | 1 6               |
| C 17 | 0.05 $\mu$ F    | 500             | B 405    | 2 3               |
| C 18 | 0.05 $\mu$ F    | 500             | B 405    | 2 3               |
| C 19 | 50 $\mu$ F      | 25              | JD 53T   | 2 9               |
| C 20 | 50 $\mu$ F      | 25              | JD 53T   | 2 9               |
| C 21 | 0.001 $\mu$ F   | 600             | B 847    | 1 3               |
| C 22 | 0.001 $\mu$ F   | 600             | B 847    | 1 3               |
| C 23 | 8 + 16 $\mu$ F  | 450             | JE 561   | 7 6               |

2 Horizontal Mounting clips H I

Special price for complete kit

**£2.15.0**

### APPROVED CAPACITOR KIT FOR THE MULLARD 5 VALVE 10 watt circuit

| Ref.   | Capacitance      | Volts D.C. Wkg. | List No. | List Price s. d.  |
|--------|------------------|-----------------|----------|-------------------|
| C1/2   | 50 + 50 $\mu$ F  | 350             | KB 418   | 12 6              |
| C 3    | 8 $\mu$ F        | 450             | JF 553TS | 3 6               |
| C 4    | 8 $\mu$ F        | 450             | JF 553TS | 3 6               |
| C 5    | 100 $\mu$ F      | 12              | JF 28T   | 3 9               |
| C 6    | 0.02 $\mu$ F     | 600             | A 61     | 1 1 $\frac{1}{2}$ |
| C 7    | 0.1 $\mu$ F      | 600             | A 65     | 1 6               |
| C 8    | 0.1 $\mu$ F      | 600             | A 65     | 1 6               |
| C 9    | 0.1 $\mu$ F      | 600             | A 65     | 1 6               |
| C 10   | 100 $\mu$ F      | 25              | JF 54T   | 3 9               |
| C 11   | 100 $\mu$ F      | 25              | JF 54T   | 3 9               |
| * C 12 | 180pF $\pm$ 5%   | 350             | L 431    | 1 6               |
| C 13   | 0.001 $\mu$ F    | 600             | B 822    | 1 3               |
| C 14   | 33pF $\pm$ 10%   | 350             | L 430    | 1 4 $\frac{1}{2}$ |
| C 15   | 680pF $\pm$ 10%  | 350             | L 435    | 1 7 $\frac{1}{2}$ |
| C 16   | 270pF $\pm$ 10%  | 350             | L 433    | 1 4 $\frac{1}{2}$ |
| C 17   | 3300pF $\pm$ 10% | 350             | L 435    | 3 6               |

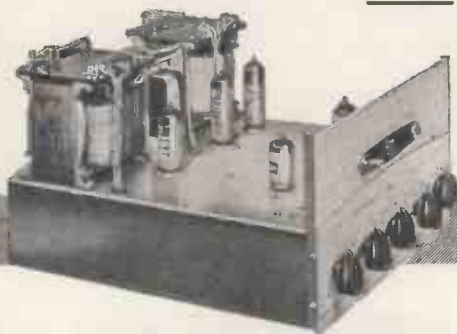
Mounting clip for C 1/2

Special price for complete kit

**£2. 5. 0**

\* The capacitance at this stage is determined by the impedance of the Loud Speaker.

3.75 ohms requires 180pF  $\pm$  5%  
 7 ohms requires 120pF  $\pm$  5%  
 15 ohms requires 82pF  $\pm$  5% } 1/6 each



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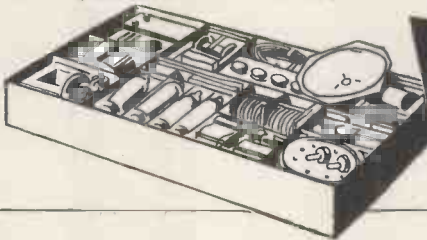
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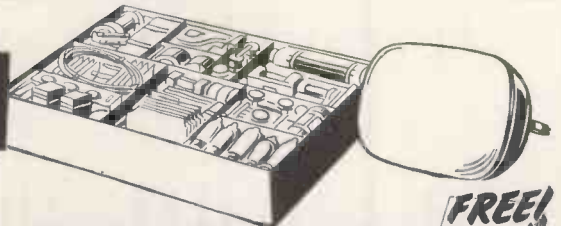
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**FREQUENCY RANGE**  
**20 c/s to 700 Mc/s**  
**AND D.C.**

This together with other new designs for 1955, may be inspected on stand no. 103, 19th to 21st April, at the R.M.C.M.F. Exhibition and on stand no. 89, 25th to 28th, April, at the Physical Society Exhibition.

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The latest PFA unit is built especially for use with our range of Williamson Amplifiers. Separate bass and treble control in equaliser section. Low noise—high gain, 5 mv. input, 6 valves. Price **£20.**

★ Demonstrations of all these units at B.K. Partners Ltd., 229 Regent St., London, W.1, and Classic Electric Co, Ltd., Croydon.

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## OMNI-DIRECTIONAL

# 3-Speaker System

W15/CS SUPER 8/CS SUPER 5

*Treble Units Facing Upwards Crossover Frequencies 800 and 5,000 c/s*

The bass speaker is the W15/CS with a fundamental resonance below 30 C/S; the middle speaker is the Super 8/CS; and the third speaker is the Super 5 with response well maintained to 16,000 C/S. The crossover unit is a ½ section type, with crossover frequencies of 800 and 5,000 C/S. A volume Control is now fitted to the middle and top speakers which also face upwards to avoid undue directional effects.

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Cash and S.A.E. with order.

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WIRELESS WORKS LTD.

BRADFORD ROAD · IDLE · BRADFORD · YORKS

Phone: Idle 1235/6 (2 lines). Grams: Wharfedel, Idle, Bradford.



### PRICES (TAX FREE)

|                              |            |           |          |
|------------------------------|------------|-----------|----------|
| W15/CS sand-filled Enclosure | £47        | 0         | 0        |
| Treble Assembly .....        | £18        | 0         | 0        |
| HS/CR3 Crossover with V.C.'s | £8         | 10        | 0        |
|                              | <u>£73</u> | <u>10</u> | <u>0</u> |

2 Sand-filled Back Panels (40in. x 24in.) to complete the enclosure, where a suitable corner is not available, can be supplied at £12 per pair.

# Valves for Industry

## R.F. Heating

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

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

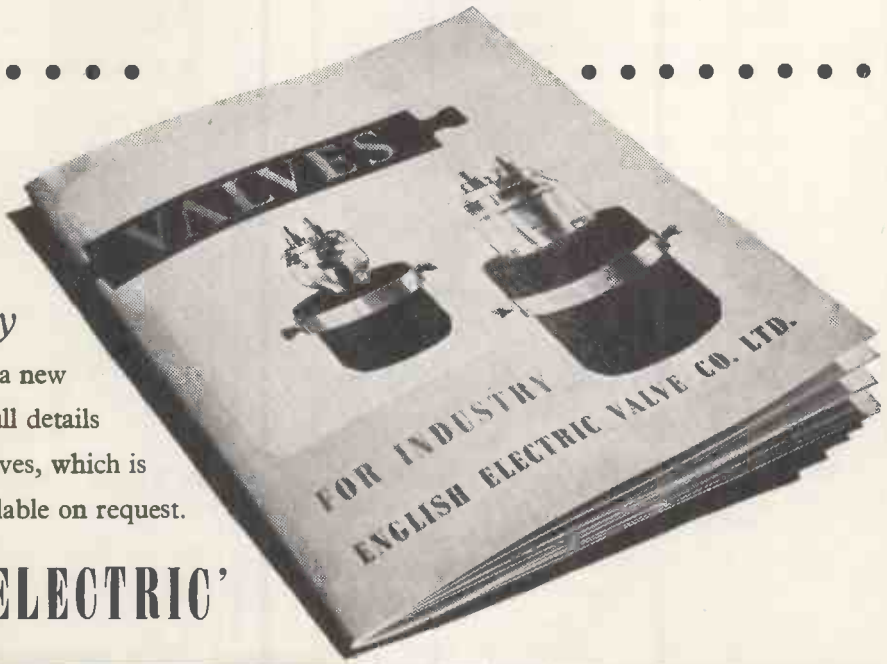


Company of 10 kW of valves used operation under use. They are are low in are available range of rectifying



### Valves for Industry

is the title of a new publication giving full details of these valves, which is available on request.



## 'ENGLISH ELECTRIC'

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## HARTLEY-TURNER SOUND EQUIPMENT

### THE HARTLEY 215 LOUDSPEAKER

The 215 Speaker is designed to cover the entire audio frequency range as a single unit. Employing a mechanical crossover and special coil assembly the response of the 215 extends from 20 c/s to 20 Kc/s.

The very free suspension enables the lower frequencies to be reproduced without distortion.

The power handling capacity is 10 Watts.

The 215 speaker when used in conjunction with the Hartley-Turner True Bass Baffle provides the best means of obtaining distortion free reproduction.

The prices are:—

Hartley-Turner 215 Loudspeaker at £14 10s plus £4 14s 3d purchase tax.

Hartley-Turner True Bass Baffle at £8.

*Illustrated literature sent free and post free on request to:—*

**H. A. HARTLEY CO. LTD.**  
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*If you require supplies of any items of Communication Equipment and are not already served, our Purchasing and Export Departments can help you. Let us know your requirements.*

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| Output 12/15 Volts D.C. 2.5 Ampere. | ..         | 13/6 |
| Output 12/15 Volts D.C. 4 Ampere.   | ..         | 22/6 |
| Output 12/15 Volts D.C. 6 Ampere.   | ..         | 35/- |

New range H.T. Rectifiers ( $\frac{1}{2}$  Wave)

| Max. A.C. Input | Max. D.C. Current | List Price |
|-----------------|-------------------|------------|
| 125 Volts       | 80 mA             | 4/3        |
| 250 Volts       | 50 mA             | 8/-        |
| 250 Volts       | 300 mA            | 18/-       |

Trade Supplied

- We use only freshly manufactured selenium plates and components, no ex-W.D. materials whatsoever

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## COSSOR Model 1322

Model 1322 — used in conjunction with a cathode ray oscillograph — provides equipment for the display, measurement and correct adjustment of RF and IF response curves of television receivers. This entirely new instrument comprises a swept oscillator covering the Television BANDS I and III (5-75 Mc/s. and 155-255 Mc/s.) and a frequency marker oscillator so that precise calibration of the oscillograph display may be made; accuracy of the frequency of the marker pips being verified by reference to an internal crystal. The

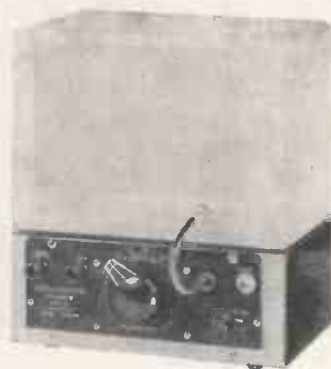
## Telecheck and Marker Generator for Bands I and III

alignment oscillator is set to the video carrier to which the receiver is tuned and the sweep (either 1 Mc/s. or 10 Mc/s.) is automatically derived from the time base voltage of the display oscillograph. The response of the "strip" under test to the frequency band applied is then presented on the screen of the cathode ray tube. The RF output of Model 1322 is available at 75 ohms and is adjustable from a maximum of 40 millivolts to a minimum of 10 microvolts through a coarse and fine attenuator.

## TELECHECK CONVERTER FOR BAND III

## Model 1321

This adaptor provides owners of Model 1320 "Telecheck" with an extension of the frequency range of the original instrument into the BAND III television channel. Thus, alignment procedures adopted for BAND I RF/IF "strips" are available also for BAND III receivers. A selection of the desired BAND is made by means of a switch. Pattern generator facilities for picture time base linearity checks have been retained. Model 1321 Adaptor is designed for permanent attachment to the standard "Telecheck" providing a neat, light and compact unit. Mounting is effected by four screws and the inter-connecting wiring is carried in a single insulating sleeve.



# COSSOR ELECTRONIC INSTRUMENTS

Write for illustrated leaflets about both these instruments :

COSSOR INSTRUMENTS LIMITED (Dept. 1) Highbury Grove · LONDON · N.5

Telephone: CANonbury 1234 (33 lines)

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**32/6 per 1200 ft reel**

On the well-known universal Ferrovoice Spool

600 ft 19/6

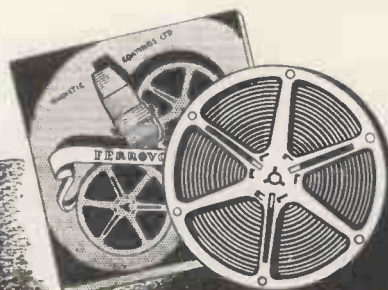
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The problems of obtaining satisfactory time constants and at the same time keeping component bulk down to a minimum are all too familiar. These polarised miniature electrolytic capacitors —CASTANET by name—go all the way in removing what has for a long time been a thorn in the side of designers. A mere 22 mm by 6 mm, with a capacity of 50 microfarads and a D.C. leakage of less than one microamp at 70V., CASTANET capacitors are capable of operating over a temperature range of—60° C. to + 150° C. After shelf storage, without volts, at 70° C. for several thousand hours, the capacity, power factor and D.C. leakage current values show no significant change.



## The place for 'Castanet'...

The determination of the place for CASTANET is simple. It is anywhere where space is at a premium and essential characteristics demand stability of performance coupled with low leakage current over a very wide temperature range. The units are normally provided with a 4 BA stud and anode tag. A silicone rubber grommet is available by means of which the units can be mounted on a chassis and connected in series or parallel, providing a range of working voltages and capacities. Time constants of the order of one hour can be obtained making the units ideal for very long period discharge circuitry, in addition to the more conventional applications.

**Plessey**

**'Castanet'**

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# Tantalum Electrolytic Capacitors

Manufacturers are invited to write for Plessey Publication No. 659/1 which contains comprehensive details of the product.

'Castanet' Electrolytic Capacitors are produced by the Chemical & Metallurgical Division of The Plessey Co. Ltd., Wood Burcote Way, Towcester, Northants.



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

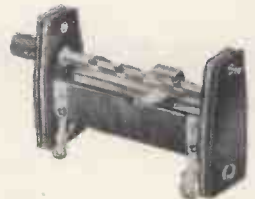
**PRE-SET POTENTIOMETERS.** Completely enclosed in high-grade phenolic mouldings. Solder tags heavily silver plated for quick soldering. Fully insulated spindles with integral control knobs. Tapped for 2-hole 6 B.A. fixing on  $\frac{1}{4}$ " centres. Type 126, wire-wound. Type 127, carbon.



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68U designed and built with the same precision and care



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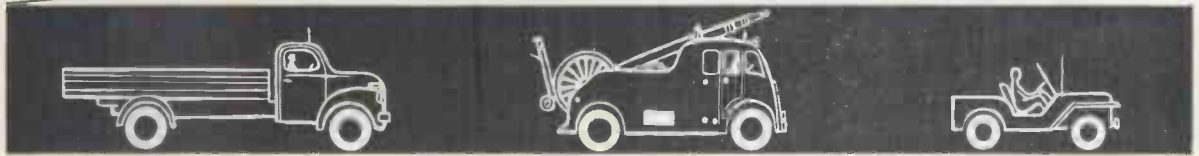
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**VHF TRANSMITTER RECEIVER**



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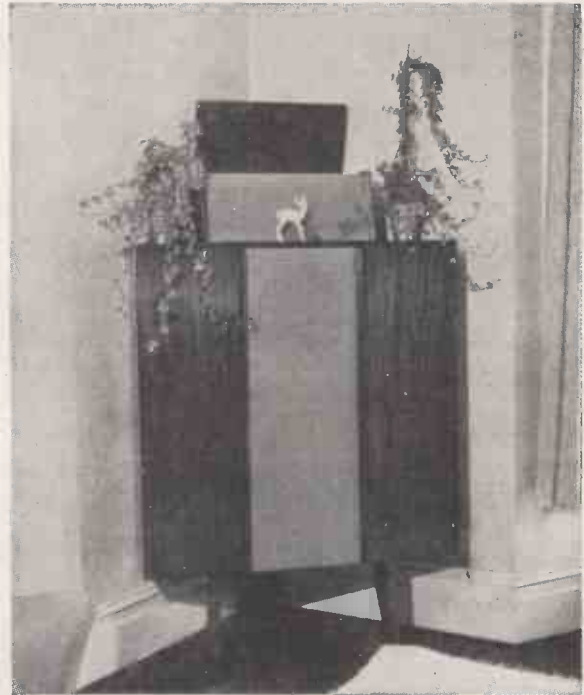
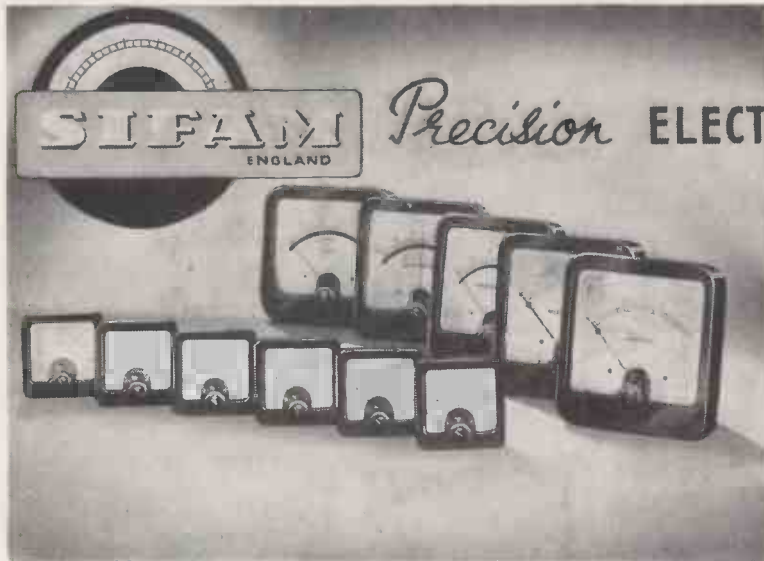
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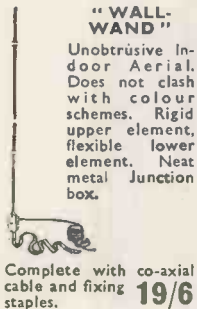
June 28 - July 9 1955

# WOLSEY

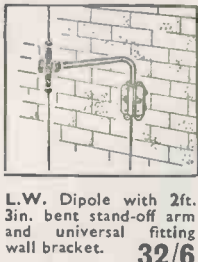
## "QUICK-FIX" AERIALS for BAND I, BAND III and F.M.

**Peak Performance types for Everywhere**

**"WALL-WAND"**  
 Unobtrusive In-door Aerial. Does not clash with colour schemes. Rigid upper element, flexible lower element. Neat metal Junction box.

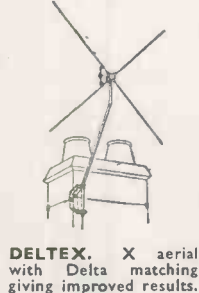


Complete with co-axial cable and fixing staples. **19/6**



**L.W.** Dipole with 2ft. 3in. bent stand-off arm and universal fitting wall bracket. **32/6**

**LW/VA.** As above, with 4ft. 6in. almost vertical arm. **39/6**



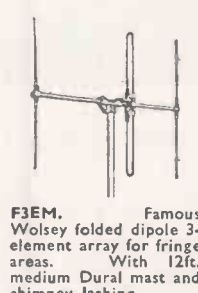
**DELTEX.** X aerial with Delta matching giving improved results. **77/6**

**DXL.** With 6ft. stand-off arm and chimney lashing **77/6**  
**DXW.** With 4ft. 6in. arm and wall bracket. **65/-**



**HL.** "H" aerial with 4ft. 6in. cranked arm and chimney lashing. **82/6**

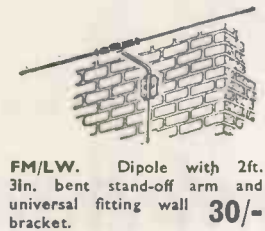
**HM/CA.** With 9ft. x 1 1/2in. medium Dural mast and chimney lashing. **£5.17.6**



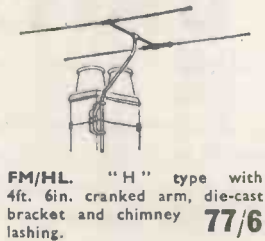
**F3EM.** Famous Wolsey folded dipole 3-element array for fringe areas. With 12ft. medium Dural mast and chimney lashing.

Channels 1, 2, 3 **£12.12.6**  
 4 and 5 **£12.2.6**  
 Aerial only available. Price on request.

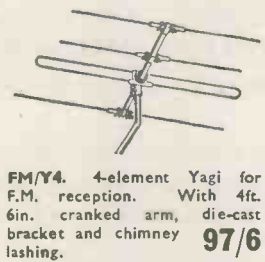
### F. M. AERIALS



**FM/LW.** Dipole with 2ft. 3in. bent stand-off arm and universal fitting wall bracket. **30/-**

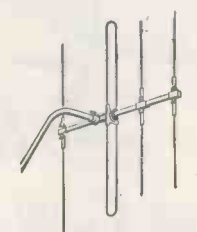


**FM/HL.** "H" type with 4ft. 6in. cranked arm, die-cast bracket and chimney lashing. **77/6**

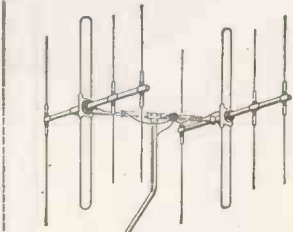


**FM/Y4.** 4-element Yagi for F.M. reception. With 4ft. 6in. cranked arm, die-cast bracket and chimney lashing. **97/6**

### BAND III AERIALS

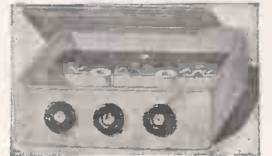


**Y4.** 4-element Yagi for districts not fully covered in primary service area. With 4ft. 6in. cranked arm, die-cast bracket and chimney lashing. For use with 70-80 ohms co-axial cable only. **77/6**



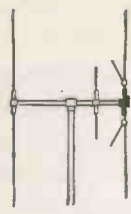
**BA/Y4.** Broadside Array for Band III fringe areas. Two Y4 aeriels connected via matching lines and splitter box. Complete with cranked arm, die-cast bracket and chimney lashing. For use with 70-80 ohms co-axial cable only. **£7.15.0**

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*Patent Pending*  
 For linking separate Band I and Band III aeriels (both 70-80 ohms) to receiver via one down-lead.  
**1957.** Wall or wainscot mounting. **15/-**  
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### The WOLSEY "TWIN-BAND" COMBINED BANDS I AND III AERIAL



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- ★ All Band I types available for all Channels, vertical or horizontal polarisation.
- ★ All types PRE-ASSEMBLED for speedy installation.
- ★ Wolsey's unique SQUARE FITTING ensures self alignment plus rigidity.
- ★ All Junction Boxes completely waterproof and positively locked to cross-arm.

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Write for descriptive leaflets, or ask your usual dealer to demonstrate. Alternatively, these and other Stentorian speakers may be heard at our London Office (109 Kingsway, W.C.2) any Saturday from 9 a.m. to noon.



WHITELEY ELECTRICAL RADIO CO. LTD  
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**Telecommunications**

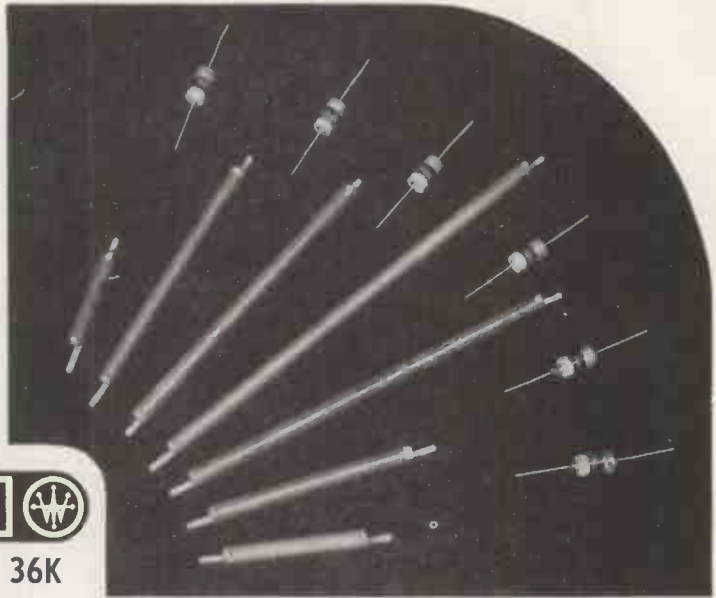
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# WESTALITE

## RECTIFIERS TYPE 36EHT & 36K

| TYPE No. | PEAK INVERSE VOLTAGE | R.M.S. INPUT VOLTAGE | OUTPUT VOLTAGE |      | PEAK PULSE INPUT VOLTAGE | TYPICAL OUTPUT VOLTAGE AT 100 $\mu$ A |
|----------|----------------------|----------------------|----------------|------|--------------------------|---------------------------------------|
|          |                      |                      | 100 $\mu$ A    | 2 mA |                          |                                       |
| 36K1     | 85                   | 27                   | 35             | 30   | -                        | -                                     |
| 36K6     | 510                  | 162                  | 210            | 185  | -                        | -                                     |
| 36K14    | 1190                 | 378                  | 490            | 440  | -                        | -                                     |
| 36EHT25  | 2125                 | 675                  | 875            | 820  | 1810                     | 1640                                  |
| 36EHT70  | 5950                 | 1890                 | 2450           | 2320 | 5080                     | 4580                                  |
| 36EHT100 | 8500                 | 2700                 | 3500           | 3250 | 7250                     | 6550                                  |
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For further information on EHT rectifiers, write for Data Sheet No. 60 to: Dept. W.W.4.

**WESTINGHOUSE  
BRAKE & SIGNAL CO. LTD.**

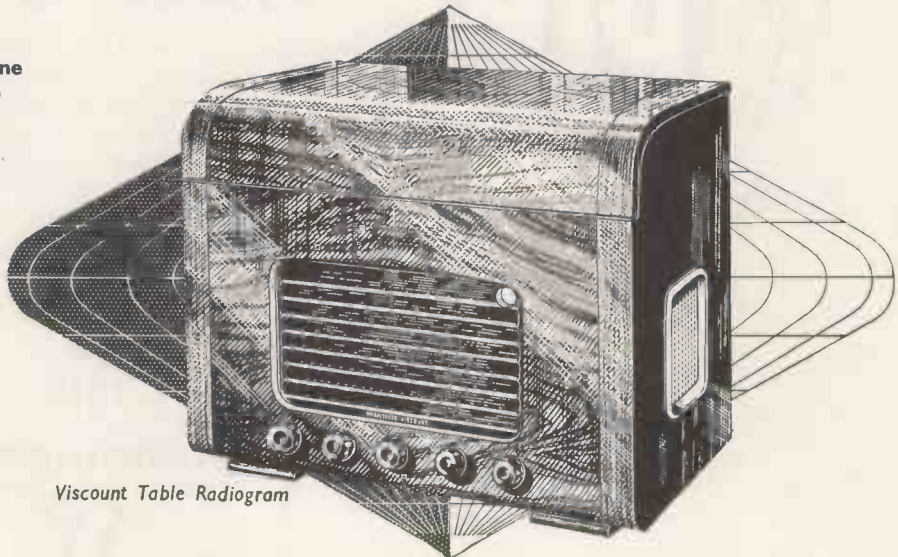
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Reports reach the factory daily as to the excellence of its performance in all parts of the world.



Viscount Table Radiogram

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Full details on request.

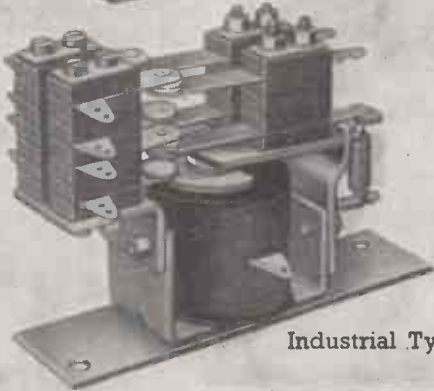
AMBASSADOR RADIO AND TELEVISION

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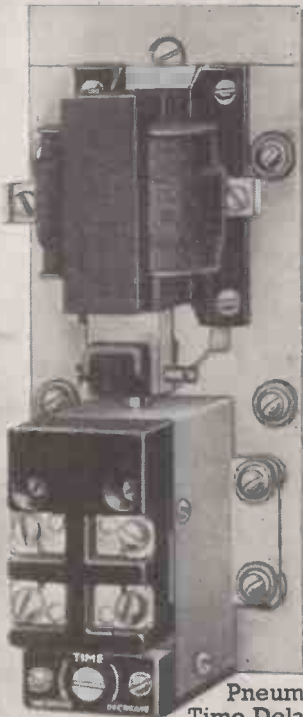
Instrument Type



Industrial Type



Miniature Moving-Coil Type



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Also manufacturers of:- Cartridge Thermostats, Adjustable Contact Thermometers, Magnetic Amplifiers, Low-Inertia Integrating Motors.

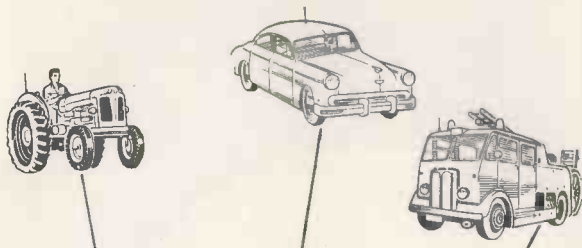
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OF LONDON

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- AM/250/M ... 5 watt Vehicle Station, 60 to 100 Mc/s.
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Single or up to 5 channels.
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Supplied to the G.P.O. and Home Office.

**HUDSON ELECTRONIC DEVICES, LTD.**

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## FOR HIGH PERFORMANCE THE B.30 SERIES

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### UP TO 4 WAVE BANDS — GRAM. SWITCHING

Fully tropicalised, iron-cored coils wound on moulded bakelite formers. Ceramic based, compression-type trimmers. Close tolerance, silvered mica padders.

**B30/G — TUNING CAPACITY 483-532 pF.**  
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Coverage 12.5-550 m. in 4 bands.

**B32/G — TUNING CAPACITY 483-532 pF.**  
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**B34/G — TUNING CAPACITY 483-532 pF.**  
**B35/G — " " 354-399 pF.**  
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PRICES: B30-33 93/9 + 30/6 P.T.  
B34-35 84/5 + 27/5 P.T.

### FOR USE WITH THESE I.F. TRANSFORMERS

**WEYRAD  
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Operating at  
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A very wide choice of I.F. stage arrangements is possible. The types listed cover transformers of the highest possible electrical and mechanical quality, low cost versions for manufacturers and special types providing variable selectivity characteristics.

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# Connoisseur VARIABLE 3-SPEED GRAMOPHONE MOTOR



## CONNOISSEUR Super Lightweight 3-head Pick-up with Sapphire Stylus

Prices: Complete Pickup with one head (either Standard 78 r.p.m. or Microgroove 33 $\frac{1}{2}$  or 45 r.p.m.) £4 10s. 0d. + P.T. £1 12s. 1d. Total £6 2s. 1d. Each additional head £2 10s. 0d. + P.T. 17s. 10d. Total £3 7s. 10d. Replacement Armature 10s. 3d. + P.T. 3s. 8d. Total 13s. 11d.

Fitted with Diamond Stylus, complete Pickup with one head £7 12s. 9d. + P.T. £2 14s. 5d. Total £10 7s. 2d. Each additional head £5 12s. 9d. + P.T. £2 0s. 2d. Total £7 12s. 11d. Replacement Armature £? 13s. 0d. + P.T. £1 6s. 0d. Total £4 19s. 0d.

We present an entirely new three-speed unit operating at 33 $\frac{1}{2}$ , 45 and 78 r.p.m. The full 12" turntable is lathe-turned and manufactured of non-ferrous material. The main spindle is precision ground and lapped to mirror finish and runs in phosphor bronze bearings. The synchronous motor is dynamically balanced and resiliently mounted, making it virtually vibrationless, with low noise level and low hum induction.

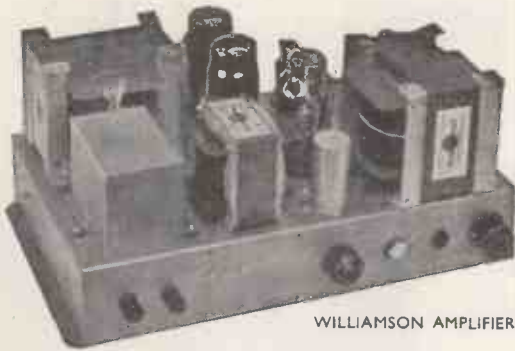
The speed change is arranged mechanically and gives a 2% variation on all speeds, the synchronous motor running at constant speed at all settings. No braking action is employed to obtain speed change.

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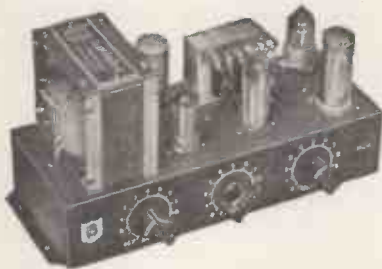
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WILLIAMSON AMPLIFIER



P.A.I. PRE-AMP



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| "    Bronze 8 AL         | £3 10 8  |
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| "    Super 8 CS          | £6 6 7   |
| "    Super 8 CS/AL       | £6 13 3  |
| "    Golden 10           | £7 13 3  |
| "    Golden CSB          | £8 6 7   |
| "    W.12                | £9 5 0   |
| "    W.12 CS             | £9 15 0  |
| "    Super 12 CS/AL      | £17 10 0 |
| "    W.15                | £17 0 0  |
| "    W.15 CS             | £17 10 0 |
| GOODMANS Axiom 101       | £6 12 1  |
| "    "    102            | £9 18 2  |
| "    "    150 Mk. II     | £10 5 6  |
| "    "    22 Mk. II      | £14 14 0 |
| "    Audiom 60           | £8 12 6  |
| "    "    70             | £13 15 0 |
| "    "    80             | £22 10 0 |
| "    "    90             | £28 0 0  |
| W.B. HF.810              | £3 5 6   |
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| Model 2010 | £18 6 6 |

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| RC80M AC/DC                | £26 3 5  |
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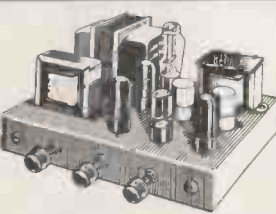
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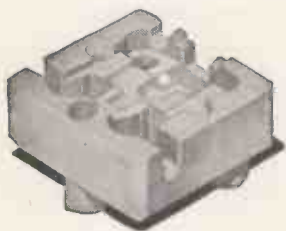
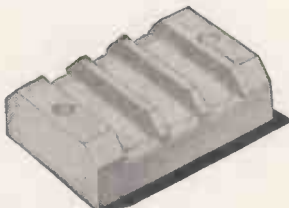
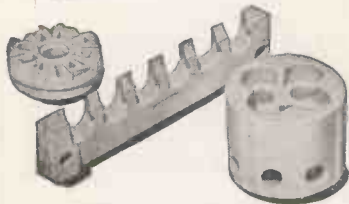
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how the system responds to waves which are square.

We don't claim to make reproducers which will produce  
mathematically precise square pressure waves but we do make  
loudspeakers which are unusually free from major vices.

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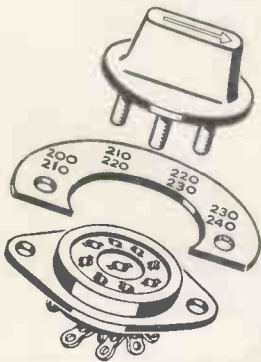
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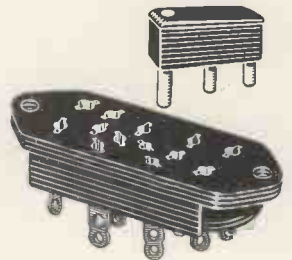
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Non-standard marking is available to special order.

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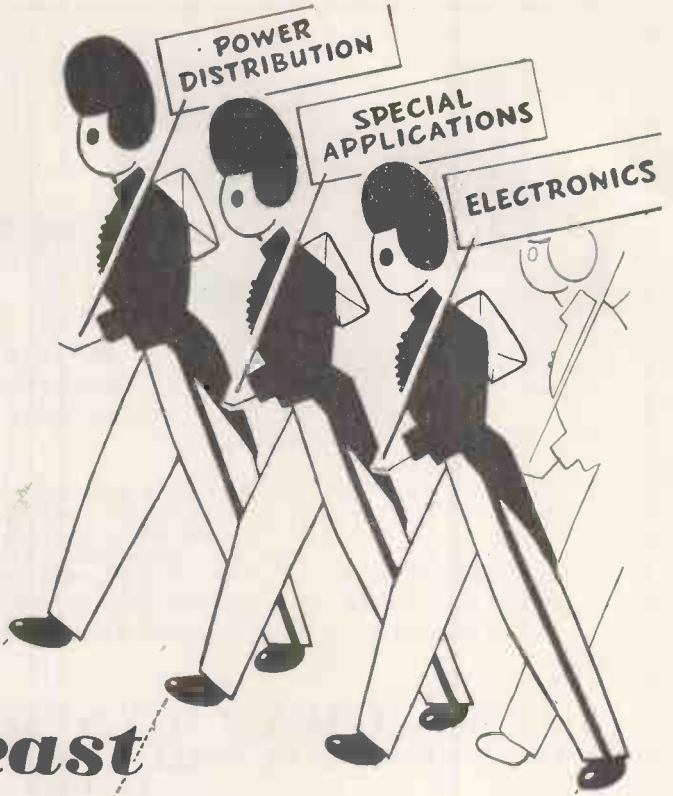
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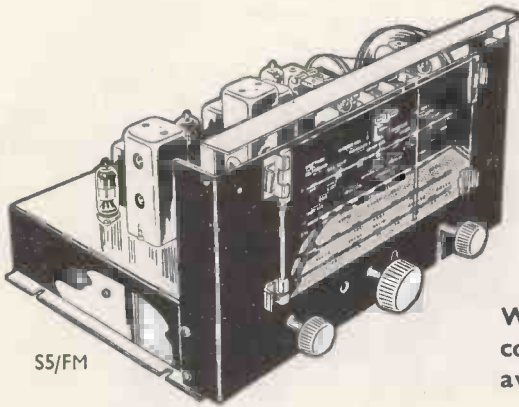
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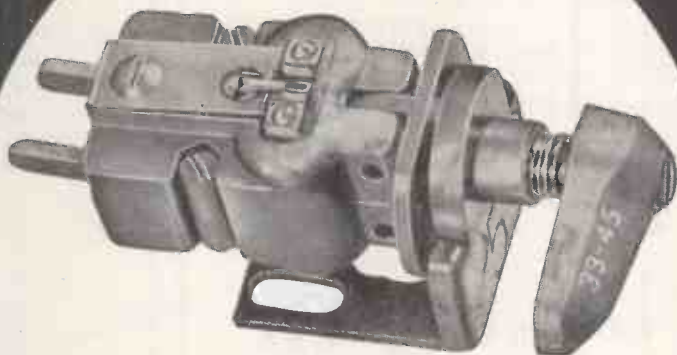


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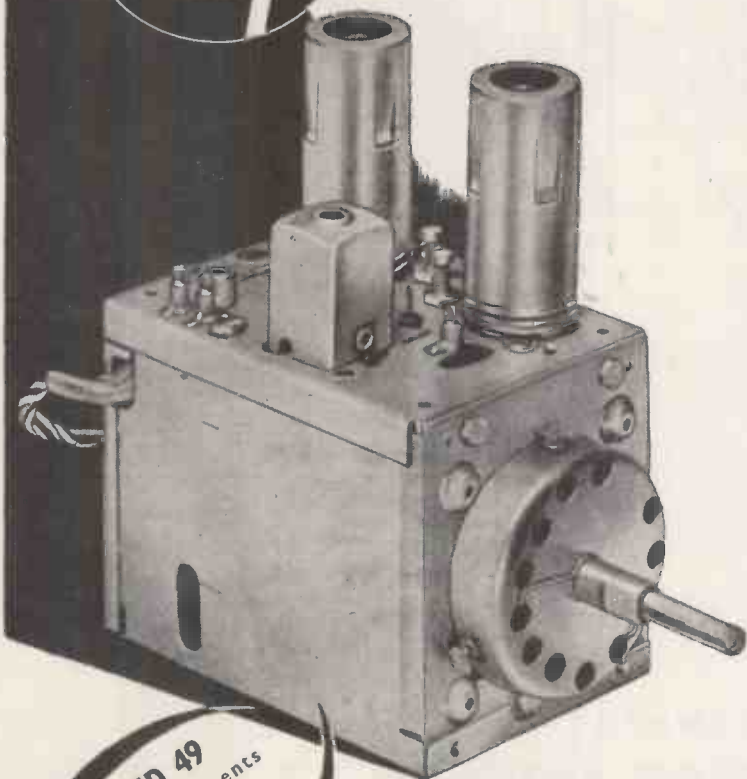


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## The release of the Oak 12K switch type television tuner



**STAND 49**

Radio Components  
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**S**PECIFICALLY designed for the British market, and based on the well-proved NSF-OAK rotary switch principles, this switch-type cascade amplifier television tuner reflects, once again, the consistently high quality for which all NSF-OAK products are

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*Sole licensees of Oak Manufacturing Company, Chicago*

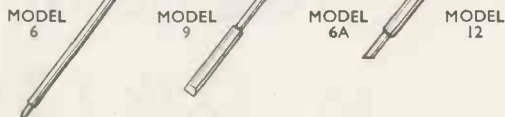
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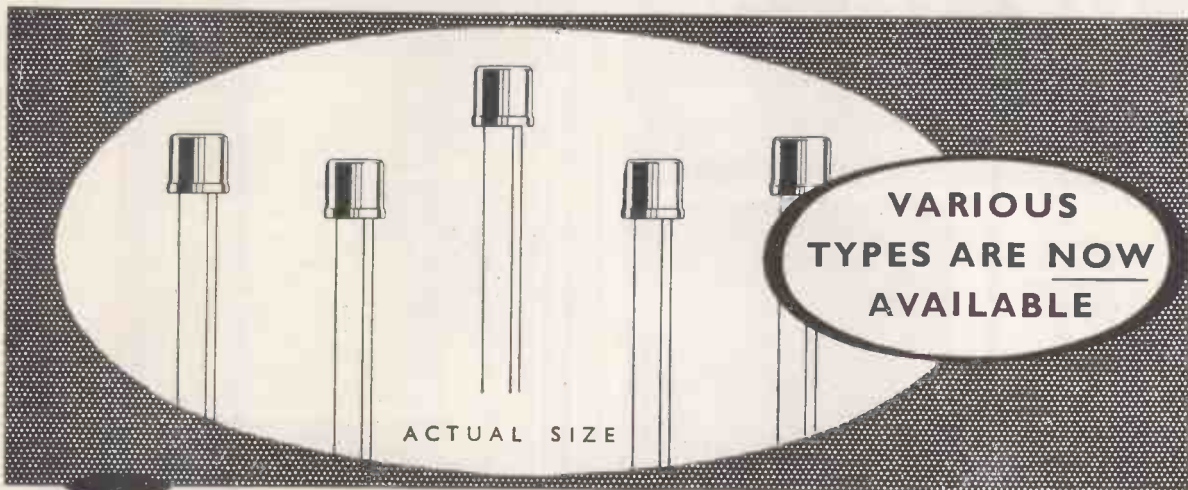
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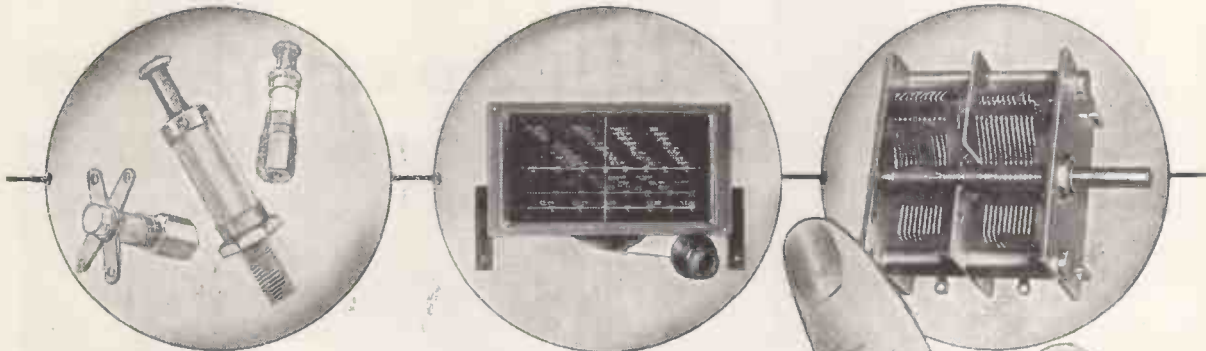
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in equipment for the DEAF  
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enables the deaf to hear the programmes without disturbance to others.



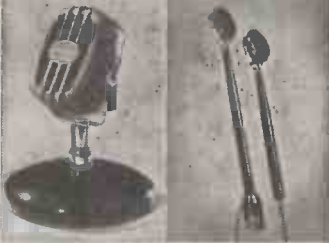
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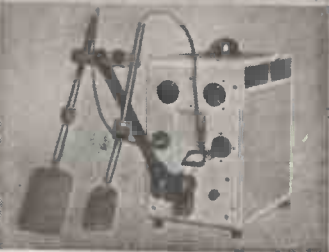
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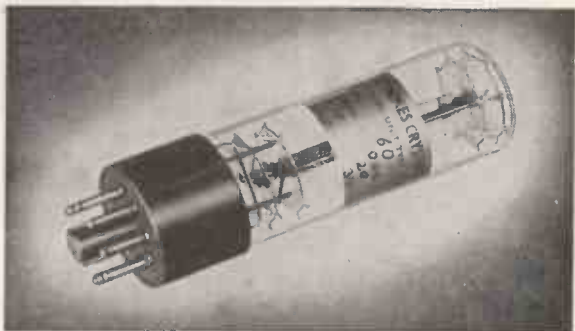
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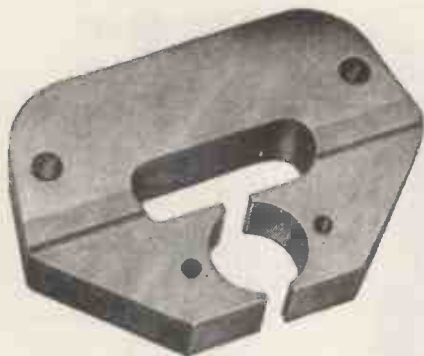
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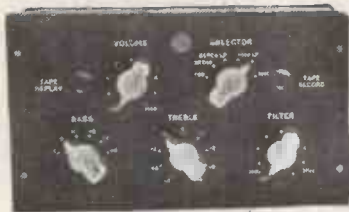
Photographs by courtesy of Taylor Electrical Instruments Ltd. of model 88a Multirange Measuring Meter, 20,000 o.p.v. D.C., 2,000 o.p.v. A.C., and model 77a Multirange Universal Test Meter, 20,000 o.p.v. D.C., 5,000 o.p.v. A.C.

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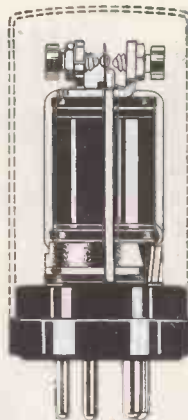
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CONDENSER SPECIALISTS FOR OVER 20 YEARS

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## Announcing the new Manning-Carr P.53C Miniature Polarised Relay

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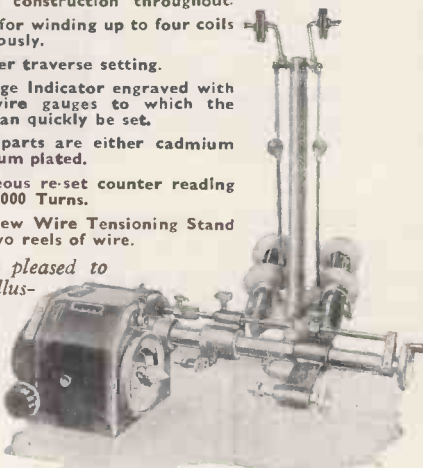
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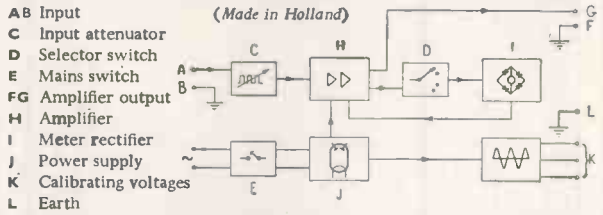
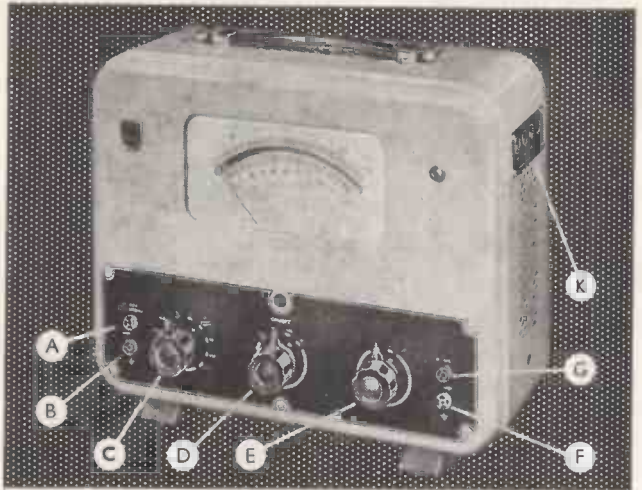
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For measurement of voltage in the acoustic and ultra-sonic field

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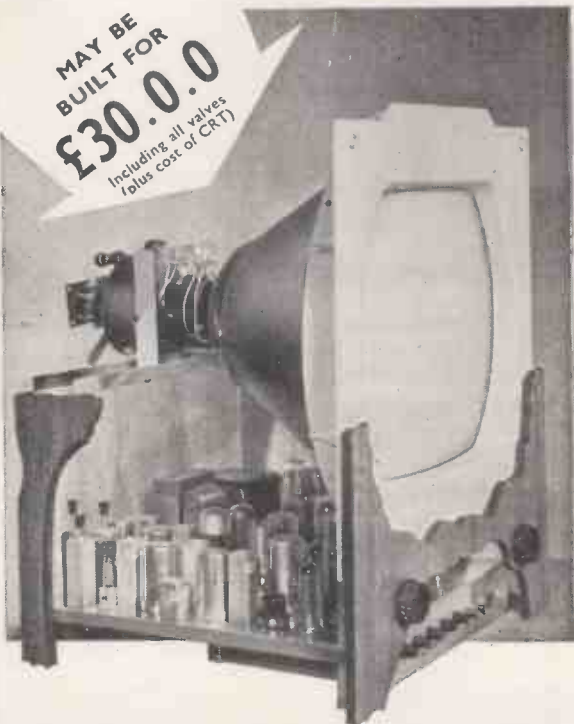
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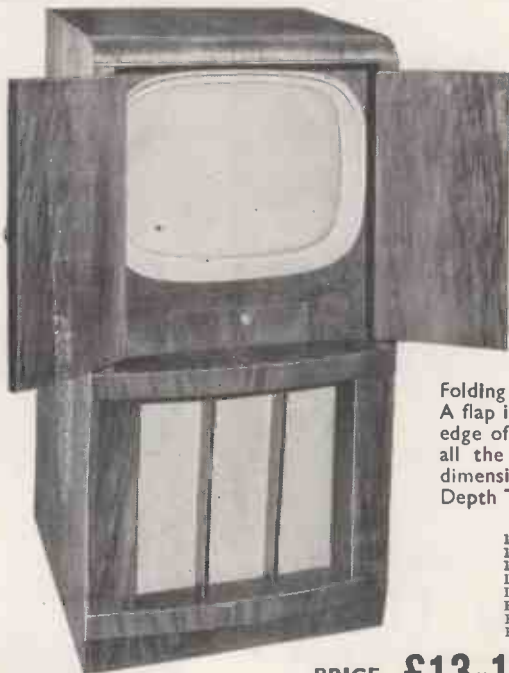
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BUILT FOR  
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Including all valves  
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THE COMPLETE TELEVISOR IS SAFE TO HANDLE, BEING COMPLETELY ISOLATED FROM THE MAINS BY A DOUBLE WOUND MAINS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



## The NEW PREMIER TELEVISOR

SUITABLE FOR USE WITH THE ENGLISH ELECTRIC CATHODE RAY TUBE T901 OR ANY POPULAR WIDE ANGLE TUBE

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 Focalliser, permanent magnet focusing with simple picture centring adjustments, suitable for any 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.

**SOUND CIRCUIT.** Coupling from anode of frequency changer, two IF stages, Double Diode Triode detector and first LF Amplifier, Diode Noise Limiter and Beam type Output Valve, feeding a 10in. Speaker. ALL COILS PRE-TUNED.

**TIME BASES.** 2 valve sync. Separator, giving very firm lock and excellent interlace.

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

**FRAME TIME BASE.** Blocking Oscillator driving a Beam Output Valve coupled through a Transformer to the high efficiency FERROXCUBE Cored Scanning Coils.

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

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.

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 3/6, Post Free.

## PREMIER TELEVISOR CONSOLE CABINETS For 14", 16" and 17" Televisors

A handsome Walnut Cabinet that will be a fitting housing for a first-class Televisor.

Folding doors are fitted to cover the Cathode Ray Tube when not in use. A flap is provided which gives access to the 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 the Cabinets are the same: Height 38½in. Width 19in. Depth Top 19in. Depth Bottom 21in.

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| 17in. White Moulded .....                                   | 21/- (pkg. & post 1/6) |
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PRICE **£13-10-0** PLUS 21/- PKG. & CAR. H.P. TERMS: DEPOSIT **£3.7.6** & 12 MONTHLY PAYMENTS OF 18/9

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

# PREMIER RADIO COMPANY

Limited supplies of C.R. TUBES

**VCR517C**

6 1/2 in. picture. This tube is a replacement for the VCR97 and VCR517. Guaranteed full size picture. Price 35/- plus 2/6 pkg., carr., ins.

**VCR516**

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



ALL BRAND NEW

**CABINETS—PORTABLE**

**Model PC/1**

Brown Rexine covered

Overall dimensions 15/11

15 in. x 13 in. x 5 in.

Clearance under lid when closed 2 1/2 in.

**Model P2/C**

Grey Lizard Rexine covered

Overall dimensions 45/-

15 in. x 13 in. x 6 in.

Clearance under lid when closed 3 in.

**Model PC/3**

Rexine type covering in various colors

Overall dimensions 69/6

16 in. x 14 in. x 10 in.

Clearance under lid when closed 6 1/2 in.

All the above Cabinets are supplied with Panel, Carrying Handle and Clips.



Packing and Postage 2/6.

**UNITELEX 5-watt Amplifier Type MG4/MG4A**

For Gramophone and Microphone operation, enclosed in metal case, output suitable for 15 and 3 ohms Speakers, switched input 2VA miniature Valves, separate treble and bass tone controls, for A.C. mains 200/250 v. Price, enclosed in metal case, £9/19/6. Price, less metal case, £8/18/6. Packing and Postage 7/6.

SPECIAL OFFER!

**CONSOLE TV CABINET**

Ex-Baird at £10.10.0

Send for copies of photographs.

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| E.H.T. Penoid Type S.T.C. |          |         |      |
|---------------------------|----------|---------|------|
| Type K3/25                | 650 v.   | 1 mA.   | 4/7  |
| " K3/40                   | 3.2 kV.  | 1 mA.   | 6/-  |
| " K3/45                   | 3.6 kV.  | 1 mA.   | 8/2  |
| " K3/50                   | 4 kV.    | 1 mA.   | 8/8  |
| " K3/100                  | 8 kV.    | 3 mA.   | 14/8 |
| " NS/160                  | 12 kV.   | 1 mA.   | 21/6 |
| " K3/180                  | 14.4 kV. | 1 mA.   | 24/6 |
| H.T. Type S.T.C.          |          |         |      |
| Type RM1                  | 125 v.   | 60 mA.  | 4/-  |
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| " RM4                     | 250 v.   | 250 mA. | 18/- |
| L.T. Type Full Wave       |          |         |      |
| 6 v. 1 amp.               |          |         | 4/-  |
| 12 v. 1 amp.              |          |         | 8/-  |
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**BATTERY CHARGERS**

200-250 v. A.C. Will charge 2 v. 6 v. and 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green Hammered enamel. Size 6 in. long, 3 1/2 in. wide, 3 1/2 in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain Ex - Govt. components. Plus 2/6 P. and P. **39/6**



**BATTERY CHARGER KITS**

All incorporate metal rectifiers. Transformers are suitable for 200-250 v. A.C. cycle mains. Cat. No.

2002 Charge 6 volt accumulator at 1 amp. Resistance, supplied to charge 2 volt Accumulator ..... **13/6**  
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**ALUMINIUM CHASSIS 18 s.w.g.**

Substantially made from Bright Aluminium with four sides:

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| 7 x 5 1/2 in. ....      | 4/- | 10 x 9 x 3 in. ....     | 7/-  |
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| 9 1/2 x 4 1/2 in. ....  | 4/3 | 14 x 10 x 3 in. ....    | 7/11 |
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**ALUMINIUM PANELS 18 s.w.g.**

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

**STOP PRESS**

First release of the Famous COMMUNICATION RECEIVER TYPE RA-1B manufactured by the BENDIX RADIO CORP. OF AMERICA, valve line-up 6K7, R.F. Amp., 6L7 1st det., 6K7 Osc., 6K7 1st IF. Amp., 6K7 2nd IF. Amp., 6K7 CW. Osc., 6B7 2nd det., AVC and 1st Audio. 6K6 Audio output. Frequency coverage 0.15 to 1.5 Mcs. (2,000-200 metres) in three bands. 1.8 to 15.0 Mcs. (166-20 metres) in three bands. The frequency coverage on each band is approximately 2/1 giving EXCELLENT BAND SPREAD TUNING. Power requirements are 1.5 amps. at 12 volts and approximately 70 mA. at 225 volts. WRITE FOR FULL DETAILS.

**GRAMPHONE PRE-AMPLIFIER**

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

*Famous Manufacturer's Surplus of*

**ANTI - INTERFERENCE AERIALS**

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

**COMPONENT PARTS**

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

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

## The New "PREMIER PORTABLE" TAPE RECORDER

USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6  
**COMPLETE 39 GNS CASH**

Packing & Carriage 1 gn.

(Including Reel of Scotch Boy Tape and Microphone)

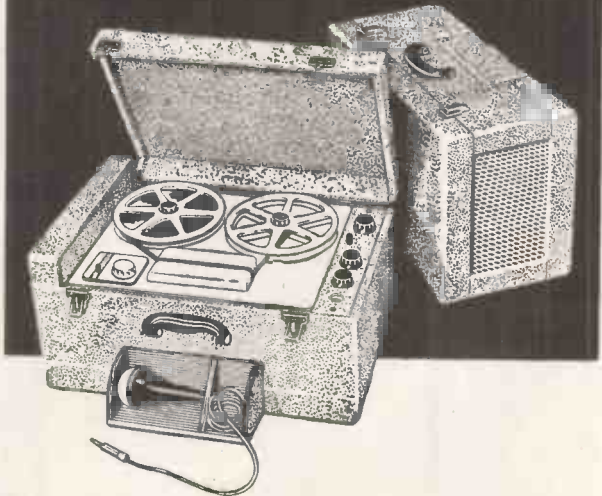
H.P. Terms: Deposit £10.4.9 and 12 monthly payments of £2.16.11,

or Complete Kit Including All Parts, Valves, Speaker Cabinet, Tape Unit, Reel of Scotch Boy Tape, Rewind Spool and Microphone at **£37.4.0** plus pkg. & carr. 15/-.

H.P. Terms: Deposit £9.6.0 and 12 monthly payments of £2.10.0.

**SPECIFICATION**

- ★ TWO SPEEDS 7 1/2 in. AND 3 1/2 in.
- ★ 7-VALVE HIGH QUALITY AMPLIFIER.
- ★ THREE SPECIALLY DESIGN-ED RECORDING MOTORS.
- ★ INDEPENDENT TREBLE AND BASS CONTROLS.
- ★ 1,200ft. TAPE REELS PROVIDING PLAYING TIMES OF 1 HR. AND 2 HRS.
- ★ MAGIC EYE RECORD LEVEL INDICATOR.
- ★ DROP-IN TAPE LOADING.
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- ★ COMPARTMENT FOR HOUSING MICROPHONE.
- ★ ONE KNOB DECK OPERATION.
- ★ SPECIALLY DESIGNED MICROPHONE BY A LEADING MANUFACTURER.



**SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW:—**

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- Portable Cabinet (rexine covered). £4/19/6, plus postage and carriage 5/-.
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- Reel Scotch Boy Tape MC2-111 (1,200ft.), £1/15/-, plus packing and carriage 1/-.
- Instruction Booklet, 2/6. Post free.



# PREMIER RADIO COMPANY

## 1155 RECEIVER UNIT

### NEW CONDITION

In original cases complete with 10 valves. Frequency range 18.5 Mc/s. 75 Kc/s. in 5 wave-bands. £11/19/8. Plus 10/8 packing and carriage.  
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## POWER SUPPLY UNIT WITH OUTPUT STAGE FOR ABOVE



Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6in. speaker is built into the unit. Price £25/5/-, plus 9/- packing and carriage. The two above Units together on Hire Purchase Terms: £4/6/2 Deposit and 12 monthly payments of £1/3/11 plus 15/6 pkg. and carriage.

**PUSH-PULL OUTPUT TRANSFORMERS.** 2 x 6V6 into 2/3 ohms, 5/6, post free.

**T.1154. BRAND NEW COMPLETE WITH VALVES.** £3/19/6, post and carriage 7/6.

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**HEAVY DUTY POWER RESISTANCE.** 17.5 ohms, 8 a., with adjustable tapping 19in. long, 2in. diameter, 10/-, postage and carriage 2/-.

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**VACUUM PUMPS.** For model makers, etc. Ex-B.A.F. Type B3-Mk. III, £2/6, postage and carriage 2/-.

## E.A.R. MULLARD 5-10 AMPLIFIER



PRICE  
**£18.18.0**

Plus postage and packing 7/6.

This Amplifier is based on the Mullard design and incorporates a change-over switch for standard, L.F. records and radio. Plug-in filter supplied, alternative types available. The switched input is fed in on 2 Co-axial Sockets, output is available for 3 to 15 ohms Speakers. Power supply for Pre-amplifier or Radio Unit provided by the Amplifier, H.T. 300 volts 40 mA. and 6.3 volts 2 amps. H.F. Terms are available, Deposit £4/14/6 and 12 monthly payments of £1/6/3.

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**GARRARD 301 TRANSCRIPTION UNIT.** Cash Price £25/3/8. Deposit £8/6/-, 12 monthly payments £1/15/- Post and packing 7/6.

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**LEAK TL.10 AMPLIFIER AND PREAMPLIFIER.** Cash price £28/7/-, Deposit £7/2/-, 12 monthly payments £1/19/6. Post and packing 7/6.

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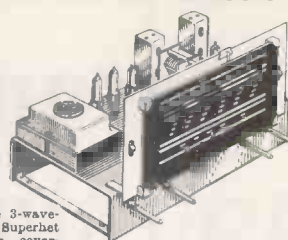
**TRUVOX TYPE C AMPLIFIER.** Cash price £16/16/-, Deposit £4/2/-, 12 monthly payments £1/3/8. Post and packing 7/6.

**TRUVOX MK. III DECK.** Cash price £23/2/-, Deposit £5/17/-, 12 monthly payments £1/12/- Post and packing 7/6.

**ELFEO TUNER UNIT MODEL RF/720.** Cash price £15/15/-, Deposit £3/18/9, 12 monthly payments £1/1/11. Post and packing 5/-.

**REGENTONE HANDY GRAM.** Cash price £21. Deposit £5/2/-, 12 monthly payments £1/9/6. Post and packing 7/6.

## RADIOGRAM CHASSIS



5 Valve 3-wave-band Superhet Receiver covering short, medium and long waves. Using the latest miniature all glass valves, overall chassis size 13in. x 7in. high x 6in. deep, dial aperture 10in. x 4in. **BRAND NEW, READY FOR USE AND GUARANTEED.** Packing and postage 10/-.  
**£10-5-0**  
Or on Hire Purchase Terms, deposit £2/11/3 and 8 monthly payments of £1/1/9.

**CABINET** available for above Chassis in figured walnut lined with white asbestos, size 3ft. wide, 2ft. 8in. high 3ft. 5in. deep, £15/15/-.  
Or on Hire Purchase Terms, deposit £3/18/9 and 12 monthly payments of £1/1/11.  
Packing and Carriage extra.

## GARRARD S5 UNIT

Garrard rim drive 78 r.p.m. complete with magnetic pickup and turntable.  
**£4-19-6**  
Postage and packing 2/6.

## FREQUENCY MODULATION

All components for the Denco F.M. Unit, less Valves.  
Packing and postage 1/6.  
**£4-16-1**

## COMPONENTS AVAILABLE FOR THE MULLARD AND OSRAM DESIGNS.

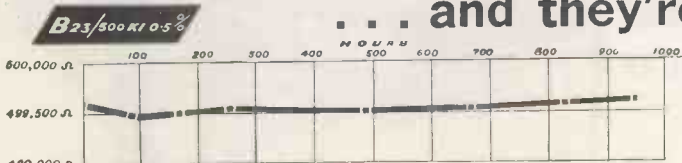
### Consistency of Performance

# Just one of a bunch . . .

We test our precision resistors on a sampling basis. Here's the performance of one little fellow, taken at random from a batch and loaded at its full rated power for close on 1,000 hours. You'll see from the chart how it stood up to the treatment: a total excursion of 0.036 per cent. and an absolute change of only 0.01 per cent.



## . . . and they're all much alike!



Even our miniature precision resistors are guaranteed a standard tolerance of 0.1 per cent.

Welwyn Precision Wirewound Resistors for

- Long term stability
- Freedom from noise
- Fine performance in tropical conditions



Products include:

- Toroidally Wound Power Potentiometers.
- Pancilmatic High Stability Carbon Resistors.
- Vitreous Enamelled Wirewound Resistors.
- Carbon Composition and Wirewound Potentiometers.
- Insulated High Stability Carbon Resistors.
- High Voltage Composition Resistors.

# Rigorous inspection

*ensures  
faultless  
performance*



*One of a line of testing booths where the final electronic test is carried out.*

Continual, exacting inspection is an important routine at the B.S.R. factories. Throughout the entire production cycle, each Monarch Autochanger is submitted to the most stringent tests for quality, accuracy and performance. Here, the inspector's word is final.

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AUTOMATIC RECORD CHANGER



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# Wireless World

RADIO, ELECTRONICS, TELEVISION

*Managing Editor:*

HUGH S. POCOCK, M.I.E.E

*Editor:*

H. F. SMITH

APRIL 1955

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VOLUME 61 NO. 4

PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR  
OF PUBLICATION

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# VALVES, TUBES & CIRCUITS

## 28. A NEW 25W AUDIO OUTPUT PENTODE

The EL34 is an indirectly-heated octal-based output pentode which is now being added to the Mullard range of audio valves. It has a rated anode dissipation of 25W and the high mutual conductance of 11mA/V. This valve covers all applications requiring powers between 11W (single valve) and 100W (push-pull), and is equally suitable for high quality domestic amplifiers and public address equipment. It has a comparatively small diameter for a 25W output pentode: the straight-sided envelope rises directly from a foot less than 38mm in diameter. The maximum overall length is 113mm and the maximum seated height 98mm.

Two triode-connected EL34's operated in push-pull for a domestic amplifier give an output of either 14W at less than 1% total harmonic distortion with a line voltage of 430V, or 16W at 3% distortion with a line voltage of 400V. For public address equipment two EL34's may be operated in pentode push-pull, again using cathode bias, and with a line voltage of 375V the available output is 35W at 5% total harmonic distortion. For even higher powers fixed bias may be used with anode voltages of up to 800V; the power output when the anode voltage is 800V is 100W at 5% distortion.

A single EL34 operated in Class A gives an output of 11W at 10% distortion with a line voltage of 265V.

A special technique has been devised to enable the EL34 to operate at high anode voltages whilst retaining a single-ended octal-based construction. The valve envelope is made completely of glass, with a conventional pressed glass foot, and clamped into a metal ring which holds together the glass and the plastic material of the octal base. The stiff wire leads projecting from the glass envelope line up exactly with the pinning in the octal base; during manufacture these leads are passed straight inside the octal pins, without crossing over outside the bulb, and so the risk of flash-over is very much reduced. For high voltage operation the valvholder of course must also be able to withstand the high tension.

Such a small valve as the EL34, dissipating a large amount of power at the anode and screen grid as heat, needs reasonable ventilation. It should be mounted vertically, and the air should be able to circulate freely. The distance between two EL34's should be at least 40mm, and the distance from the cabinet and other components at least 30mm. Wirewound resistors, mains transformer, and rectifier should not be in the immediate vicinity.



### Abridged Data

#### HEATER

|                |     |   |
|----------------|-----|---|
| V <sub>h</sub> | 6.3 | V |
| I <sub>h</sub> | 1.5 | A |

#### TYPICAL OPERATING CONDITIONS

##### Single valve

|                          |       |      |
|--------------------------|-------|------|
| V <sub>b</sub>           | 265   | V    |
| V <sub>a</sub>           | 250   | V    |
| V <sub>g2</sub>          | 265   | V    |
| V <sub>g3</sub>          | 0     | V    |
| V <sub>g1</sub>          | -13.5 | V    |
| I <sub>a</sub>           | 100   | mA   |
| I <sub>g2</sub>          | 14.9  | mA   |
| g <sub>m</sub>           | 11    | mA/V |
| r <sub>a</sub>           | 15    | kΩ   |
| μ <sub>g1-g2</sub>       | 11    |      |
| R <sub>a</sub>           | 2     | kΩ   |
| V <sub>in</sub> (r.m.s.) | 8.7   | V    |
| P <sub>out</sub>         | 11    | W    |
| D <sub>tot</sub>         | 10    | %    |

##### Pentode Push-Pull

|                                | Self Bias | Fixed Bias |    |
|--------------------------------|-----------|------------|----|
| V <sub>b(a)</sub>              | 375       | 800        | V  |
| V <sub>b(g2)</sub>             | 375       | 400        | V  |
| R <sub>g2</sub> (common)       | 470       | 750        | Ω  |
| I <sub>a(o)</sub>              | 2 x 75    | 2 x 25     | mA |
| I <sub>a</sub> (max. sig.)     | 2 x 95    | 2 x 91     | mA |
| I <sub>g2(o)</sub>             | 2 x 11.5  | 2 x 3      | mA |
| I <sub>g2</sub> (max. sig.)    | 2 x 22.5  | 2 x 19     | mA |
| V <sub>g1</sub>                | -22.5     | -39        | V  |
| R <sub>k</sub>                 | 130       | —          | Ω  |
| R <sub>a-a</sub>               | 3.4       | 11         | kΩ |
| V <sub>in</sub> (g-g) (r.m.s.) | 42        | 47         | V  |
| P <sub>out</sub>               | 35        | 100        | W  |
| D <sub>tot</sub>               | 5         | 5          | %  |

##### Triode Push-Pull (Self Bias)

|                                |        |        |    |
|--------------------------------|--------|--------|----|
| V <sub>b</sub>                 | 400    | 430    | V  |
| R <sub>k</sub> (common)        | 220    | 250    | Ω  |
| I <sub>a(o)</sub>              | 2 x 65 | 2 x 64 | mA |
| I <sub>a</sub> (max. sig.)     | 2 x 71 | 2 x 67 | mA |
| V <sub>g1</sub>                | -29    | -32    | V  |
| R <sub>a-a</sub>               | 5      | 10     | kΩ |
| V <sub>in</sub> (g-g) (r.m.s.) | 44     | 48     | V  |
| P <sub>out</sub>               | 16     | 14     | W  |
| D <sub>tot</sub>               | 3      | <1     | %  |

#### LIMITING VALUES

|                      |     |    |
|----------------------|-----|----|
| V <sub>a</sub> max.  | 800 | V  |
| p <sub>a</sub> max.  | 25  | W  |
| V <sub>g2</sub> max. | 425 | V  |
| p <sub>g2</sub> max. | 8   | W  |
| I <sub>k</sub> max.  | 150 | mA |

#### BASE

| Pin:— | 1  | 2 | 3 | 4  | 5  | 6  | 7 | 8 |
|-------|----|---|---|----|----|----|---|---|
|       | g3 | h | a | g2 | g1 | NC | h | k |



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6BW7—The 6BW7 is recommended in areas where extra sensitivity is required. It has a slope of 9.3 mA/V with anode and screen voltages of 180 v.

★ The PCC84 and PCF82 and .3 amp equivalents of these types and are suitable for equipments where series connected valves are used.

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and  
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radio.**

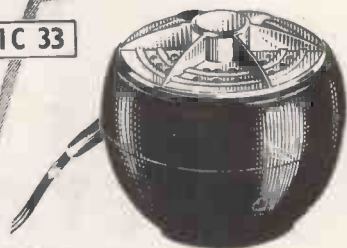
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**MIC 33**



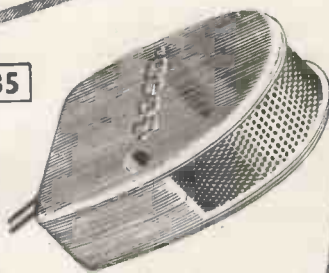
**MIC 36**



A handsome omni-directional instrument of high sensitivity and a substantially flat response from 30 to 7,000 c/s. Alternative models, with or without switch, are available with suitable adaptors for floor or table stands or for hand use.

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**MIC 35**



A general purpose hand microphone of robust construction with substantially flat response from 50 to 5,000 c/s. Suitable for recording apparatus. Public Address equipment etc.

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## "BELLING-LEE" NOTES

### EARLY CONVERSION TO BAND III

We always look upon readers of the "Wireless World" as a collection of individuals to whom all their friends turn for advice on anything concerning radio or television.

If you haven't given the matter much thought, we would like to remind you of the importance of having new aerials or adaptors, or where necessary, converters ordered and fitted as early as possible. If everybody leaves this matter till the commencement of the band III programme, there will not be the manpower available to carry out the work. The conversion of most receivers other than thirteen channel sets, will mean their return to the dealers, who must not be expected to do them all at once. A tremendous number of viewers who now receive a good picture on an indoor aerial will require a band III aerial on the roof, although, because of their small physical size, it will often be possible to fix up to a six element array in the loft. In a favourable location, such an aerial might have a range of 7-10 miles or over. An aerial of this type would cost £2.7.6. Where it is necessary to erect an outdoor aerial, on a wall or lashed to a chimney, most viewers have the work carried out by their dealer, who often places the work to contract with a firm of specialised aerial riggers. If you want a "Belling-Lee" aerial, it is important to insist upon having one erected. Most people are satisfied if they see a reasonable picture on their set and many sets are not seen at their best because of indifferent aerials.

The average price of erecting a T.V. aerial is between £2.10.0 and £3.0.0, therefore if there is any doubt as to which aerial will be required, remember that the difference in price between a better aerial and one not so good or so sensitive, is less than the cost of an installation firm coming and raising ladders a second time.

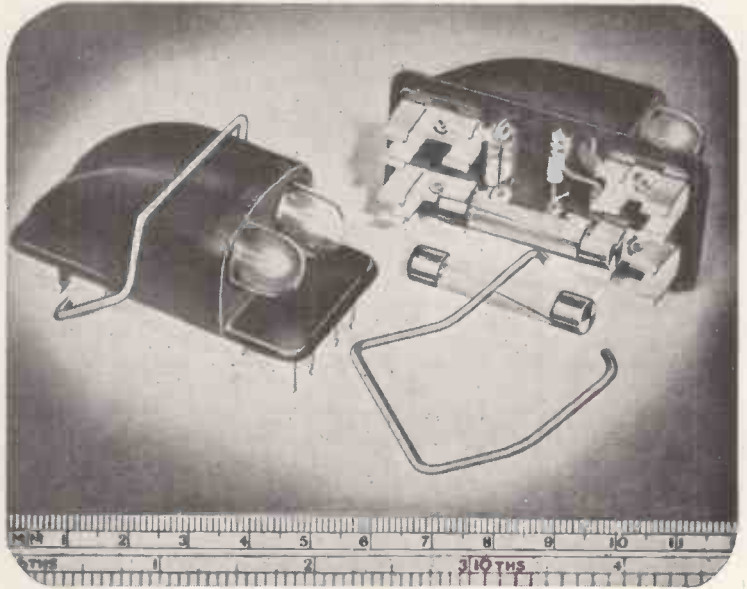
"Belling-Lee" Adaptors are available to convert a band I aerial to a combined band I/band III; from 4/6d. for a "Lafrod" to £1.16.0 to convert and band I dipole to a combined aerial for band III reception up to 20 miles.

All these aerials are guaranteed and insured for three years, and have been proved on a local transmitter.

Advertisement of  
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Great Cambridge Rd., Enfield, Middx.  
Written 18th February, 1955

## TWIN NEON INDICATOR LID

*gives visual signal  
of fuse failure*



This is fitted with two bayonet cap neon lamps with their associated resistor network, and is intended to carry a pair of  $1\frac{1}{2}$  in. x  $\frac{1}{2}$  in. fuses of the standard glass or H.R.C. types.

The lamps are designed to go out on a fuse failure; it has been said that it would be more convenient if the lamps were to light, but engineers designing critical and important equipment will not countenance such an arrangement where there would be no indication in the event of a lamp failure, whereas now the worst that can happen is for an apparent "fuse failure" signal when no such failure has occurred.

The lid is designed to be a direct replacement for the lid of our standard twin safety fuseholder, thus providing neon indication without any modification to existing circuit wiring. A replacement safety clip ensures non-reversibility.

Complete boxes with or without back connections can also be supplied if desired under List Nos. L.730 or L.731.

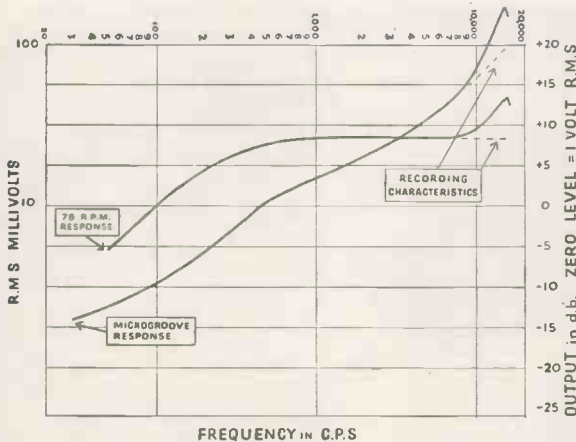
The unit is suitable for Relay Control equipment or any similar gear having a number of fused mains or H.T. circuits, and saves the cost of separate indicator lamps with their attendant wiring and additional space requirements.

The neons will glow satisfactorily over a voltage range of 180/250 V. a.c. (r.m.s.) and 220/250 V. d.c.

L.732 PRICE 16/3

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# PICK-UP DESIGN FOR HIGH FIDELITY RECORD REPRODUCTION



*Frequency Response Curves of type 18 pick-up for 78 r.p.m. and Microgroove Records.*

The increasingly high standard of present day recordings call for continuing developments in pick-up design. Long established principles still hold good, but design requirements are now much more exacting and require the application of precision engineering techniques. In the light of present knowledge the requirements for a high fidelity pick-up are:

- (1) The frequency response should extend smoothly over the entire audible recorded range (30 c.p.s. to 15,000 c.p.s.).
- (2) Distortion should be kept below the audibly detectable minimum. In this respect intermodulation measurements are probably the most significant, since they have the particular advantage that they are a direct measurement of the most objectionable form of distortion from the final listening point of view.

Possible causes of distortion in a pick-up which must be avoided are:

- (i) Non-linearity arising either mechanically or electrically.
  - (ii) Undamped mechanical resonances outside the audible range, which can produce audible cross-modulation effects.
  - (iii) Sensitivity to pinch-effect.
  - (iv) Distortion of record material due to excessive mechanical impedance.
- (3) Record wear must be kept to a negligible minimum. The movement of the pick-up must be highly compliant both vertically and horizontally and the playing weight must not cause distortion of the record material but must be sufficient to ensure continuous contact between stylus

and groove walls at the maximum recordable modulation level.

- (4) Long stylus life is necessary to avoid damage to records by rapidly worn styli and frequent changing of styli.
- (5) The design must be stable to ensure maintenance of the performance specification both in production and in prolonged use.
- (6) Sensitivity must be as high as possible consistent with the above in order to obtain the high signal/noise ratio for the complete reproducing equipment necessary for the wide dynamic range of modern recordings.

The above requirements are incorporated in the design of the type 18 pick-up used on "His Master's Voice" Model 3001. For performance consistency and freedom from mechanical resonances in the required frequency range, a magnetic system was chosen. Exhaustive experiments on the moving iron types of movement showed that provided that the reluctance of the return magnetic path is kept high and the signal flux in the armature is kept small compared with the saturation flux, then this type of movement possesses as linear a transfer characteristic as a corresponding moving coil design. The moving iron type was, therefore, chosen for its higher sensitivity and greater simplicity.

A cantilever stylus mounting with vertical axis of rotation has been used, since this effectively decouples the pick-up head from the stylus for vertical pinch effect movements and permits the use of a higher armature mass for a given effective inertia at the stylus point, thus reducing the signal flux density.

The material used for the suspension of the moving system in the pick-up was chosen for its stability and high mechanical resistance, stiffness ratio in order to ensure reliable and effective damping of the mechanical resonances outside the required frequency range.

For the long playing head a highly polished diamond stylus held to precise dimensional tolerances has been incorporated, since this is the only material which possesses sufficiently good wearing properties for extreme high fidelity reproduction of microgroove records. A sapphire stylus is used on the 78 r.p.m. head, since the larger tip radius used for these recordings together with the extremely high compliance of the pick-up movement result in adequately long life.

The features mentioned above and others combine to make the type 18 pick-up a reliable means of obtaining the full recorded quality from present day recordings and the best possible quality from old recordings.

## "HIS MASTER'S VOICE"

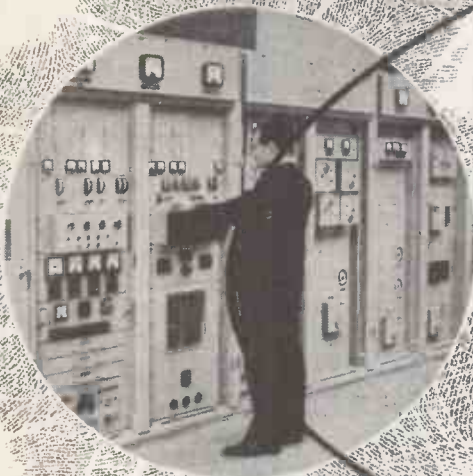
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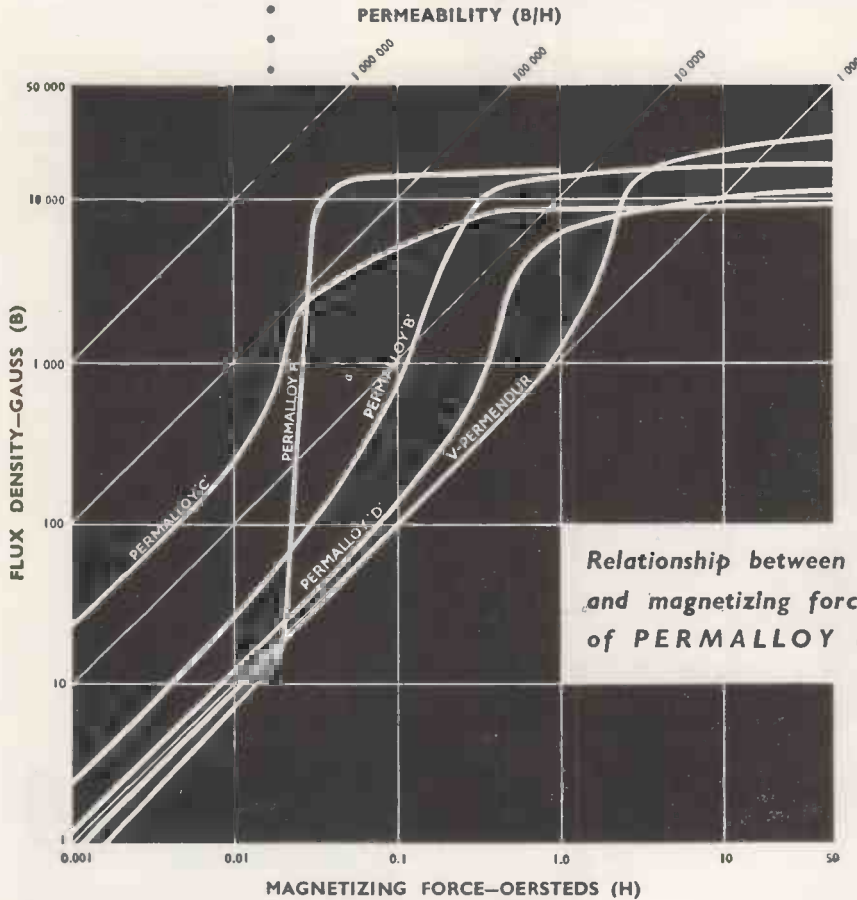
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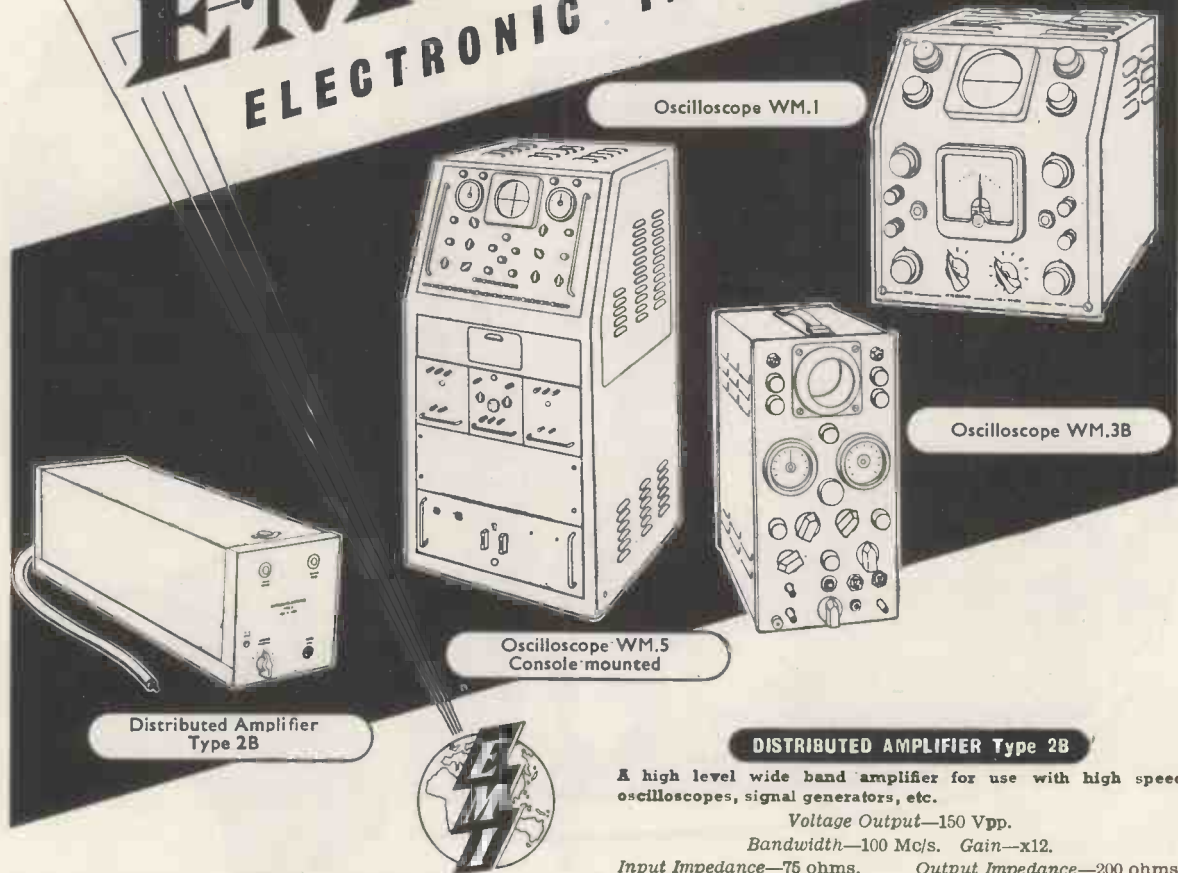
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Oscilloscope WM.1

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- (c) 25 Mc/s bandwidth 'Y' Amplifiers.
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**Time Range**—0.5 micro-seconds. }  
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**Max. writing speed**—0.5 micro-second/cm.

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**An inexpensive general-purpose miniature measuring oscilloscope.**

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**Max. sweep speed**—2 micro-seconds/cm.

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Associated with "His Master's Voice", Marconiphone, Columbia, etc.





*a New*

## STABILISED POWER SUPPLY UNIT FOR PHOTO-MULTIPLIERS

Ediswan now have available a new stabilised power supply unit which has been specially designed to feed Photo-Multipliers. It is particularly suitable as a supply unit for Ediswan Mazda Photo-Multipliers type 27.M1, 27.M2 and 27.M3.

### BRIEF SPECIFICATION — R.1184

| INPUT  | OUTPUT  | STABILITY   | OUTPUT RESISTANCE         | RIPPLE                 |
|--|---|---|---------------------------|------------------------|
| 200–250 v., 40–100 c.p.s.  | High stability low ripple D.C. supply variable between 300 and 1,100 volts. Max. current 2 mA. Pos. or neg. may be earthed. | A 10% change in mains input voltage results in a change of less than 0.1% between 1,100 volts and 600 volts output. | Approximately 1,500 ohms. | Less than 0.01% R.M.S. |
| MOUNTING The Unit is suitable for standard rack mounting or for bench use. Bench Stands are available. |   |   |                           |                        |



PRICE — £48

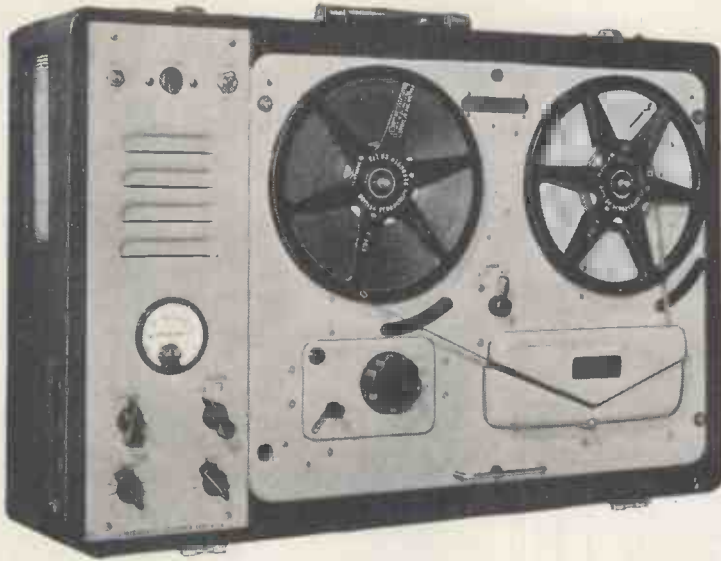
*Further information is available on request*

# EDISWAN

RADIO DIVISION · THE EDISON SWAN ELECTRIC COMPANY LIMITED  
155 Charing Cross Road, London, W.C.2. Telephone: Gerrard 8660. Telegrams: Ediswan, Westcent, London  
Member of the A.E.I. Group of Companies

# VORTEXION

# HIGH QUALITY TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8½ in. x 22½ in. x 15½ in. and weighs 30 lb.

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

- ★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.
- ★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

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

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

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

## TYPE C.P.20A AMPLIFIER

For A.C. Mains and 12 volt working giving 15 watts output, has switch change-over from A.C. to D.C. and "Stand-by" positions. Consumes only 5½ amperes from 12 volt battery. Fitted with mu-metal shielded microphone transformer for 15 ohm microphone, provision for crystal or moving iron pick-up with tone control for bass and top. Outputs for 7.5 and 15 ohms. Complete in steel case with valves. **PRICE £30 16 0.**



*Manufactured by*

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

Telephones: LIBerty 2814 and 6242-3

Telegrams: "Vortexion, Wimble. London"

# The Cultured Voice of Quality

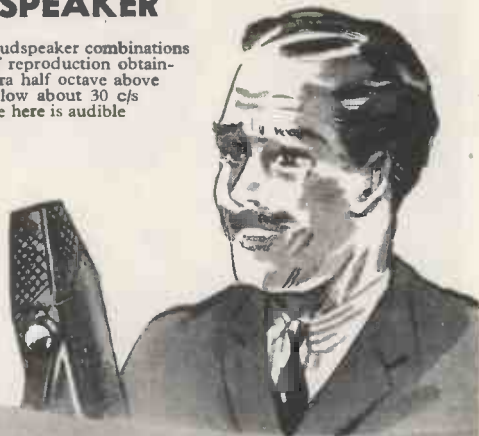


## SOUND SALES PHASE INVERTER SPEAKER

For its size, this is one of the most attractive loudspeaker combinations I have yet come across . . . "the standard of reproduction obtainable must be heard to be believed." That extra half octave above about 12 kc/s and the corresponding one below about 30 c/s usually cost an awful lot of money. The range here is audible from below 30 up to above 13,000 c/s!

TECHNICAL REPORT by P. WILSON, M.A.,  
of "THE GRAMOPHONE"

Price **£14.10.0**  
complete with cabinet



OBTAINABLE FROM ALL LEADING STOCKISTS **SOUND SALES LIMITED**  
WEST STREET, FARNHAM, SURREY Tel.: FARNHAM 6461/2/3 Manufacturers of Electronic Equipment Established since 1931

Extract from one of many letters received:—"It is unbelievable that a speaker at this price can be so very good. A friend of mine who heard it remarked that the clarity was amazing. I am now really hearing my records for the very first time."—J. A. Pearson, Doncaster.



Type O-120

# Two NEW



# 'Scopes!

## MAY WE SEND YOU PARTICULARS?



Type O-100

Portable, Lightweight, High-sensitivity Audio 'scope. 4mV/cm. r.m.s. (max.). Push-pull Plate deflection. External terminal connections to "X" Amplifier and C.R.T. available. 3c/s to 25Kc/s.

Servo and General Purpose 'scope. 7mV/cm. r.m.s. (max.). Direct coupled, symmetrical "X" and "Y" Amplifiers. Triggered Time Base. Time and Voltage calibration. D.C. to 4Mc/s.

# Furzehill Laboratories Ltd.

57, CLARENDON ROAD · WATFORD · HERTS.

Cables: FURZLAB, LONDON.

Tel.: Gadebrook 4686/7



# In the U.S.A.

and all over the world  
you will find



EQUIPMENT

This advertisement, prepared by our American Agents, is appearing in current U.S.A. technical publications and is reproduced here for the interest of our friends in this country.

**Leonard Carduner** (President, British Industries Corp., New York): Mr. Leak, please tell our readers what the "Point One" amplifier combination does in a high fidelity music system.

**H. J. Leak:** As you know, Mr. Carduner, the amplifier is actually the "heart" of the system. Your record player, radio tuner, or tape recorder feeds electrical impulses into the pre-amplifier and amplifier. These, in turn, strengthen the signals and feed them into a speaker.

It is difficult to strengthen a signal without distortion. "Point One" means that the Leak reproduces voice and instruments with insignificant harmonic distortion of 0.1% at 8 watts! This gives the illusion of the actual "presence" of the performer.

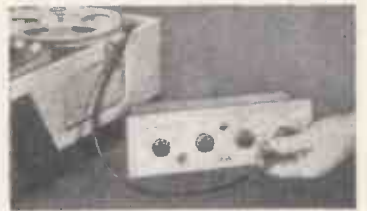
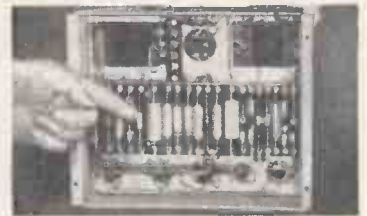
**L.C.:** In demonstrating the "Point One" amplifier at Audio Fairs, the most impressive thing we do is to turn the amplifier on its side, show people the terminal board "custom" construction used in American scientific instruments, almost never in radios.

**H.J.L.:** We had a practical reason for this . . . because every terminal connection is easily accessible. It keeps servicing costs down . . .

**L.C.:** Yes, and many have praised the control panel of the "Point One" pre-amplifier, because it offers every sensible adjustment to match the new hi-fi records . . . and full 25 db bass and treble range.

**H.J.L.:** In fact, the "Point One" has more adjustments than the Leak amplifiers supplied to the B.B.C., but no superfluous settings to add unnecessary cost.

**L.C.:** Well, you have one very important exclusive feature. Plug-in jacks on the Leak front panel make it easy to give any tape recorder the full benefit of the Leak circuit, in recording and playback! People with portable tape recorders, who put them away when not in use, can connect them instantly. Practical features like this make the "Point One" most enjoyable to use.



**T.L.10 & POINT ONE 27 GUINEAS COMPLETE, in Great Britain.**  
AMPLIFIER                      PRE-AMPLIFIER                      *Price made possible only by world-wide sales.*

Write for illustrated literature *W*.

**H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3**  
'Phone: SHEpherds Bush 117314                      Telegrams: Sinusoidal, Ealux, London                      Cables: Sinusoidal, London

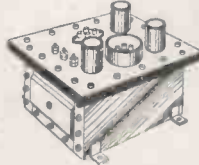
## SPECIAL PAGE FOR INDUSTRIAL USER

### R. F. HEATER CONSTRUCTORS KIT

All the parts including metal chassis for building a 250/500 watt R.F. Heater for dielectric or induction heating is available as a kit complete with theoretical diagram and practical notes—price for the complete kit of parts is £40 plus carriage at cost.

#### RADAR TRANSFORMER

For pulse work at 4 kV., this is Ministry style No. 224261 Type 2. Oil filled and fitted with two valve holders and ceramic insulators. It contains a pulse transformer, a choke and a filament transformer, all of which are designed to operate on 4 kV., 25/- each.



#### HIGH POWER TRANSFORMERS

For R.F. Heaters, transmitters, etc., etc. These are open wound type for maximum cooling and have the normal 200-250 primary fully screened.  
 Type 5F4. 1,000 v. at 1 amp., e.g. .5 K.V.A. Price £8/10/-, carriage and packing 5/-  
 Type 5F7. 1,500 v. at 1 amp., e.g. 1.5 K.V.A. Price £15, carriage and packing 7/6.  
 Type 5M1. 1000-0-1000 v. at 1.5 amps., e.g. 1.5 KVA. Price £12/10/-, carriage and packing 7/6.  
 Type 5M2. 1000-0-1000 v. at 500 ma. and 4 v. at 4 a. Price £7/10/-, carriage and packing 4/6.  
 Type 5M3. 375-0-375 v. at 250 ma. and 4 v. at 4 a. Price 37/6, carriage and packing 3/6.

#### AUTOMATIC MOTOR STARTER

For remote control of D.C. motor between 1 and 3 kw., adjustment for 100 v. or 230 v. Unused and in first-class condition, complete with metal and wired glass cover. Price £10, carriage 5/-.

#### POWER FILAMENT TRANSFORMERS

Type 5M4. 4 v. at 4 a. 2-0-2 v. at 10 a. Price 13/6, carriage and packing 3/6.  
 Type 5M5. 3.15-0-3.15 at 10 a. 4-0-4 at 10 a. 4-0-4 at 2 a. 4 at 4 a. 2.5-0-2.5 at 3 a. Price £27/6, plus carriage and packing 3/6.  
 Type 5M6. 34 v. at 2 a. tapped 32 v., 30 v. and 25 v., for relays, etc., £2/6, plus 3/6 carriage and packing.

**POWER CHOKES.** Open wound type and feet with clamps.  
 Type 5M7 30 Henry at 500 ma., 35/-  
 Type 5M8 20 Henry at 500 ma., 32/6.  
 Type 5M9 15 Henry at 500 ma., 27/6.  
 Type 5M10 10 Henry at 500 ma., 22/6.  
 Type 5M11 25 Henry at 250 ma., 13/6.  
 Type 5M12 3 Henry at 10 amps., 13/6.  
 Type 5M13 200 Henry at 5 ma., 15/-.

#### POWER FOR TR1154/55

We can offer brand-new, and unused, the two rectifier units for mains operating the transmitter TR1154 and its associated receiver B1156. Both rectifier units are completely enclosed in metal cases and operate directly from normal 60 cycle A.C. mains. Price £17/10/- the pair, carriage and packing £2 extra.

#### TRANSMITTER 1131

This is a high powered transmitter for operating over the same frequency range as the Receiver 1132, i.e., 70-130 megacycles. It is a very bulky transmitter and probably contains around £200 worth of equipment. As far as we know these have never been used but of course have been in store for a long time and therefore they will need attention before being put into operation. We offer these less valves £37/10/-. Buyer collects. We also have a quantity already stripped so if you are needing spares for this transmitter please get in touch with us now.

#### R1132

We have a small quantity of these receivers still available less valves. Their condition unfortunately is not good but they appear to be repairable, and of course, contain a multitude of spare parts. At 30/- each they represent a real bargain. If not collecting, please include 5/- for packing and carriage.

#### RECEIVER TRANSMITTER 38

This is the British equivalent of the walkie-talkie. It operates on the frequency range 7.4-9 meg. It has many novelty applications in the home and can eventually be turned into a useful little portable receiver. Complete and with valves, unused but not guaranteed, price 37/6, post 2/6 extra.

#### STABILAVOLT

This is a valve designed and constructed to facilitate the taking off of several voltages, each of which will be stabilized. These are brand new and unused. Price 10/6 each, post 1/- extra.

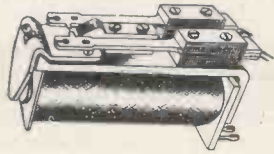
#### POTTED MAINS TRANSFORMERS

These are of really superior construction fitted in cast metal cases and compound filled. Terminals come to ebonite baseboard. All are upright mounting and have 220/230 normal 50 cycle mains input and fully screened primary.  
 Type 5P1. 265-0-265 at 300 m.a.; 6.3 v. at 7 amp.; 4.4 v. at 2.5 amp.; Price 35/- plus 3/6 carriage.  
 Type 5P2. 365-0-365 at 150 m.a.; 4 v. at 3.5 a.; 6.3 v. at 4.2 a. Price 32/6, carriage and packing 3/6.  
 Type 5P3. 1540 v. 2 v. at 2 a.; 4 v. at 1 a.; This is an ideal transformer for televisions and scopes using V.O.R. 97, etc. Price 25/-, carriage 2/6.

#### POTTED CHOKES

These chokes are in similar type cases and therefore match the above transformers.  
 Type 5F4. 5 H. at 300 m.a. Price 10/-, carriage and packing 2/6.  
 Type 5F5. 10 H. at 150 m.a. Price 12/6, post and packing 2/6.

#### RELAYS P.O. 3000 TYPE



Ref. 5A1. 2000 ohm, slow close coil plat. contacts, one break, two make. Price 12/6 each.  
 Ref. 5A2. 2000 ohm. standard coil, plat. contacts, change over make before break, two make, 1 break. Price 15/-.  
 Ref. 5A3. 200 ohm. standard coil, plat. contacts, two make. Price 7/6 each.  
 Ref. 5A4. 10 ohm. standard coil, one pair plat. contacts, also mounted but not operated by the relay, are thermal change-over contacts, make before break. Price 8/6 each.

#### RACKS AND RACK EQUIPMENT

Standard 6ft. rack, heavy gauge channel construction, tapped holes and standard 19in. centres. Price £4/15/- plus carriage. Ditto, but enclosed with sheet metal sides (vented) and with door, fitted handle and locking bars. Price £5/15/-.  
 Ref. 5A8. Safety switch, cuts off mains directly door is opened. Price 8/6.

#### MOUNTING PLATES FOR ABOVE RACKS

Fitted with slide supports to hold chassis. Chassis will be included if requested but this will already have several holes punched and drilled.  
 Ref. 5A5. 14in. front plate with chassis supports. Price 17/6.  
 Ref. 5A6. 12in. front plate with chassis supports. Price 13/6.  
 Ref. 5A7. 10 1/2in. front plate with chassis supports but cut out for meters and other items. Price 8/6.

#### AUTO TRANSFORMERS

For working American equipment of our main etc., etc. Input tapped 200-240 v. Output 115 v. In addition to those listed below, we have special this month 150/200 watt totally enclosed in metal box with input and output leads. Price 47/6, plus 2/- post and packing. Totally enclosed and screened.

|                    | Price    | Carr. |
|--------------------|----------|-------|
| 50 watt            | £1/2/6   | 1/6   |
| 100 watt           | £1/16/-  | 1/6   |
| 150 watt           | £3/-     | 2/-   |
| 250 watt           | £4/10/-  | 2/6   |
| 500 watt           | £5/10/-  | 2/6   |
| Unscreened.        |          |       |
| 1 KVA (3,000 w.)   | £6/10/-  | 5/-   |
| 1.5 KVA (1,500 w.) | £7/17/6  | 5/-   |
| 2 KVA (2,000 w.)   | £10/17/6 | 7/6   |
| 3 KVA (3,000 w.)   | £12/7/6  | 10/-  |
| 5 KVA (5,000 w.)   | £18/5/-  | 12/6  |

#### SLIDER RESISTORS

Heavy Duty Type.  
 Size 7in. x 1/4in. 11 ohms 4.5 amp., 22/-; Size 9in. x 1/4in. 1.2 ohms 15 amp., 15/-; Size 13 1/2in. x 1/4in. 3 ohms 10 amp., 15/-; 1 ohm 25 amp., 15/-.



#### AMERICAN FORCES UNITS I-122A and TR-24A

These provide a means for rotating an aerial (or other medium) to any desired azimuth. The operation is briefly as follows:—

1. Dial on control panel is turned to desired azimuth.
2. The Selsyn in the indicator generates a voltage which after being amplified causes the driving motor to rotate the tower.
3. As the tower rotates towards the null position the voltage applied to the drive motor decreases and is removed before the tower stops. If the tower stops before correct position voltage is again automatically applied. If the tower rotates beyond the correct position, the reverse relay operates and causes the tower to move backwards, until it stops at the null point where it remains at rest.

#### PROTECTION DEVICES

1. Circuit breaker prevents voltage being applied before valve 7 has warmed up.
2. Circuit breaker prevents the drive motor from over-loading.

#### SELSYN MOTORS

Both receiver and transmitter selsyns are three phase rotor induction motors. The operation is briefly as follows:—  
 Stators of transmitter are connected to corresponding stators of receiver. Note the rotor of one is connected to single phase supply. A voltage would appear on the rotor terminals of the other. This voltage will be of the same frequency as the voltage applied but its value will depend upon the relative angular positions of the rotors of the two selsyns.

#### DRIVING MOTOR

This is a two phase squirrel cage induction motor geared to the antenna mast. In order to operate the motor from a single phase source a condenser is connected in series with one of the phase winding. Direction of rotation is reversed by switching the condenser from one phase to the other by means of reversing relay.

#### IMPEDANCE AMPLIFIER

When the two selsyns have an angular displacement a voltage is generated in the receiving selsyn. This is amplified by two independent amplifiers. THE IMPEDANCE AMPLIFIER controls the magnitude of an impedance connected in series with the antenna motor and consequently controls the motor. THE CONTROL IMPEDANCE consists of the anode circuit of Valve 7, matched to the motor by means of Transformer 102. When Valve 7 has negative bias the anode circuit has high impedance. When conducting, however, the impedance falls to just a few ohms. The effect of which will vary the voltage to the motor and thus control its speed of rotation.

#### THE RELAY AMPLIFIER

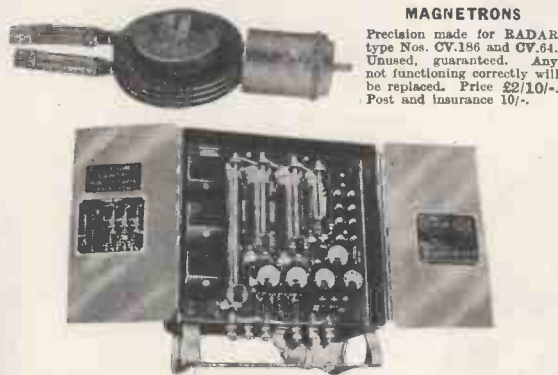
The output of the selsyn receiver is also applied to the relay amplifier, through transformers so that it is either in phase with or 180° out of phase with the amplifier voltage depending upon which side of the present position the antenna rests. The relay controls the direction of rotation of the motor.

#### POWER SUPPLIES

The equipment is fitted with power components for 117 volts 60 c.p.s. but will operate off our Mains if supply is connected through a slip-down transformer of 1 K.W. rating. Price £55 the two units, or separately I-122A £25, TR-24A £35, carriage extra at cost.

#### MAGNETRONS

Precision make for RADAR type Nos. CV-156 and OV-64. Unused, guaranteed. Any not functioning correctly will be replaced. Price £2/10/- Post and insurance 10/-.



#### CHARGING SWITCHBOARD

Feed this Switchboard through a Mains Transformer and Rectifier giving 24 volt D.C. up to 50 amps, and you have an excellent multi-circuit charger for simultaneously charging several batteries at different currents. This is an ex-Government switchboard rated at 550 watts 18 volts fitted into steel cases with doors. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are brand new, in original cases. Price £4/10/-, carriage 10/-.  
 We can supply a 12 volt, 50 amp. Mains Transformer at £4/5/-, plus 5/- carriage.

#### IMPORTANT NOTICE.

The equipment described on this page is not available at our normal retail shops—it can be seen at our special sales department address as below. Order and enquiries should also be addressed as below:—

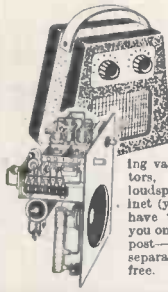
**E.P.E. LTD., SPECIAL SALES DEPT., BOURNE HOUSE, GROVE ROAD, EASTBOURNE, SUSSEX.**



**THE TWIN 20**

This is a complete fluorescent lighting fitting. It has built-in ballast and starters—stove enamelled white and ready to work. It is an ideal unit for the kitchen, over the work-bench, and in similar locations. It uses two 20-watt lamps. Price, complete less tubes, 29/6, or with two tubes, 39/6. Post and insurance, 2/6. Extra 20-watt tubes 7/6 each.

**ALL MAINS THREE**



A handy mid-gig A.C./D.C. 3-valve mains receiver giving powerful reception over long and medium waves. All component parts, including valves, coils, resistors, etc., but not loudspeaker and cabinet (you may already have these) will cost you only 19/6 plus 1/6 post—data available separately 2/- post free.



**NOBLEMAN GRAM**

A 70 Gn. RADIOGRAM direct from makers for only 40 Gns. Or £4 deposit. A beautiful piece of furniture yet a most up-to-date radiogram—figured walnut lined syncamore—radio raised to comfortable level—compartment for records—5-valve A.C. mains superhet, covers long, medium and short waves—all latest refinements, negative feed-back tone control, etc.—large multi-coloured edglet dial—latest "HI G" three-speed auto-changer with the famous pick-up—plays all types of records perfectly. Free Delivery in London Area. Elsewhere £2.

**ELPREQ TAPE RECORDER**



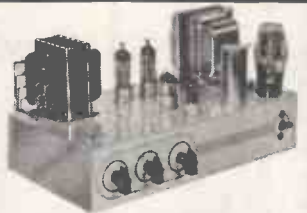
This instrument combines the Mk. IIIU Truvox Tape Deck and the Cleveland Wide Band Amplifier with a special high flux speaker and forms one of the finest tape recorder combinations available to-day. It will, of course, play pre-recorded tapes as well as make its own recordings of radio, music, meetings, telephone conversations, letters, etc., etc. The price, complete with reel of tape and ready to operate, is

**39 Gns.**

Carriage and insurance 12/6. Hire Purchase terms if required.

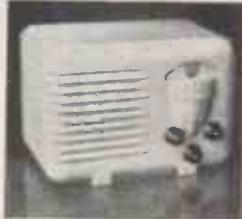
**DID YOU GET YOUR £1 BACK?**

3-speed record player with pick-up using the famous Acos "HI G" turnover crystal—motor also by very famous maker—speed selection is by Bakelite knob. All on unit board ready for installation. A wonderful bargain at £6/10/- plus 5/- carriage—Hire Purchase 15/- deposit.



**MULLARD AMPLIFIER "510"**

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity, with a power output exceeding 10 watts and a harmonic distortion less than .4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is £12/10/- or 25/- deposit, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.



**MINIATURE PORTABLE T.V.**

Uses standard conventional circuitry employing a total of 13 valves and 2 crystal diodes. The Cathode-ray tube used is a 2 1/2 in. Service type VCR139A. The layout is extremely clean, straightforward and professional. The wiring, whilst naturally being a little more intricate due to miniaturisation, is nevertheless completely accessible. The total cost comes to £16-£17. Its size will be approximately 9 1/2 x 8 x 6 in. Full construction data, layout, diagrams, templates, etc., running into some 50 sheets, is available, price 5/- post free.



**CABINETS FOR ALL**

We confidently believe we carry the best stock of cabinets in London. The one illustrated is The Bureau, a really beautiful cabinet elegantly veneered in walnut and finely polished. The control board is revealed when the front is dropped. Both radio board and motor board are left uncut to suit your own equipment. Price is 16 guineas, carriage 12/6. We have many other types in stock. Pay us a visit, or send for Cabinet List.



**THE CONTEMPORARY**

In the modern trend is this very stylish contemporary console. Veneered in oak with contrasting mouldings, and is ideal for use with modern furniture or with other contemporary fittings or furnishings. The radio and motor board is uncut and its size, 30 x 15 1/2 in., provides ample room for all equipment. Price £8.15/-, carriage, etc., 12/6.



**MINI-MAINS FOUR**

Uses a 4-valve circuit with high-efficiency coils—covers long and medium wave bands and fits into the neat white or brown Bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £3/19/6 plus 2/- post. Constructional data free with the parts or available separately 1/6.



**P.V.C. HEATER WIRE**

This has a resistance of 16 ohms per ft. It is wound on non-hygroscopic insulation and covered over with P.V.O. shrunk sleeving. Quite suitable for use underground or under water. Ideal also for twisting around pipes to stop freezing or to pre-heat liquid. Price 1/- per yard.

**YOURS FOR £1 ONLY**

**COMMUNICATIONS RECEIVER R1155**



This set, as most will know, is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F., so obviously a robust receiver which will give years of service. Slightly used but

completely overhauled and guaranteed in perfect working order. PRICES Grade 2 £7/19/6, Grade 1 £9/19/6, or new and unused £11/19/6. Or will be sent against deposit of £1. If you cannot call to collect please include an additional 10/- to cover cost of transit case and carriage. This partly returnable to you if and when you return the transit case.

**MAINS POWER PACK FOR R1155**

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price £5/10/- complete with speaker ready to work, carriage 3/6. If bought with receiver, deposit is 11/-.



**BARGAIN FOR CONSTRUCTORS**

Modern style cabinet in contrasting veneers, with metal chassis, three knobs, coloured scale, and pointer. Price 29/6, post, etc., 2/- All other components to build 2-waveband superhet. Price £5. Data, 1/6 (free with components).



**GRAMOPHONE AUTO-CHANGER**

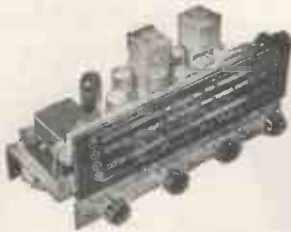
The latest model by very famous manufacturers. 3 speed, mixes 10in. and 12in., with crystal turn-over pick-up, brand new and perfect in original cartons. Price £11/10/-, Carr., etc., 12/6.

**E. P. E. LTD. (SEE OVER)**

**BEST SELECTION OF RADIO CHASSIS IN LONDON**

**THE "WINDSOR 5"**

This is a 5-valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type local valves are used and the chassis is complete and ready to operate. Chassis size 15in. x 6in. x 6in. Price £9/10/6 complete with 8in. speaker. Carriage and insurance 10/- H.P. terms if required.



**TABLE RADIO CABINET**

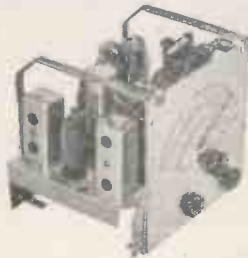
Due to a special purchase, we are able to offer this very fine cabinet, size approx. 15½ x 14 x 6½in. Walnut veneered and satin finished, 37/6 carriage and packing 3/6. Note.—This cabinet is the correct one for the Windsor chassis above with 6½in. speaker.



**SUPERHET RADIO BY BEETHOVEN**

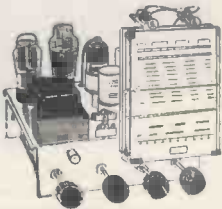
**NOW AVAILABLE FOR LONG, MEDIUM and SHORT WAVES**

Extremely well built on chassis size approx. 9½ x 7½ x 8½ using only first-class components, fully aligned and tested, 110-240 volt A.C. mains operation. Large clear edge-lit dial. Three wave bands covering Long, Medium and Short waves. Complete with five Mullard valves, frequency changer, double diode triode, pentode output and full wave rectifier. Complete with Rola loud-speaker ready to operate. Special cash-with-order price this month, £3/17/6, carriage and insurance 7/6. Hire purchase terms £3 deposit, balance over 12 months.



**SAVE £1**

Really beautiful walnut veneered and polished cabinet for only 39/6 if purchased at the same time as the Beethoven 5 valve superhet chassis (illustrated) above. Bought separately the price of the cabinet is 59/6. H.P. deposit on cabinet and chassis is 32/- only.



**THE EXPORT 5**

**3-WAVE BAND 5 VALVE SUPERHET CHASSIS**

Brand new, tested and ready for immediate operation, full vision scale size 6in. x 8in. covering the long wave 900-2,000 metres, medium wave 185-550 metres, and short wave 16-50 metres. Complete with valves and covered by our six months' guarantee. First-class parts. Parmeko mains, transformer

Eric resistors, Hunts condensers, etc. Special points include: (1) Flywheel tuning. (2) Dust core I.F.'s. (3) Sockets for extension speaker and pick-up. (4) 4-watts output. Price £9/10/-, carriage, packing and insurance 7/6 extra.

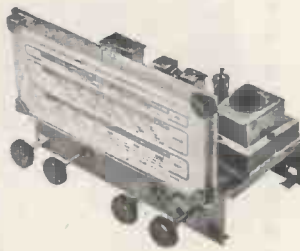
**10/- SECURES THIS BARGAIN**

The set, a product of one of our famous manufacturers, has H.F. stage, tuning indicator, and all modern refinements, covers 5 wavebands including a short wave to 11 metres. Offered less valves, power-pack, scale and drive, otherwise complete and unused, price £5. or 10/- deposit, balance over 12 months, carriage 7/6 (uses octal range valves).



**THE CLEVELAND "ORGANTONE"**

The Cleveland "ORGANTONE" is a 5-valve 3-wave band superhet covering long, medium and short wave. Built to a very stringent specification. Osram miniature valves are employed and low loss iron cored coils account for an excellent signal to noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages, and particular care has been taken to ensure freedom from frequency drift.



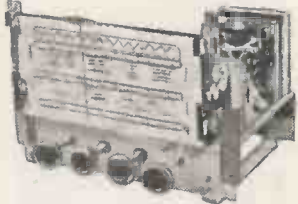
The output stage utilises variable negative feedback for tone control, and, but for standard pentode correction, no cut in the ordinary sense is applied. A gram. position is provided and reproduction of records is particularly good. An amply proportioned power transformer with a primary tapped for 110-280 volts gives complete isolation from the mains. Chassis size is 12in. x 7in. x 7in.—Scale size is 10½in. x 4½in. This receiver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results. Price £11/10/- or £1/5/- deposit—carriage, etc., 7/6. A circuit diagram and photograph available price 2/- post free.

**ANOTHER CLEVELAND CHASSIS—"THE TREMEMDO"**

The first Cleveland chassis was good, but this one is really superb. It has a 7-valve circuit with 6 watts output, fitted with independent bass and treble controls. It is really an efficient R.F. circuit coupled to a high-fidelity amplifier. The chassis size is the same as the Organtone, namely 12 x 7 x 7 with the 10½ x 4½ multi-coloured scale, and it is built to the same exacting specification as the Organtone. Price £14/10/-, carriage and packing, 7/6. H.P. terms if required.

**DULCI RADIO CHASSIS**

Complete range of these famous receivers now available at all our branches—cash or Hire Purchase—demonstrations gladly given.



3-wave (L. M. & S.) 5-valve £12/12/- Ref. B3.

Pushpull 6-valve 3-wave £15/15/- Ref. B3PP

All available on H.P.—deposit 10 per cent, balance over 12 months.

|   | £  | s. | d. | Ref.    |
|---|----|----|----|---------|
| Pushpull with B.F. stage 3-wave 7-valve     | 18 | 18 | 0  | B3PF/BF |
| 6-wave L.M. and 4 short waves (band spread) | 15 | 15 | 0  | B6      |
| 6-wave with pushpull                        | 18 | 18 | 0  | B6PF    |
| 6-wave with pushpull and H.F. stage         | 23 | 2  | 0  | B6PFRF  |

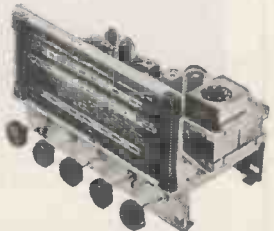
**THE ARMSTRONG F.C. 48**

Among high class radio chassis, the name Armstrong is probably the most famous, and their new model FC48 certainly lives up to tradition. Of course, only the best of everything has been used and extreme attention has been paid to the fitting up—it is virtually a 10 valve circuit, for among its eight valves two double triodes are employed. Special features of this chassis are (a) 8-watts output in a pushpull circuit with ample negative feed-back to ensure the highest fidelity; (b) provision for using F.M., e.g., power brought out to sockets and indicator on dial; (c) independent bass and treble controls with visual indication of setting; (d) four wave-bands covering 16-51, 50-120, 190-550, and 1,000-2,000 metres. The size of this chassis is 12½in. x 9in. x 9½in. Price £23/18/-, plus 7/6 carriage and insurance.



**THE LATEST DULCI**

This is the Model F3PP. Developed especially to meet the increasing demand for high fidelity equipment. Particularly suitable for replacement in a radiogram. This is a 7-valve 3-wave band superhet with pushpull output, incorporating separate bass and treble controls thereby ensuring a maximum control of fidelity, volume and tone. Wave band coverage 16-50, 190-550, 900-2,000 metres. Valve line X79, 6BA6, ECC83, GZ30, and two 6AQ5. This chassis is suitable for use on A.C. mains from 100-110 v. and 200-250 v. Price 17 guineas or £2 deposit, carriage and insurance 7/6.





# THIS MONTH'S NEW OFFERS

## Hi-Fi EQUIPMENT

We carry good stocks of the latest equipment and except for very busy periods we can usually give demonstrations. To name a few items of stock which we carry and recommend.

### SPEAKERS

The latest W.B. cantrix cone speaker units all in die cast frames with universal impedance speech coils 3 ohm., 7.5 ohm., and 15 ohm.

|                            |         |
|----------------------------|---------|
| Model H.F. 812 8in. ....   | £3 5 6  |
| Model H.F. 912 9in. ....   | £3 9 6  |
| Model H.F. 1012 10in. .... | £3 17 6 |

Also in die cast frames but with 3 ohm. or 15 ohm. speech coils.

|                            |         |
|----------------------------|---------|
| Model H.F. 510 5in. ....   | £1 19 6 |
| Model H.F. 610 6in. ....   | £2 12 6 |
| Model H.F. 1214 12in. .... | £9 15 6 |

We also carry a range of G.E.C. Wharfedale and Goodmans Hi-Fi speakers.

### PICKUPS

ACOS HI-G HEADS for use with Garrard or Collaro plug-in units in brown or ivory £2/- each.

THE B.J. ARM, new type to give correct tracking over the whole recording. Extra lightweight, suitable for Decca, Garrard and Chancery heads £2/19/6.

ACOS EP20 HI-G with the new HI-G plug-in heads, all designed to obtain the nearest to perfect reproduction—pressure only 8 grammes. Complete with either head £3/7/6; extra head £2/2/-.

THE NEW LEAK TL-10 AMPLIFIER WITH "POINT-ONE" PRE-AMP. In the amplifier world the name Leak probably stands highest. It is symbolic of precision sound engineering. The TL-10 has an output of 10 watts and with its pre-amplifier will operate from any good pickup. A continuously variable input attenuator in the pre-amp permits the use of crystal, moving iron or moving coil pick-up. Provision is made for tape recording and play-back as an exclusive feature. Easy accessible jacks being provided on the front panel for speedy hook-up. The complete amplifier with pre-amp. £28/7/-, or TL-10 amplifier only 17 gns. or "Point-One" amp. only 10 gns.

## ELECTROLYTIC CONDENSERS

Recent manufacture. Not Gov. surplus.

### SINGLE SMOOTHING TYPES.

|                        |      |
|------------------------|------|
| 8 m.f.a. 150 v. ....   | 1/6  |
| 8 m.f.a. 450 v. ....   | 1/11 |
| 8 m.f.a. 500 v. ....   | 2/6  |
| 16 m.f.a. 350 v. ....  | 2/3  |
| 16 m.f.a. 450 v. ....  | 2/9  |
| 16 m.f.a. 500 v. ....  | 3/9  |
| 32 m.f.a. 350 v. ....  | 2/11 |
| 32 m.f.a. 450 v. ....  | 4/9  |
| 32 m.f.a. 500 v. ....  | 5/9  |
| 64 m.f.a. 350 v. ....  | 3/9  |
| 64 m.f.a. 450 v. ....  | 5/9  |
| 100 m.f.a. 350 v. .... | 4/-  |
| 100 m.f.a. 450 v. .... | 4/9  |
| 150 m.f.a. 350 v. .... | 4/9  |

### MULTIPLE TYPES

|                           |      |
|---------------------------|------|
| 8-8 m.f.a. 450 v. ....    | 3/11 |
| 8-8 m.f.a. 500 v. ....    | 4/6  |
| 16-8 m.f.a. 450 v. ....   | 3 11 |
| 16-8 m.f.a. 500 v. ....   | 5/-  |
| 16-16 m.f.a. 450 v. ....  | 4/11 |
| 16-32 m.f.a. 350 v. ....  | 4/9  |
| 32-32 m.f.a. 350 v. ....  | 4/9  |
| 32-32 m.f.a. 275 v. ....  | 5/6  |
| 50 m.f.a. 25 v. ....      | 5/6  |
| 250-50 m.f.a. 350 v. .... | 9/6  |

### BIAS TYPES

|                      |     |
|----------------------|-----|
| 25 m.f.a. 24 v. .... | 1/- |
| 50 m.f.a. 12 v. .... | 1/- |
| 50 m.f.a. 50 v. .... | 2/- |

## THE CLEVELAND OCTAVIAN

In this instrument is combined the exceptional qualities of the G.E.C. metal cone loud-speaker in its ideal cabinet (the Octagonal illustrated below) and a most modern 3-valve amplifier. This combination will give a realism of musical reproduction not easily obtained even at twice or three times its price and is definitely the reproducer for bringing out the full frequency now available in long playing microgroove recordings. If you can please come to one of our branches and hear this fine instrument—failing this, then take our word that it is really good and send an order today. Price 27 guineas or £4/10/- deposit, balance over 12 months. Amplifier available separately at £10/10/-.



## OCTAGONAL SPEAKER CABINET

Conforming exactly to the designer's specification—for G.E.C. metal cone speaker—price £12/10/- or 37/6 deposit, carriage and insurance 6/- extra. G.E.C. metal cone (extra octave) speaker £8/15/-.

## A NEW APPROACH

to an almost universal problem....

An electronic computer to indicate foot-candle results is the subject of our latest publication. The computer uses 3-valves and information is fed into 12 ratio arms. The result "home," "draw" or "away" is indicated on a centre zero-meter, suitably scaled. The information to be fed into the ratio arms can be derived from the operator's own pet methods, or alternatively the data freely available in newspapers and

popular magazines can be used. The circuit is quite an interesting one but is not at all difficult to construct or operate. When complete the unit is entirely self-contained and mains operated. The price of all components needed, excluding metal and chassis, is £3/10/-, plus 2/6 post. Our Publication "A New Approach" is given free with orders, alternatively will be supplied separately at 7/6. post free.

## BENDIX RA-1B COMMUNICATIONS RECEIVER

Originally intended for the American Forces this fine receiver. (A small quantity of which has been released by the Ministry of Supply) is available to you if you act promptly Designed to receive C.W. or R.T. it uses probably the finest Vernier tuning and band spreading arrangement possible, it covers the following bands:—

|        |         |          |                         |
|--------|---------|----------|-------------------------|
| Band 1 | 15 to   | .315 mc. | } i.e. 20 to 200 metres |
| Band 2 | .315 to | .680 mc. |                         |
| Band 3 | .680 to | 1.5 mc.  |                         |
| Band 4 | .18 to  | 3.7 mc.  |                         |
| Band 5 | 3.7 to  | 7.5 mc.  |                         |
| Band 6 | 7.5 to  | 15.0 mc. |                         |

The sensitivity is 4 micro volts for full output. It uses 8 valves and operates from batteries (12 or 24 volt) or from the mains through a power pack. It has built in output stage with a jack socket for phones. Controls, all of which are brought to the front panel, include: aerial switch, aerial compensating condenser, main tuning condenser, band selector, C.W. switch, power on/off switch, and volume control. Very compactly built in crackle finished case, these sets are brand new having never been used and in perfect working order—special price this month is £14/10/- each or 45/- deposit, balance over 12 months—carriage and insurance 10/- . Order now to avoid disappointment. Circuit diagram and component data given free with sets, or available separately price 2/6, post free.

## A PRESENT FOR WIFE OR MOTHER

Probably the most thrilling part of dressmaking is the cutting out operation. Any dressmaker then will be pleased to receive a pair of electric (mains operated) scissors. The scissors illustrated not only prevent the fatigue of cutting out, but also permit more control as they have only to be guided. These Swiss made scissors will cut all materials but not fingers they are in fact 100% safe even for young children to use. Price is 66/6 post free.



## MADE-UP—READY TO WORK

The astonishing "Occasional 55"—two valves T.R.F.—completely assembled and ready to switch on—complete with all valves and 5in. speaker—Covers both medium and long wave bands and uses dust cored coils in a unique modern circuit which gives almost superb performance. Price £6/5/-, plus 3/6 post—Bakelite or wooden cabinet available price 16/6, post 2/6.



## FRICITION DRIVE MOTOR



Operates from standard 50 cycle mains—a thoroughly good job with dozens of applications—limited quantity only—17/6 each, post and packing 1/6.

## SPECIAL BATTERY VALVES

All .45 v. heaters. 1T4, 1B5, 155, 3A4 offered as a set 30/- the four.

## THIS MONTH'S SNIP

Mains transformer and choke by Haines Radio Ltd, Standard 50 cycle input with 10 volts tapplings. Secondary: 500-0-500 volt at 500 milliamps and 6.3 volt at 6 amps., also choke to match 10 Henry's at 500 milliamps. Limited quantity only at 45/- the pair. Carriage and packing 6/- extra.

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All by best makers. Rola, Elac, Plessey, Truvox, etc.

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|-----------------|
| 5in. p.m. 19/6  |
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| 10in. p.m. 25/- |
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HALF MEG. POTS. With switch 1/9, less switch 1/3, double pole switch, 2/- (all short spindle but room for knob)

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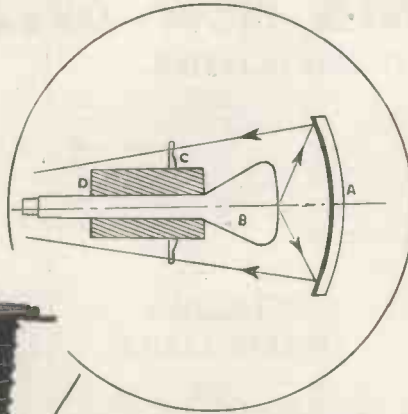
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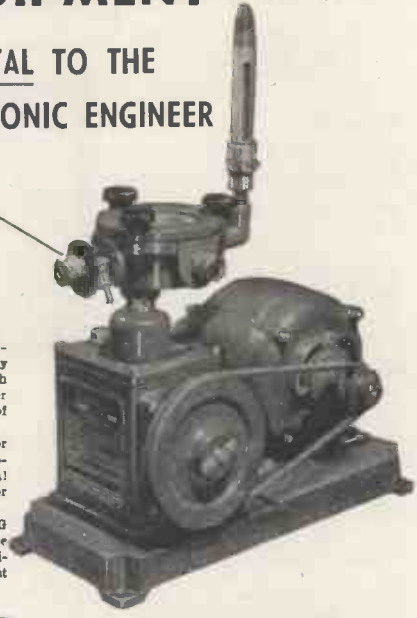
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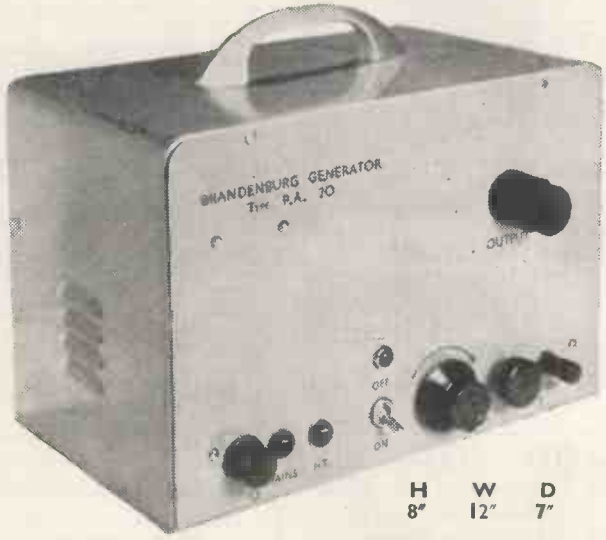


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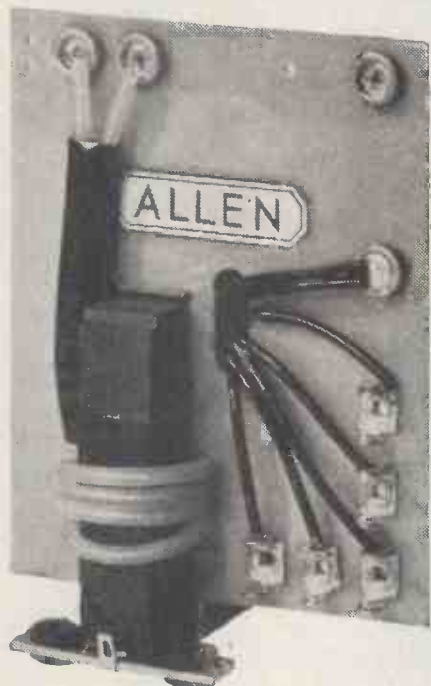
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Note the following "Star" features:

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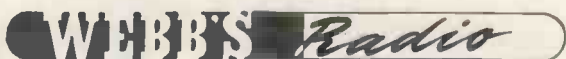
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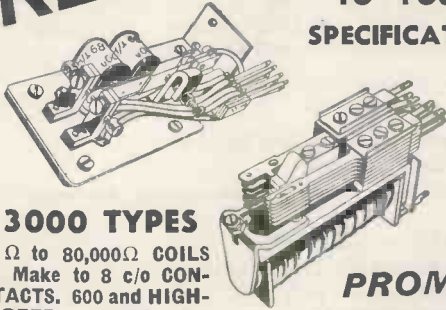


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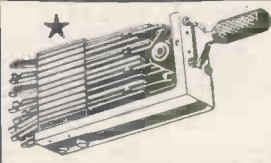
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OSRAM 618 Eric resistor-pot, kit with ceramite tube resistors, very highly recommended, 29/8; Lab resistor kit, 32/4; T.C.C. condensers, 55/-; PARTRIDGE Components, with loose lead terminations, Mains trans., 44/-; Smoothing Choke, 29/6; Output trans., 76/9. Price includes Partridge carriage/packing charge. Printed panel, 14/6. W.B. chassis, 28/6. DENCO 16 S.W.G. All-Chassis with beautiful Bronze Front Panel, 21/- (Printed.) S.A.E. List.

MULLARD 5 VALVE 10 WATT AMPLIFIER. T.C.C. Condensers, 45/-; Eric resistor-pot kit, 37/6; Elstone Mains trans., 36/-; Elstone Output trans., 45/- (both types); Denco chassis, 14/6; Printed bronze panel 14in. x 6in., 6/6. Small parts as per our list. Matched valves available for both the above designs.

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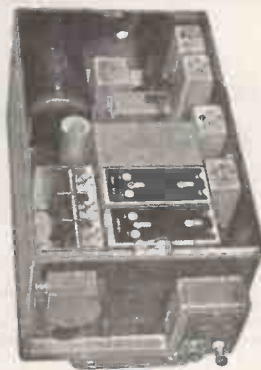
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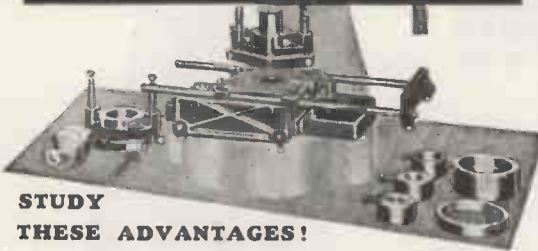
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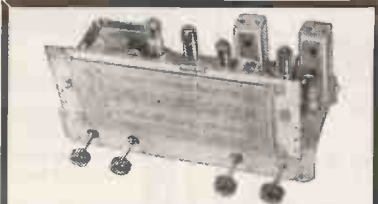
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| 10/500 v.         | 2/6 | 200/350 v.               | 5/6  |
| 16/600 v.         | 4/6 | 8+16/450 v.              | 5/6  |
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| 32/350 v.         | 4/6 | 16+16/450 v.             | 5/6  |
| 32/600 v.         | 5/6 | 16+16/500 v.             | 6/6  |
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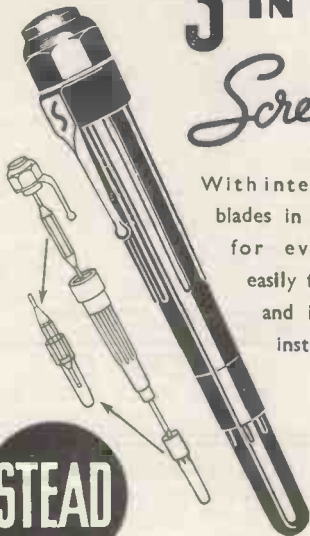


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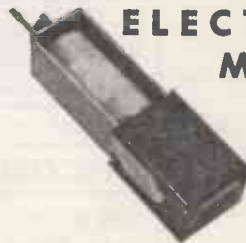
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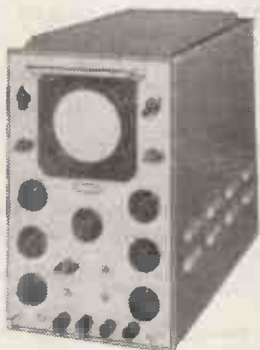
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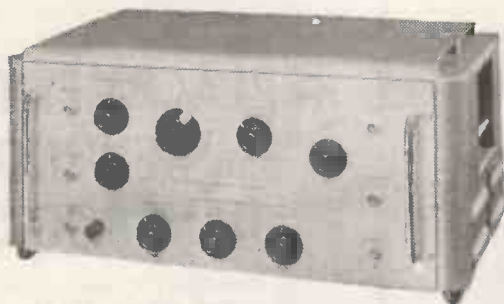
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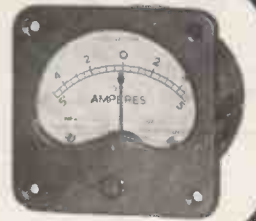
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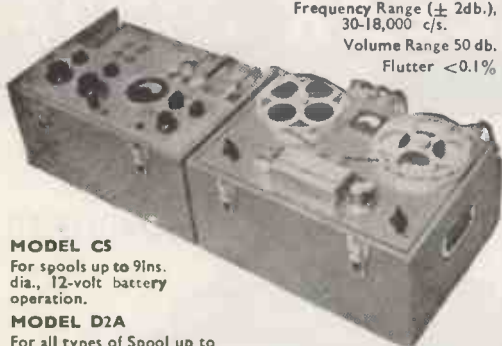


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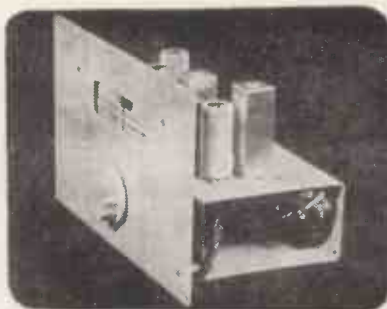
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| Model "A" .....                            | £11 17 6 |
| "A" kit .....                              | £7 5 0   |
| "A" tuning scale, magic eye...             | £2 0 0   |
| Standard power unit.....                   | £3 0 0   |
| Aerials 5- and .....                       | £1 10 0  |
| CB4, less output stage, mains driven ..... | £21 0 0  |
| "B" local station receiver.....            | £9 0 0   |

**MULLARD 5-10 AMPLIFIER**

|   |          |
|---|----------|
| Complete parts kit including valves.....                                | £12 10 0 |
| Built and Tested .....  | £14 10 0 |
| Scaled down to 11in. x 6in. plan. Hammer finish symmetrical frontplate. |          |

See these and Transistor Receiver at **MARBOROUGH YARD, MARLBOROUGH ROAD, N.19.** 25 mins. West End, 8 mins. Archway Station. Evening dems. arranged.

**BEL SOUND PRODUCTS CO. ARC. 5078**



Manufacturers of  
**POST OFFICE  
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MAGNETIC RELAYS**  
3,000 and 600

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**H.M. GOVERNMENT AND  
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COILS up to 80,000Ω.  
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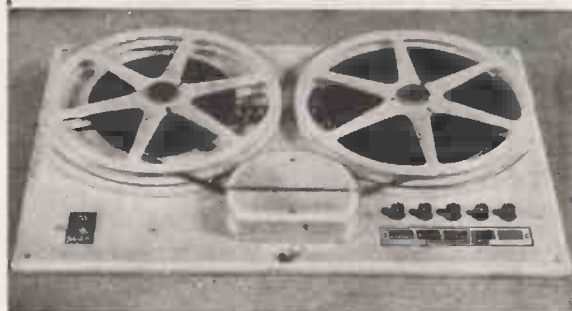
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### THE A.10 AMPLIFIER

Output: 10-12 watts.  
Distortion: 0.1% total harmonic at 8 watts.  
Frequency Response: within 1 db 15-30,000 cps.  
Input: 250 millivolts for 10 watts output.

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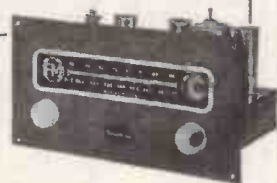
1. Input—4 position.
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4. Treble Lift and cut giving  $\pm 15$
5. Bass f db—continuously variable

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Coverage: 85-95 mc/s.  
Image Rejection: 26 db.  
I.F. Rejection: 60 db.  
Output: 3 volts r.m.s.

Circuit: a low noise triode. R.F. stage is coupled to a high stability frequency changer. This is followed by two I.F. stages and a triple diode triode ratio detector and A.F. stage.

Valves: The latest type Mullard. ECC85, EF 85, EABC 80, EM 34.



- Permeability tuning.
- Freedom from drift.
- Automatic limiting
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- A.F. attenuator.
- 3 position H.T. supply socket.

AMPLIFIER £19.15.0  
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*Demonstrations at your local High Fidelity specialists, or at our showrooms in Holloway. Special High Fidelity demonstrations each Thursday evening from 7 p.m.*

We consider that these two units used in conjunction, will (with the co-operation of the B.B.C.) give you the last word in quality reception. The control panels of both are the same size ( $9\frac{3}{4} \times 5\frac{1}{2}$ ) and finished in Florentine bronze; and will look well together in your cabinet. An A.M. Tuner to match will be available shortly.

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**AMERICAN  
RELAYS  
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**MAGNETIC DEVICES LTD**  
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**MULTI CHANNEL TRANSMITTER T-4/FRC,** with modulators MD-1/FRC, 2 Mc/s to 18 Mc/s. Each channel 400 w. output.

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**MAGNETO 10 LINE U.C. TELEPHONE SWITCH-BOARDS** (complete). And 40 Line F and F.

**MARCONI SIGNAL GENERATORS Type T.F. 144G.** As new, checked.

**A.R.88D's, A.R.77's, S27's, HRO, BC.312, BC.342, R.109** and others.

**METAL RECTIFIERS Type 1B, D.C.** output 10 amps at 22 v. input 220/250 v., 50 c/s.

All above items in excellent working condition  
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**SPARES** A large selection available for SCR399 (BC610), ET4336, SCR610, EEB Telephones, and Teleprinters type 7B.

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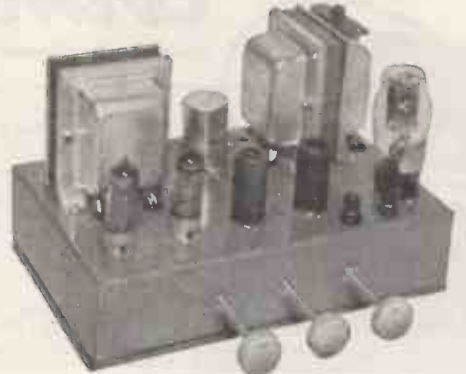
Large stock of Tx condensers, crystals and other components.

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Response 10-20,000 Cycles within 2db, Hum and Noise -74db, total Distortion 0.4%, Output 12 Watts.

**18 GNS.**

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**ELECTROLYTIC CONDENSERS, 32-mfd. 450-v. D.C.,** by Zenith, Micamold, etc., new and guaranteed, cartons of 12 condensers, 10/-, post paid.

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**WIRE STRIPPERS,** strips the insulation from flexes and cables up to 1/4 in. dia., micrometer adjustment, brand new boxed, usual toolshop price 15/-, our price 3/6, post 6d., 3 for 10/-, post paid.

**ARROW SWITCHES, 250-v. 25-amp. rotary 4-position, 3-heat and off, series parallel,** panel mounting, complete with pointer knob, brand new, 2/6, post 1/3, ditto smaller Diamond H., 250-v. 15-amp., 2/6, post 9d.

**YENNER 24-VOLT TIME DELAY SWITCHES,** consists of high-grade clockwork motor with external press wind, 2 electro-magnets, 8-pole cam-operated contacts, in smart metal cases fitted 4-way terminal block, new boxed, 7/6, post 1/-.

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**ELECTRO-MAGNETIC COUNTERS, G.P.O. subscribers pattern, 3-ohm. coil, 0-9999** repeating, size 4 1/4 x 1 1/2 x 1 1/2 in., 5/-, post 1/-.

**ELECTRIC BELLS, 12-v. D.C., single dome 3in. dia., 1 1/2 in. high, very superior,** worth 20/-, our price, brand new boxed, 3/6, post 9d.

Many other bargains; send 3d. with S.A.E. for current lists.

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for BAND III  
COMMERCIAL TELEVISION



Specially developed for incorporating into new T.V. receivers, or for tuning standard receivers for reception of Band III. Price £6.

ABOUT 2 1/2 MILLION T.V. SETS WILL PROBABLY BE TUNED FOR BAND III RECEPTION. MAKE SURE THAT YOU ARE UP TO DATE. WRITE TO US TODAY FOR FULLEST DETAILS



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**SELENIUM RECTIFIERS**

| L.T. Types               |      | H.T. Type H.W.            |       |
|--------------------------|------|---------------------------|-------|
| 2/8 v. 1/2 a.h.w....     | 1/9  | 120 v. 40 mA.....         | 3/11  |
| 6/12 v. 1/2 a.h.w.       | 2/9  | 250 v. 50 mA.....         | 5/11  |
| <b>F.W. Bridge Types</b> |      | 250 v. 80 mA.....         | 7/9   |
| 6/12 v. 1 a.....         | 4/11 | 250 v. 150 mA.....        | 9/9   |
| 6/12 v. 1.5 a....        | 7/9  | RM4 250 v. 250 mA.....    | 11/9  |
| 6/12 v. 2 a.....         | 9/9  | 300 v. 275 mA.....        | 12/11 |
| 6/12 v. 3 a.....         | 12/9 | <b>F.W. (Bridge Type)</b> |       |
|                          |      | 250 v. 80 mA.....         | 11/9  |

**CO-AXIAL CABLE.** 75 ohms 1/4 in., 7d yard. Twin screened feeder, 9d yd.

**SILVER MICA CONDENSERS.** 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF), .002 mfd. (2,000 pfd.). All at 5d. each, 3/9 dozen one type.

**DIAL BULBS, M.E.S.,** 8 v. 0.15 a., 6/9 doz.; 6.5 v. 0.15 a., 6/9 doz.; 4.5 v. 0.3 a., 6/9 doz.

**ELECTROLYTICS** (Current production) NOT ex Govt.

| Tubular Types     |      | Can Types          |      |
|-------------------|------|--------------------|------|
| 8μF 450 v....     | 1/9  | 16 mfd. 350 v....  | 1/11 |
| 8 mfd. 500 v....  | 2/6  | 16μF 450 v....     | 2/9  |
| 16μF 350 v....    | 2/3  | 24μF 350 v....     | 2/11 |
| 16μF 450 v....    | 2/9  | 32μF 350 v....     | 2/11 |
| 16μF 500 v....    | 3/9  | 32 mfd. 450 v....  | 4/9  |
| 32μF 350 v....    | 3/9  | 64 mfd. 450 v....  | 4/9  |
| 32 mfd. 500 v.... | 5/9  | 100 mfd. 450 v.... | 4/9  |
| 8-16μF 500 v....  | 4/11 | 8-8μF 450 v....    | 3/11 |
| 25μF 25 v....     | 1/3  | 8-8 mfd. 500 v.... | 4/9  |
| 50μF 12 v....     | 1/3  | 8-16μF 450 v....   | 2/11 |
| 50μF 50 v....     | 2/3  | 16-16μF 450 v....  | 4/11 |
| 100 mfd. 12 v.... | 1/9  | 16-32μF 350 v....  | 4/9  |
| 100 mfd. 25 v.... | 2/3  | 8 mfd. 450 v....   | 2/3  |
| <b>Can Types</b>  |      | 8 mfd. 500 v....   | 2/9  |
| 8 mfd. 350 v....  | 1/3  | 32-32μF 450 v....  | 5/11 |
| 8 mfd. 450 v....  | 2/3  |                    |      |
| 8 mfd. 500 v....  | 2/9  |                    |      |

**VOLUME CONTROLS** with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

**WIRE WOUND POTS:** 20 ohms, 500 ohms, 5K, 20K, 50K, 100K (medium length spindles), 2/9, 220 ohms, 2K, 10K, 20K, Preset type, 1/9 each.

**AMMETERS.** Moving coil. G.E.C. 0-5 amps., 2in. scale, 11/9.

**EX-GOVT. E.H.T. SMOOTHING CONDENSERS**

|   |     |
|---|-----|
| 25 mfd., 4,000 v. Blocks.....   | 4/9 |
| 5 mfd., 2,500 v. Blocks.....  | 3/9 |
| 5 mfd., 3,500 v. Cans.....  | 3/3 |
| 1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)..... | 9/6 |
| 1.5 mfd., 4,000 v. Blocks.....  | 5/9 |

**EX-GOVT. ACCUMULATORS** with non-spill vents. Unused and guaranteed. 2 v. 16 A.H., 5/9 each.

**EX-GOVT. BLOCK PAPER CONDENSERS**

|                    |     |   |      |
|--------------------|-----|---|------|
| 2 mfd. 800 v.....  | 1/9 | 8-8 mfd. 450 v....                      | 5/9  |
| 4 mfd. 500 v.....  | 2/9 | 8 mfd. 500 v.....                       | 5/9  |
| 4 mfd. 1,000 v.... | 4/3 | 8-8 mfd. 500 v....                      | 6/11 |
| 4 mfd. 1,500 v.... | 4/9 | 15 mfd. 500 v....                       | 7/9  |
| 4 mfd. 2,000 v.... | 6/9 | 4 mfd. 400 v. plus 2 mfd. 250 v., 1/11. |      |

**EX-GOVT. BLOCK ELECTROLYTICS.** Small size, 2,000 mfd. 12 v. for L.T. smoothing, 1/11 ea.

**M.E. SPEAKERS.** All 2-3 ohms, 8in. R.A. field, 600 ohms, 11/9. 10in. R.A. field, 1,500 ohms, 23/9. 10in. R.A. field, 1,000 ohms, 23/9.

**SPECIAL OFFER.** Mains Trans. 200-250 v. 50 c/s. Primary Secs. 250-0-250 v. 200 mA, 6.3 v. 4 a. 5 v. 3 a., 8/11

**GOODMANS 3 1/2 in. P.M. SPEAKER** (ex equip.), with battery pentode trans., 12/9.

**HEAVY DUTY BATTERY CHARGER** For normal 200/250 v. A.C. mains input. To charge 12 v. battery. Variable charge rate of up to 10 amps. Fitted Meter and Fuses. Guaranteed 12 months. Carr. 7/6. 28/19/6.

**HEAVY DUTY BATTERY CHARGER KIT** For normal 200/250 v. A.C. mains. Comprises mains transformer, 2 F.W. Metal Rectifiers, 2 variable resistors, 4 insulated terminals, 2 meters, 4 fuses and circuit. Total output 18 amps. Separate outputs for 6 v. and 12 v. Will make Ideal Charger for Garages. Carriage 15/-. 28/19/6.

**DRYDEX HANDLAMPS.** suitable for garage lights, etc. (Normal price 2/6). Limited number. Brand new boxed, fitted with bulb, 19/6.

**R.S.C. TRANSFORMERS**

**FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED**

**MAINS TRANSFORMERS**

Primaries 200-230-250 v. 50 c/s.

**FULLY SHROUDED UPRIGHT MOUNTING**

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|--|------|
| 250-0-250 v. 60 mA, 6.3 v. 2 a., 5 v. 2 a., Midget type, 2 1/2-3 1/2 in.                                   | 17/6 |
| 350-0-350 v. 70 mA, 6.3 v. 2 a. 5 v. 2 a. ...  | 19/9 |
| 250-0-250 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.   | 26/9 |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a....  | 23/9 |
| 250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion   | 31/- |
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| 300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.  | 26/9 |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.   | 23/9 |
| 350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a. ct., 0-4-5 v. 3 a.   | 26/9 |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.   | 33/9 |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 2 a., 5 v. 3 a.  | 33/9 |
| 425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc. | 49/9 |
| 450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.  | 69/6 |

**TOP SHROUDED DROP THROUGH TYPE**

|   |       |
|---|-------|
| 250-0-250 v. 70 mA., 6.3 v. 2.5 a.                          | 13/9  |
| 260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. ...             | 16/9  |
| 350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. ...             | 18/9  |
| 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.                | 22/9  |
| 300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. | 23/9  |
| 350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.          | 22/9  |
| 350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.  | 23/9  |
| 350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.   | 29/11 |
| 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.                | 29/9  |

**E.H.T. TRANSFORMERS.** 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 ..... 36/6

**FILAMENT TRANSFORMERS**

|                              |      |
|------------------------------|------|
| Primaries 200-250 v. 50 c/s. |      |
| 6.3 v. 1.5 a. ....           | 5/9  |
| 0-4-6.3 v. 2 a.....          | 7/9  |
| 6.3 v. 3 a. ....             | 8/11 |
| 6.3 v. 6a.....               | 17/6 |
| 12 v. 1 a. ....              | 7/9  |
| 0-2-4-5-6.3 v. 4a....        | 16/9 |
| 12 v. 3 a. or 24 v.          |      |
| 6.3 v. 2 a. ....             | 7/6  |
| 1.5 a. ....                  | 17/6 |

**CHARGER TRANSFORMERS**

All with 200-230-250 v. 50 c/s. Primaries: 0-0-15 v. 1 1/2 a., 11/9; 0-9-15 v. 3 a., 16/9; 0-0-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 22/9;

**ELIMINATOR TRANSFORMERS**

|  |      |
|--|------|
| Primaries 200-250 v. 50 c/s. 120 v. 40 mA. | 7/11 |
| 120 v. 40 mA., 5-0-5 v. 1 a.               | 14/9 |

**OUTPUT TRANSFORMERS**

|  |      |
|--|------|
| Midget Battery Pentode 661 for 3S4, etc.   | 3/6  |
| Small Pentode, 5,000 Ω to 3Ω.....  | 3/9  |
| Standard Pentode, 5,000 Ω to 3Ω.....   | 4/9  |
| Standard Pentode, 8,000 Ω to 3Ω.....   | 4/9  |
| Battery Pentode, 10,000 ohms to 3 ohms...  | 4/9  |
| Multi-ratio 40 mA. 30:1, 45:1, 60:1, 90:1, Class B Push-Pull.....                    | 5/6  |
| Push-Pull 8 Watts 6V6 to 3 ohms.....   | 8/9  |
| Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω.....  | 8/9  |
| Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω.....                              | 16/9 |
| Push-Pull 20 Watts high quality sectionally wound, 6L6, KT86, etc., to 3 or 15Ω..... | 47/9 |

**SMOOTHING CHOKES**

|                                       |      |
|---------------------------------------|------|
| 250 mA., 3 H., 50 ohms.....           | 11/9 |
| 150 mA., 7-10 H. 250 ohms.....        | 11/9 |
| 100 mA., 10 H. 200 ohms.....          | 8/9  |
| 80 mA., 10 H. 350 ohms.....           | 5/6  |
| 60 mA., 10 H. 400 ohms.....           | 4/11 |
| 50 mA., 40 H. 1,000 ohms. Potted..... | 10/9 |
| 20 mA., 30 H., 1,000 ohms.....        | 4/9  |

**THE SKY CHIEF/2 T.R.F. RECEIVER**



A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions, and parts list, 2/6. This receiver can be built for a maximum of 24/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

**P.M. SPEAKERS.** All 2-3 ohms. 6 1/2 in. Plessey, 16/9. 8in. Plessey, 16/9. 10in. R.A., 26/9. 10in. Plessey, 18/6. 10in. Rola with Trans., 29/6.

**R.S.C. BATTERY CHARGER KITS.**

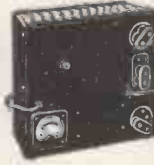
For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., 25/9. To charge 6 v. or 12 v. battery at 2 a., 31/6. To charge 6 v. or 12 v. battery at 4 a., 49/9.

ABOVE KITS CONSIST OF BLACK CRACKLE LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT.

Any type assembled and tested for 6/9 extra.

**R.S.C. 6 v. or 12 v. BATTERY CHARGER**

For normal A.C. mains input 200-230-250 v., 50 c/s. Selector panel for 6 v. or 12 v. charging. Variable charge rate of up to 4 AMPS. Fused, and with 5 amp meter. Well ventilated metal case with attractive crackle finish. Guaranteed for 12 months, 69/6. Carr. 2/6.



**EX-GOVT. MAINS TRANSFORMERS**

|                                  |      |
|----------------------------------|------|
| All 230 v. 50 c/s. input         |      |
| 8.8 v. 4 a. ....                 | 9/9  |
| 48 v. 1 a. ....                  | 9/9  |
| 0-11-22 v. 30 a. ....            | 72/6 |
| 16-18-20 v. 35 a. ....           | 79/6 |
| 7.7 v. C.T. 7 amps. 4 times..... | 25/9 |
| 460 v. 200 mA., 6.3 v. 5 a. .... | 27/9 |
| 278-0-278 v. 100 mA. ....        | 8/9  |

|   |      |
|---|------|
| 300-0-300 v. 150 mA., 610-0-610 v. 150 mA., 1,220 v. 350 mA.  | 29/9 |
| 400 v. C.T. 150 mA. 4 v. 6 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a. | 22/9 |

**EX-GOVT. AUTO TRANSFORMERS**

|  |         |
|--|---------|
| 15-10-5-0-195-215-235 v. 500 watts.....                                | 27/9    |
| Double wound 10-0-200-240 v. to 10-0-275-295-315 v. 1,000 watts.....   | 69/6    |
| 0-230 v. in steps of 11 volts from 57.5 v. KVA (21 amps).....          | 28/15/- |
| Double wound 0-110-240 v. to 0-130-140-150-160-170 v. 1,500 watts..... | 69/6    |

Carriage on any of above 6/- extra.

**EX-GOVT. SMOOTHING CHOKES**

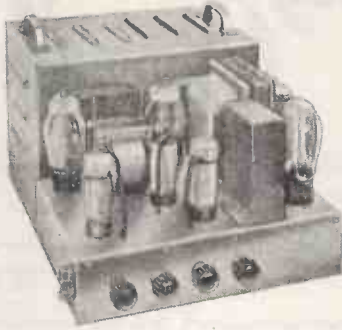
|   |       |
|---|-------|
| 250 mA., 10 H. 50 ohms.....               | 14/9  |
| 250 mA. 10 H. 100 ohms.....               | 14/9  |
| 250 mA. 3 H. 50 ohms.....                 | 8/9   |
| 150 mA. 10 H. 50 ohms.....                | 10/11 |
| 100 mA. 10 H. 100 ohms, Tropicalised..... | 6/9   |
| 100 mA. 5 H. 100 ohms, Tropicalised.....  | 3/11  |
| 50 mA. 50 H. 1,000 ohms. Potted.....      | 8/11  |
| 90/100 mA. 10 H. 100 ohms. Potted.....    | 8/9   |
| 50 mA. 5-10 H. ....                       | 2/9   |
| L.T. type 1 amp. ....                     | 2/9   |

**CHASSIS**

|   |      |   |       |
|---|------|---|-------|
| 18 s.w.g. undrilled aluminium amplifier type (4-sided). |      | 16 s.w.g. aluminium receiver type.          |       |
| 14in. x 9in. x 2 1/2 in.                                | 6/11 | 12in. x 8in. x 2 1/2 in.                    | 5/3   |
| 14in. x 10in. x 3in.                                    | 7/11 | 16in. x 8in. x 2 1/2 in.                    | 7/6   |
| 16in. x 10in. x 3in.                                    | 8/3  | 20in. x 8in. x 2 1/2 in.                    | 8/11  |
| 18 s.w.g. aluminium receiver type.                      |      | 18 s.w.g. aluminium amplifier type 4-sided. |       |
| 6in. x 3 1/2 in. x 1 1/2 in.                            | 1/11 | 12in. x 8in. x 2 1/2 in.                    | 7/11  |
| 7 1/2 in. x 4 1/2 in. x 2in.                            | 2/9  | 16in. x 8in. x 2 1/2 in.                    | 10/11 |
| 10in. x 6 1/2 in. x 2in.                                | 3/3  | 20in. x 8in. x 2 1/2 in.                    | 13/6  |
| 11in. x 6in. x 2 1/2 in.                                | 3/11 | 14in. x 1 in. x 3in.                        | 13/6  |

# R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A 4

A NEW DESIGN FOR 1955 HIGH GAIN "PUSH PULL OUTPUT." BUILT-IN PRE-AMP. TONE CONTROL STAGES. INCLUDES 7 valves, sectionally wound output transformer, block paper reservoir condenser, and reliable small components. AN INPUT OF ONLY 20 millivolts IS REQUIRED FOR FULL OUTPUT. THIS MEANS THAT ANY TYPE OF MICROPHONE OR PICK-UP IS SUITABLE. Two separate inputs controlled by separate volume controls allow simultaneous use of "Mike" and Gram., or Tape and Radio, etc., etc. Individual controls for Bass and Treble "lift" and "cut." Six negative feedback loops giving total of 24 D.B. Frequency response  $\pm 3$  D.B. 30-20,000 c/s. H.P. Terms now available on request. Cover as illustrated if required. price 17/6 extra.



Hum level 66 D.B. down. Certified total harmonic distortion of only 0.35% measured at 10 watts. Comparable with the very best designs. SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC ORGAN OR GUITAR. For STANDARD OR LONG PLAYING RECORDS. Size 12 x 10 x 9 in. For mains A.C. 200-250 v. 50 c/s. Power consumption 175 watts. Outputs for 3 and 15 ohms speakers. The kit is complete in every detail. Chassis is fully punched. Easy to follow point-to-point wiring diagrams, are supplied. EXTRA HIGH SENSITIVITY, HIGHEST QUALITY for Assembled ready for use 50/- extra. **9 Gns.** plus carr. 7/6.

**W.B. "STENTORIAN"** High fidelity P.M. Speaker, HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required we highly recommend this unit with an amazing performance. £3/17/6.

**MICROPHONES.** Crystal, hand or Desk type, good quality Acos, 50/-. Stand type with base and adjustable stand, £6/19/6. Both suitable for use with our amplifiers.

**PLESSEY 3-SPEED MIXER AUTOCHANGERS** with high impedance magnetic pick-up with duo point alloy stylus for long playing or standard records. (Will play 2,000 records before replacement stylus required). Brand new, cartoned, guaranteed. Limited stocks at only 10 gns. plus 5/- carr.

**H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPHIRE STYLUS).** Speed 33 1/3 r.p.m. BRAND NEW, CARTONED. Only £3/19/6 (approx. half price). Carr. 5/- (For 200-250 v. A.C. Mains).

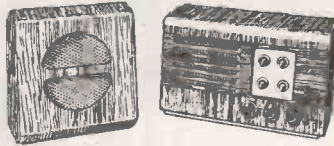
## R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5



A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads, in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carr.

## A PUSH PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/7/6

For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Rois at 27/9.) The amplifier can be supplied ready for use for £5/- extra. Full descriptive leaflet, 6d.



**R.S.C. MASTER INTERCOMM. UNIT**, with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood or Brown Bakelite cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHAS818 IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only £5/19/6. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet, can be supplied at 35/- each. Full descriptive leaflet 9d. The Master Unit can be supplied assembled and tested for 30/- extra.

## PERSONAL SET BATTERY SUPERSEDER KIT.



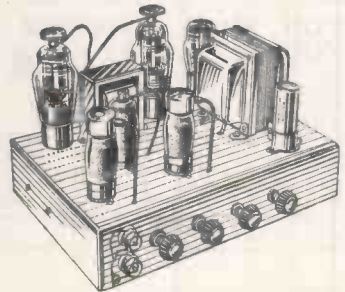
All parts for an "All Dry" Battery Eliminator. Complete with case. For 4 valve receivers requiring 90 v. 10 mA. and 1.4 v. 250 mA. Fully smoothed. Outputs from normal. 200-250 v. 50 c/s mains. Price with circuit, 35/9. Or ready for use, 42/6. Size of units 8 1/2-4 1/2 in.

**BATTERY SET CONVERTER KIT.** All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 60 v. or 90 v. as up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only 48/9. Supplied ready for use for 8/9 extra.

**H.T. ELIMINATOR AND TRICKLE CHARGER KIT** with case, Mains input 200-250 v. Output 120 v. 40 mA., and 2 v. 1 a. Price with circuit, 29/6. Or in working order, 37/8.

## R.S.C. A3 10 WATT "PUSH PULL" HIGH FIDELITY AMPLIFIER.

With Self Contained Pre-amplifier and Tone Control.



This amplifier, whilst having sufficient output to fill a small hall, is the ideal amplifier for the quality enthusiast who knows that though the average listening level is less than one watt it is necessary, for the very highest quality, to have an output of at least ten times this figure in order to obtain completely distortionless reproduction of sudden loud sounds. The layout of the components has been planned to give the very maximum of performance with the minimum of constructional effort. Large safety factors in every component A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, valves, and with easy-to-follow point-to-point wiring diagrams. The only things necessary to build this superb instrument are a soldering iron, screw-driver and pliers, everything else is supplied down to the last nut and bolt. Two independent inputs are provided with two associated independent volume controls so that programmes can be mixed together if desired, such as microphone announcements superimposed on a musical programme, or two independently controlled microphones, or even just gramophone/radio, fading over from one to the other. Variable bass lift and cut with variable treble lift and cut tone controls are fitted, giving full long playing record equalisation for uncorrected pick-ups. They are also provided so that the user can alter the total value to suit his personal taste and surroundings. Because of the large negative feedback employed the output transformer can be so designed that it provides all the specified power even with large variations of loudspeaker impedance. Terminals are provided for 3 ohm and 15 ohm loudspeakers. H.T. and L.T. available for the supply of a Radio Feeder Unit. Six Negative Feedback Loops. 130 millivolts input only required for full output. Frequency response  $\pm 3$  DB 50-20,000 cycles. Negligible hum and distortion. For A.C. mains input 200/230/250 v. 50 c/s. COMPLETE KIT of Parts, 7 GNS. (carrriage 5/-). Supplied assembled and tested for 45/- extra. H.P. TERMS AVAILABLE ON ASSEMBLED UNITS.

## FOUR STAGE RADIO FEEDER UNIT.

Design of a HIGH FIDELITY, L. and M. wave T.R.F. Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-400 v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped response characteristic. Loaded H.F. coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-6-7 1/2 in. Illustration, full set of easy-to-follow wiring diagrams and instructions and individually priced parts list 2/6. This unit can be built for only £3/15/-, including Dial and Drive Knobs and every item required.

**Radio Supply Co. (LEEDS) LTD.**

32 THE GALLS. — LEEDS, 2.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under 10/-. 1/6 extra under £2, 1/11 extra under £3. Full Price list 6d. Trade List 5d. Open to Callers : 9 a.m. to 5-30 p.m. Saturdays until 1 p.m.

# Introducing The Stern's Tape Recorder

"Fidelity"

!! A NEW DESIGN OF OUTSTANDING QUALITY !!

- WILL PLAY THE NEW PRE-RECORDED TAPES
- WILL TAKE ALL STANDARD TAPES UP TO 1,200ft.

- WILL PROVIDE 2 HOURS PLAYING AT 3 $\frac{1}{2}$ in. or 1 hour at 7 $\frac{1}{2}$ in. per second.
- INCORPORATES AN ELLIPTICAL P.M. SPEAKER 8in. x 5in., with EXTENDED FREQUENCY RANGE.

● We will supply it COMPLETE & READY FOR USE or YOU CAN ASSEMBLE IT AT HOME.



We have long delayed producing a Tape Recorder until we were completely satisfied that not only could we supply it at a genuinely low price, but also it had to be completely dependable and in addition it had to provide absolute fidelity recordings. **!!THIS WE HAVE DONE!!** and we offer our "Fidelity" model with the utmost confidence and with the knowledge that its performance equals Recorders marketed at a far higher price. It incorporates the Tape Deck and Amplifier described below both of which are so arranged that the "home assembly" of the Recorder is quickly and easily achieved.

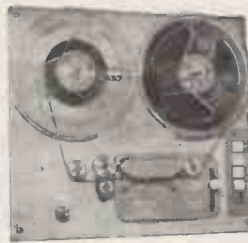


SEND S.A.E. FOR DESCRIPTIVE LEAFLET.

**YOU CAN ASSEMBLE IT YOURSELF FOR £40**

H.P. Terms are shown below. THE DECK AND AMPLIFIER ARE ASSEMBLED AND TESTED WHEN SUPPLIED.

The actual assembly of the Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Amplifier are supplied tested and ready for use, all that is required is to connect the two together (a connection chart is supplied) and secure them in the Attache Case.



THE NEW TRUVOX MODEL TR7U TAPE DECK

THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-In Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3 $\frac{1}{2}$ in. and 7 $\frac{1}{2}$ in. per sec. Positive Azimuth Adjustment. Overall size only 14 $\frac{1}{2}$ in. x 12 $\frac{1}{2}$ in.

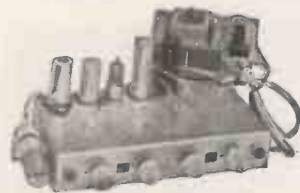


ACOS CRYSTAL MICROPHONE MODEL MIC-33-1. A highly sensitive mike which accurately matches the input arrangement of the amplifier.

SCOTCH BOY MAGNETIC RECORDING TAPE. Supplied with a 1,200ft. reel of Scotch Boy plastic tape famous for its true brilliant quality. The Recorder will take all standard makes of tape.

**BRIEFLY:**

**MODEL TRIF QUALITY AMPLIFIER.** Expressly designed to correctly operate with the above Truvox Deck for recording and playback. Supplied complete with Elliptical Speaker and has level response from 60-10,000 c.p.s. Hum level 50 db down at 4 watts. Incorporates efficient tone control arrangement and MAGIC EYE LEVEL INDICATOR. Valve line-up: EF86, ECC83 EL84, 5Y3, EM34, provides 4 watts undistorted.



MODEL TRIF AMPLIFIER

THE ATTACHE CASE illustrated is attractively finished and covered with Rexin<sup>®</sup> and is only 18in. x 14in. x 8in. It has a concealed pocket to accommodate the Mike and Mains lead and also a pocket to carry a spare reel of tape.

GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)

## PRICE SUMMARY

EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:

|                                       | CASH PRICE | DEPOSIT | 12 monthly payments of |
|---------------------------------------|------------|---------|------------------------|
| (a) TRUVOX Mk. TR7U TAPE DECK         | £23 2 0    | £5 17 0 | £1 12 4                |
| (b) AMPLIFIER MODEL TRIF WITH SPEAKER | £14 14 0   | £4 16 6 | £1 0 5                 |
| (c) PORTABLE ATTACHE CASE             | £5 0 0     | —       | —                      |
| (d) ACOS CRYSTAL MIKE "33"            | £2 10 0    | —       | —                      |
| (e) REEL OF TAPE 1,200ft.             | £1 15 0    | —       | —                      |

Please include £1 when ordering (a), or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e., THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40/-/. H.P. Terms: Deposit £10 and 12 monthly payments of £2/15/10 or in two parts as follows:—

|  | CASH PRICE | DEPOSIT | 12 monthly payments of |
|--|------------|---------|------------------------|
| (a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE.. | £33 10 0   | £8 10 0 | £2 6 8                 |
| (b) ATTACHE CASE AS ILLUSTRATED..  | £6 10 0    | —       | —                      |

See note below re packing charge

NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.



**SUPPLIED COMPLETE AND READY FOR USE £50**

FOR USE ON A.C. MAINS  
H.P. Terms: Deposit £12 10 0 and 12 monthly payments of £3 10 0  
Including mike and 1,200ft. reel of tape.

# STERN RADIO LTD.

109 and 115 FLEET STREET, LONDON, E.C.4

Phone: CENTral 5812-3-4

# RECEIVER CHASSIS

# Modernise your old Radiogram

# RECORD PLAYERS

## COMPLETE RADIOGRAM EQUIPMENT—QUALITY AT LOW COST

### STERN'S DESIGN FOR HOME CONSTRUCTORS The "SUPER-SIX"

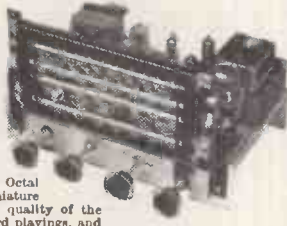
A compact and highly efficient superhet Radio-Radiogram chassis of outstanding quality.

### YOU CAN BUILD IT FOR £10/7/6

Including the OCTAL VALVE LINE-UP (£12/7/6 with the miniature valves)

Incorporating the new B.V.A. Miniature Valve Line up. This receiver is designed to the very latest specification and provision is made to incorporate either the standard Octal Valve Line-up or the new B.V.A. range of miniature valves. Great attention has been paid to the quality of the reproduction of both Radio reception and Record playings, and excellent clarity of speech and music is obtained.

- A few brief details.
- Covers 3 wavebands 18-50 metres, 190-550 and 800-2,000 metres.
  - Employs 6 valves having PUSH-PULL for 5-6 watts output.
  - Incorporates delayed A.V.C. on all wavebands and pre-selective feedback.
  - A 4 position Tone Control operation on both Radio and Gram.
  - Has independent mains supply socket for a Record Player.
  - Size of Assembled Chassis 12in. x 8in. x 8in. Dial aperture 8 1/2in. x 4 1/2in.
  - For operation on A.C. mains 200-250 volts 50 cycles.
- THE INSTRUCTION and ASSEMBLY MANUAL is available for 1/6. It contains very detailed practical drawings and circuit diagrams and a complete Component Price List.



This 3-SPEED AUTOCHANGER is by a Famous Manufacturer and is offered for

**£11/10/0** (Plus 7/6 carr. & ins.) Normal Price £16/10/0

Hire Purchase Terms £2/17/6 Dep. and 12 months at 16/4.

● These units will autochange on all three speeds, 7in., 10in. and 12in.

● They play MIXED 7in. 10in. and 12in. records.

● They have separate sapphire for L.F. and 78 r.p.m., which are moved into position by a simple switch.

● Minimum baseboard size required 14in. x 12 1/2in., with height above 5 1/2in. and height below baseboard 2 1/2in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.



## WE HAVE THE LATEST 3-SPEED AUTOCHANGERS IN STOCK

SEND S.A.E. FOR DETAILS

WE CAN ALSO OFFER THE LATEST 3-SPEED NON-AUTOCHANGE UNIT

### THE NEW ARMSTRONG F.C. 48

A high quality replacement Radio or Radiogram Chassis having provision for an F.M. Feeder Unit.

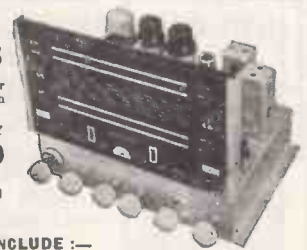
PRICE ASSEMBLED and READY FOR USE **£23/18/0**

(Plus 7/6 Carr. and Ins.) H.P. Terms £5/18/- Deposit and

12 months at £1/13/9.

#### OUTSTANDING FEATURES INCLUDE :—

- 8 Valves including 2 double Triodes.
- 3 Watts output from push-pull tetrodes. Heavy negative feedback is used, resulting in negligible distortion and high damping factor.
- Provision for using F.M. adaptor to receive the present high quality transmissions from Wrotham and the new B.B.C. V.H.F. stations.
- An accessible socket at rear provides the power supply for this unit.
- Independent controls give BASS and TREBLE lift and cut with unique Thermometer visual indicator.
- Gram. position on wavechange switch.
- 4 Wavebands Coverage 16-51, 50-120, 190-550, 1,000-2,000 metres.
- Large four-colour illuminated dial.



### !!!THE LATEST!!!

### RADIO-RADIOGRAM CHASSIS

Model F3PP. A 7-valve 3-waveband Superhet Chassis with Push-Pull Stage. This Chassis has been designed with particular regard to the quality of reproduction. It incorporates SEPARATE BASS and TREBLE CONTROLS thereby ensuring the utmost flexibility of Tone on both Radio and Gram.

Briefly:

● Waveband coverage 16-50, 190-550 and 800-2,000 metres.

● Valve line-up X79, 6BA6, 6AT6, ECC83, GZ80 and two 6AQ5's in push-pull for approx. 6 watts output.

● Negative Feedback and delayed A.V.C.

● Has independent mains supply socket for gram. connection.

● Overall size of Chassis 12in. x 8in. high x 7in. with dial size 11 1/2in. long x 4 1/2in.

For use on A.C. Mains 100/110 volts and 200/250 volts. Cash Price, tested and ready for use **£17/17/0** (plus 7/6 carr. and ins.)

H.P. Terms: Deposit £4/7/- and 12 monthly payments of £1/5/4.

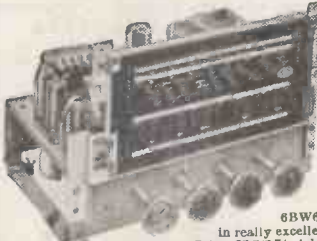
### THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3. A 5-valve 3-waveband receiver.
- Model B.3.P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P./R.F. A 7-valve 3-waveband Receiver incorporating an R.F. stage with PUSH-PULL OUTPUT.

The three Receivers are for operation on A.C. mains 100/110 volts and 200/250 volts, and employ the very latest miniature valves. They were designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram. and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wavechange and gram; (4) Tone Control (operative on gram. and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11x7 1/2 x 8 1/2in. high. Dial size 8 1/2 x 4 1/2in. Price complete and READY FOR USE, excluding speaker £12/12/- (carr. and ins. 7/6 extra). H.P. Terms £3/4/- deposit, 12 months at 17/8.

Model B.3.P.P. This model is the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/- (plus 7/6 carr. and ins.) or £3/18/- deposit, 12 months at £1/2/2. Model B.3.P.P./R.F. This model is similar in appearance and has same STAGE together with PUSH-PULL OUTPUT, employing a total of 7 valves with two type 6BW6 in Push-Pull. This makes for a really sensitive receiver with genuine quality reproduction. Price £18/18/- (plus 7/6 carr. and ins.) or £4/13/- deposit, 12 months at £1/6/9.

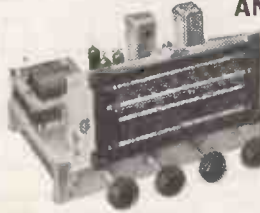


### AN OUTSTANDING OFFER

A BULK PURCHASE ENABLES US TO OFFER THIS "PUSH-PULL" 7 VALVE SUPERHET RECEIVER

For only **£12/19/6** (Carr.&ins. 7/6 extra.)

H.P.—£3/4/6 Dep. 12 mths. at 18/4.



These receivers Models AW3-7 are made by a well-known set of manufacturers and incorporate the latest Oram Valve Line-up of X79—W77—DH77—H77—U78 and two N78's in Push-Pull for approx. 7 watts output. They cover 3 wavebands 16-50 volts. A Gram. position is on the Wavechange switch. They make an excellent replacement Radiogram Chassis having a P.U. connection on the chassis. Extension speaker connection is also provided. Overall size of chassis: 12in. long x 7 1/2in. x 6 1/2in. high, dial aperture 8 1/2in. x 4 1/2in. (Dist Escutcheon available for 4/9).

THESE RECEIVERS ARE BRAND NEW AND FULLY GUARANTEED.

### SPECIAL REDUCTIONS FOR COMPLETE EQUIPMENT

SUMMARY—Select a RECEIVER CHASSIS and we will supply it TOGETHER WITH THE ABOVE 3-SPEED CHANGER AND AN 8-inch or 10-inch P.M. SPEAKER as follows:—

|                           | THE £11/10/- AUTOCHANGER WITH A SPEAKER AND:— |         |                |
|---------------------------|---|---------|----------------|
|                           | Cash Price                                    | Deposit | Monthly        |
| (a) With Model B3 chassis | £24 15 0                                      | £6 4 0  | 12 of £1 14 10 |
| (b) " " B3PP              | £28 0 0                                       | £7 0 0  | 12 of £1 18 5  |
| (c) " " B3PP/R.F.         | £31 2 0                                       | £7 15 0 | 12 of £2 3 9   |
| (d) " " Armstrong F.C.48  | £36 4 0                                       | £9 1 0  | 12 of £2 10 11 |
| (e) " " AW3-7             | £25 5 0                                       | £6 7 0  | 12 of £1 15 6  |
| (f) " " F3PP              | £30 2 0                                       | £7 10 0 | 12 of £2 2 0   |

An additional charge of 10/- is made in each case to cover Carriage and Insurance.

**STERN RADIO LTD.**  
109 and 115 FLEET ST., LONDON, E.C.4.  
Phone: CENTral 5812/3/4

# "Hi-Fi" EQUIPMENT and KITS TO SUIT ANY BUDGET

## TWO COMPLETE "Hi-Fi" AMPLIFIER KITS

### "STERNS" HIGH QUALITY 8-10 WATT AMPLIFIER



Having a front panel which is very attractively finished in deep gold, and on which the controls are clearly identified. The ideal amplifier for general home use and for small halls, etc.

Price of COMPLETE KIT including Valves and Drilled Chassis, etc. (Plus 2/6 Carr. & Ins.) **£7/10/-**

We will supply it Completely Built for **£9/10/-** (Plus 5/- Carr. & Ins.)

Designed for high quality reproduction up to an output level of 10 watts, having 6V6s in Push-Pull and incorporating negative feedback. It is suitable for use with all types of Pick-ups and most types of microphones and the output transformer provides for use of 3 and 15 ohm speakers.

#### BRIEF FEATURES

- Valve line up 6Z5, 6SN7, 5Z4, with 6V6s in push pull.
- The undistorted output level of up to 10 watts is produced from an input of 25 volts.
- First class reproduction of Radio (where a Tuning Unit is used) and Record Playing.
- Separate Bass Boost and Treble Controls providing an excellent range of frequency control.
- Very satisfactory results are obtained with an average type of high impedance Moving Coil or Crystal Microphone, a clear speech level of approx. 5 watts output being obtained.
- Power supplies (HT and LT) are available for a Tuning Unit.
- For operation on A.C. Mains 200-250 volts 50 cycles.

THE ASSEMBLY MANUAL is available for 1/- and includes detailed layouts and component Price List.

### "STERNS" 12 Watt "HIGH FIDELITY" Pull-Pull AMPLIFIER

A very high quality Unit attractively finished in deep gold with each control clearly identified on the front panel. Comprising a Main Amplifier Chassis and a Remote Control Pre-Amplifier-Tone Control Unit. The remote control unit measures only 9in.x4in.x2½in. and contains four controls, being: Bass, Treble-Volume and a Radio, Gram, Microphone Switch control. It incorporates its own feedback circuit on the Base Channel. Loop negative feedback is employed on the Main Amplifier which has a valve line up of 6J5-6N7-5U4 with two 6X2's in push-pull and 6J5 and 6SN7 are used in the remote control unit.

THE COMPLETE KIT IS AVAILABLE FOR **£14/-** (Carr. & Ins. 6/- extra.) THE COMPLETE UNIT ASSEMBLED AND READY FOR USE **£17/-** (H.P. Terms **£4/5/-** Deposit, 12 Months at **£1/3/11**.) (Carr. & Ins. 7/6 extra.)

The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV and 6.3 volts at 2 amps, and 30 mA. H.T. is provided for tuning unit, etc. This Amplifier compares well with the Williamson and similar designs at a fraction of their cost. The complete set of assembly instructions is available for 2/-.

## SPECIAL PRICE REDUCTIONS FOR COMPLETE EQUIPMENT

SELECT A TUNING UNIT and AMPLIFIER or TUNING UNIT, AMPLIFIER and RECORD PLAYER (and a SPEAKER if required) and we will supply at a REDUCED PRICE. H.P. TERMS ALSO QUOTED.

## WE CAN SUPPLY... COMPLETE KIT or ASSEMBLED CHASSIS FOR THE OSRAM 912 AMPLIFIER. Designed by General Electric Co.



A modern high quality 12 watt Amplifier for the HOME CONSTRUCTOR, having a Valve line-up of U709, B309, Z729 and two N709's in Push Pull. The Assembly instructions include five "easy stage-by-stage" diagrams and are available for 3/6.

Price of COM- **£21/4/-** (Plus 7/6 Carr. and Ins.)  
WE WILL SUPPLY THE COMPLETELY ASSEMBLED **£25/-** (Plus 7/6 Carr. & Ins.)  
AMPLIFIER for **£26/5/-** Deposit and 12 months at **£1/15/2**.

H.P. Terms: **£6/5/-** Deposit and 12 months at **£1/15/2**.

## WE HAVE IN STOCK... THE DENCO F.M. FEEDER UNIT

Consisting of a 5 valve Superhet design incorporating R.F. (6AM6) and F/C (12AH9) Stages followed by Two I.F.s. (6BA6's) and Ratio Discriminator 6AL5, the coverage provided being 88-100 Mc/s.

THE COMPLETE KIT including VALVES and DRILLED CHASSIS is available for **£6/13/6**

It is suitable for use with any type of High Fidelity Amplifier. (Plus 4/- Carr. & Ins.) The descriptive manual, including circuit and Component Layout, etc., is available for 1/6.

THE COMPLETELY ASSEMBLED CHASSIS, **£8/17/6** (Plus 6/- Carr. & Ins.) ready for use, aligned and tuned EACH PRICE INCLUDES TWO I.F. STAGES.

## THE DENCO M.T.O.I. MODULATED TEST OSCILLATOR

**£3/15/0**

(Plus 2/- Carr. and Ins.)

Has Frequency range continuously variable from 170-475 Kc/s. and 550-1,600 Kc/s. Battery operated and thereby completely self-contained.

## BRAND NEW C.R.T. MASKS

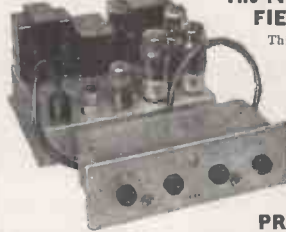
Latest aspect ratio for 12in. "Round" tubes, finished Ivory (plus 1/- postage) **12/6**

## "STERNS" MODEL CP3G 3 WAVEBAND SUPERHET TUNING UNIT

A highly sensitive tuning unit providing for excellent reception of stations on the short wavebands (16-50 metres) medium waveband (200-550 metres) and the long waveband (800-2,000 metres).

- We can supply this tuner to correctly operate with each of the amplifiers.
- Valve line-up—6K8G (Frequency Changer), 68K7g (I.F. Amplifier), 6Q7g (Detector, AVC and 1st A.F. Amplifier), and 5Z4g (rectifier).
  - A gramophone position is incorporated with the wavechange switch and the 6Q7g valve becomes the 1st A.F. Amplifier for the gramophone pick-up.
  - Volume control and tone control operative in both radio and gramophone positions of the wavechange switch.
  - This unit is precisely similar in appearance to the AN/FM unit illustrated, but the overall chassis dimensions are 12in. x 8½in. x 8½in. including the full vision dial. Size 8½in. x 4½in.
  - For A.C. Mains only, power supply required—H.T. 250 volts 30 mA., L.T. 6.3 volts 1½ amp.
- Price, completely assembled and including built-in power supply **£20/10/-**. H.P. Terms. Deposit **£2/12/6**. 12 months of 15/-.
- Price completely assembled excluding power supply **£9**. Carriage and insurance 7/6 extra.

## The NEW "LEAK" TL/10 AMPLIFIER and "Point One" PRE-AMPLIFIER



This Amplifier has a maximum output of 10 watts and maintains in every respect the world renowned LEAK reputation for precision engineering; fine appearance and fastidious wiring. The Pre-Amplifier will operate from any make or type of pick-up. A continuously variable input attenuator at the rear of the Pre-amp. permits the instantaneous use of crystal, moving iron and moving coil pickups. H.T. and L.T. supplies are available for a Radio Tuning Unit. An input attenuator is fitted. S.A.E. for descriptive leaflet.

#### PRICES:

- (a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER, **£28/7/-**, or **£7/2/-** Deposit and 12 months at **£2**.
- (b) The TL/10 MAIN AMPLIFIER ONLY: **£17/17/-**, or **£4/7/-** Deposit and 12 months at **£1/5/4**.
- (c) The "POINT ONE" PRE-AMPLIFIER ONLY: **£10/10/-**, or **£2/12/6** Deposit and 12 months at **15/-**.

## ANOTHER GENUINE BARGAIN! A PORTABLE PLAYING DESK CONTAINING

THE NEW COLLARO MODEL R.C. 54  
3 SPEED AUTOCHANGER for only **£13/5/-**  
(plus 10/- carriage and insurance)

H.P. TERMS. Deposit **£3/5/-** followed by 12 monthly payments of 18/7.

THE COLLARO MODEL R.C. 54 is the latest "mixer" 3-speed unit and incorporates the famous Studio "O" Crystal Pick Up. It is supplied accommodated in a Portable Carrying Case covered in grey rexine.

## WILLIAMSON AMPLIFIERS BY GOODSSELL

These Amplifiers hardly need enlarging upon. It being sufficient to say that they have now become the accepted standard for quality reproduction by which all others are judged. Two Models are available:

**MODEL G.W.18.** Built completely to specification and giving 15 watts output. Price **£33/15/-** (Plus 7/6 Carriage and Insurance). H.P. Terms, Deposit **£3/9/-** and 12 months at **£2/7/5**.

**MODEL G.W.12.** Uses slightly lower H.T. voltage to produce 10-12 watts output but otherwise built completely to specification. Price **£27/10/-** (Plus 7/6 Carriage and Insurance). H.P. Terms Deposit **£6/17/6** and 12 months at **£1/18/8**.

**THE MODEL P.F.A. TONE CONTROL UNIT**  
This Control Unit has established a reputation for its excellent quality of reproduction, and ability to give adequate gain for any type of pick-up.

Price **£20/-** (Plus 7/6 Carriage and Insurance). H.P. Terms. Deposit **£5** and 12 months at **£1/8/2**.

WE HAVE THEM IN STOCK and WILL BE PLEASED TO DEMONSTRATE

or send S.A.E. for illustrated and descriptive leaflet.

When submitting orders, please include postage and packing

# STERN RADIO LTD.



**CONSTRUCTORS SAY**  
**"IT'S STILL THE BEST MAINS or BATTERY PORTABLE SET"**

A Midget 4-valve Superhet Portable covering medium and long wavebands. Designed to operate on A.C. mains 200/240 volts or by an Aldry "battery". The set is designed so the main section can be supplied as a separate unit, and can be added at any time. The set supplied as an "Aldry" battery Superhet can be accommodated in the attache case illustrated (size 9 1/2 in. x 4 1/2 in. x 7 in.). This is attractively finished in lizard, maroon, dark green or blue resin. As a combined Mains/Battery Superhet Portable a polished cabinet is available to accommodate both Mains Unit and Batteries. Circuit incorporates delayed

A.V.C. and pre-selective Audio Feedback. The set is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. transformer, and drilled chassis, etc. Overall size of assembled chassis 8 in. x 4 in. x 2 1/2 in. This receiver, as illustrated, can be completely built for £8/10/3 (plus Mains Unit if required). Send 1/5 for the fully descriptive Assembly Book which includes Practical Layouts and complete Price List of Components. Portable Case available separately, 3/7/6.



**THE "MINI TWO-THREE"**

An "Aldry" Battery Portable of midget size, 6 1/2 in. x 4 1/2 in. x 3 1/2 in. designed to cover medium waveband 190-559 metres, with use of short trailer aerial.

The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.

Consists of a T.R.F. circuit using a regenerative detector with I.F. stage and a high gain output pentode. Valve line up IT4-IT4-DL94.

The 2-valve set can be completely built for £4/3/6 (less case) and the 3-valve for £5/3/6 (less case). Each price includes valves, speaker, and drilled chassis.

Send 2/- for the assembly instructions; they include simple and complete practical component layouts and diagrams.

**!! CONSTRUCTORS !!**  
**A NEW SUPERHET TRANSPORTABLE THE "SUPER THREE"**

Designed for local station reception without the use of an external aerial. This design provides for a 3-valve (plus Metal Rectifier) Superhet Receiver incorporating a Frame Aerial for "room to room" use, provision is also made for a short external aerial, if required, for the reception of Continental Stations.

Briefly the features are as follows:-

- For use on A.C. Mains 200-250 volts.
- This set includes a Mains Transformer and Chassis is NOT live to mains (as many other sets of this type are) and consequently the Receiver can safely be used in the Kitchen, etc.
- Valve line up 6K5-4J7-KT61, plus Metal Rectifier.
- The I.F. Transformer is supplied "pre-aligned" and thereby ensures extreme simplicity of Tuning—in fact, more simple than most T.R.F. Receivers.
- Compact and easy to build simple "point to point" practical diagrams are supplied with a completely drilled chassis.

The complete Receiver Chassis can be built to cover the Medium Waveband only for **£6 - 6 - 6**  
 Or to cover both Long and Medium Waves for **£6 - 16 - 3**  
 The attractive Polished Wood Cabinet 11 1/2 inches wide, 8 1/2 inches high and 6 inches deep illustrated above is **£1 - 1 - 0**  
 THE CONSTRUCTOR'S MANUAL is available for 1/-, this shows the component prices, which are all available for separate purchase.



**"PERSONAL SET" BATTERY ELIMINATOR**

A complete Kit of parts to build a Midget "Aldry" Battery Eliminator, giving approx. 69 volts at 10 m/a. and 1.4 volts at 250 m/a.

This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver, requiring H.F. and L.T. voltage as above, or approx. to 69 volts.

The Kit is quite easily and quickly assembled and is housed in a light-aluminium case size 4 1/2 in. x 1 1/2 in. x 3 1/2 in. Price of complete Kit with easy-to-follow assembly instructions, 42/6. In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts at 10 m/a and 1.4 volts at 250 m/a. Size of assembled unit 7 in. x 2 1/2 in. x 1 1/2 in. Price 47/6.



**A COMPLETE "CAR RADIO" FOR THE HOME CONSTRUCTOR**

1 1/2 in. x 4 1/2 in. x 3 1/2 in.

A design of a complete 5-VALVE SUPERHET RECEIVER employing an R.F. Stage, and incorporating a separate VIBRATOR PACK size 4 1/2 x 6 1/2 in. for use on 6 or 12 volt D.C. supplies.

We can supply all components to build this complete Receiver and Vibrator Pack including a Metal Case, Valves, Drilled Chassis and 5 in. P.M. Speaker for £13/9/6. (Carr. and Ins. 5/6 extra.) Or the Receiver Components for £8/19/6 and the Vibrator Components for £3/10/-. This is NOT an EX-GOVT. Receiver, it is a new design employing new Components. Send 2/8 for the complete set of ASSEMBLY INSTRUCTIONS, CIRCUITS and PRACTICAL LAYOUTS, including a complete individual Component Price List.



**A BULK PURCHASE ENABLES THIS SPECIAL PRICE REDUCTION**

OF THE FAMOUS

**SHAFESBURY PORTABLE AMPLIFIER**

Suitable for home use and small Halls. Has matched inputs for both Record Players and Microphone. Also provides for the "mixing" and "fading" of both Gram. and speech as requested.



**COMPRISING**

- A 4-Valve High Gain Amplifier for use on A.C. or D.C. mains 200-250 volts with 5 watts output. Incorporating independent Volume Controls for Mike and Gram., either of which can be faded at will, a variable Tone Control and independent input sockets for Mike and Gram.
- A Transverse Carbon microphone which obtains its polarizing current from the amplifier—no batteries are necessary.
- An 8 in. Goodmans P.M. Speaker with the "Ticonal" magnet for first-class reproduction.

**THE COMPLETE EQUIPMENT is all contained in the PORTABLE CARRYING CASE £18'0'0**

Having been reduced from £30/9/-, HIRE PURCHASE TERMS. DEPOSIT £4/10/- and 12 monthly payments of £1/5/4. Light in weight. Easy to CARRY. GENUINELY PORTABLE. An illustrated leaflet containing free data is available on receipt of S.A.E.

**BATTERY CHARGER KITS**

All kits are for A.C. Mains 200-250 volts. They comprise a Metal Rectifier and Transformer, tapped for 6 or 12 volt charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied. A M/cool meter 4 amp. max., 13/6 extra.

- For 6 or 12 volt batteries at max. 1 amp. .... £1/17/6
  - For 6 or 12 volt batteries at max. 2 1/2 amp. .... £2/5/3
  - For 6 or 12 volt batteries at max. 4 amp. .... £3/2/8
- An easily followed Wiring Diagram is included with each kit.

**SPEAKER BARGAINS**

|                               |         |
|-------------------------------|---------|
| PLESSEY 10in. 3 ohm V/cool    | £15/0   |
| GOODMANS, 10in. 3 ohm V/cool  | £11/3/6 |
| TRUVOX, 12in. 3 ohm V/cool    | £2/7/6  |
| ROLA, 12in. 3 ohm V/cool      | £3/19/6 |
| BAKERS, 12in. 15 ohm V/cool   | £4/19/6 |
| GOODMANS, 12in. 15 ohm V/cool | £5/19/6 |

(Carriage and Ins. 1/6 extra)

**THE NEW W.B. "STENTORIAN" HI F SPEAKERS ARE IN STOCK**

|                    |         |
|--------------------|---------|
| Model H.F. 6-inch  | £2/10/6 |
| Model H.F. 8-inch  | £3/0/6  |
| Model H.F. 9-inch  | £3/7/0  |
| Model H.F. 10-inch | £3/13/6 |

These speakers are of the very latest design and provide quality reproduction for the lower-price range, 3 or 15 ohm models are available.

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

Including a 5 in. P.M. SPEAKER and VALVES

**£6'9'6**

(Plus 7/6 carr. and Ins.)

This receiver is of the very latest design and is for use on A.C. or D.C. Mains. It covers both Long and Medium Wavebands, and includes the modern BVA miniature valves. The line up being 12BA6-12AT6-12AG-35W4. It incorporates Permeability Tuned Coils, thus ensuring excellent selectivity and sensitivity.

The overall size of the complete chassis including speaker is 10 1/2 in. x 4 1/2 in. x 6 1/2 in. An attractive Cabinet size 11 1/2 in. x 6 1/2 in. x 6 1/2 in. is available for 16/6 (plus 2/6 carriage and insura. col.)



**109 and 115 FLEET ST.**

**LONDON, E.C.4. Phone: CENTRAL 5812-3-4**

# CLYNE RADIO LTD.

## 18, TOTTENHAM COURT ROAD, LONDON, W.1

MUSEum 5929/0095.

All goods specially selected for quality and value. Prompt Service—Money-back guarantee—I will pay you to visit our new rebuilt shop premises. Situated 60 yds. only from Tottenham Court Road Tube! (Genuine).

### VERY LATEST 3-SPEED AUTO-CHANGER BY FAMOUS MANUFACTURER

Further limited quantity-mixer, turn-over crystal head. Cream finish. Our price £11/10/- only, plus 3/6 p. & p., or 50/- deposit plus p. & p., and 12 monthly payments of 16/9.

### COLLARO 80/54 PLAYER!

Just released. Fawn leatherette covered portable case, incorporating very latest Collaro 3 speed mixer-changer. Cream finish. Lightweight turn-over crystal pluck-up head. Only £13/19/6 cash, plus 5/- p. & p. Complete, or, 69/6 deposit plus p. & p., and 12 monthly payments of 19/8.

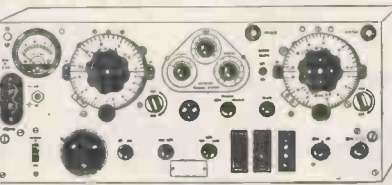
**RECALL** A well-made cabinet in medium coloured walnut veneer. Size 29 1/4 x 14 1/2 x 9 1/2 in. Unique motor-board measures 2 1/2 x 13 1/2 in. Record or tape storage aperture alongside motor-board measures 3 1/2 in. wide x 12 in. deep. Price £9/19/6 plus 10/- p. & p. H. P. terms available.

We have in stock the identical cabinet to this above illustrated, but slightly larger. Measurements: 29 1/2 in. high x 3 1/2 in. x 14 1/2 in. Uncut motor-board measures 2 1/2 x 14 1/2 in. Aperture 5 1/2 x 12 in. deep. Price £10/17/6. **R1155A RECEIVERS** guaranteed serviceable in original packing cases. £7/19/6. Fully assembled Power Pack and output stage, to plug straight into R1155 for A.C. 200/250 volts at 79/6. We have a few brand new R1155A at £11/10/6, also in original packing cases—Deduct 10/- if purchasing either receiver together with power pack. Plus 10/- packing and carriage. **R1124 RECEIVER UNIT.** Coverage 30-40 Mc/s. Including 6 valves—3 type 9D2. 1 each, 8D2, 15D2 and 4D1—8ix valve-screening cans, 24 ceramic trimmers, 6 ceramic valve holders, resistors, condensers, I.F.T.'s coils, etc. In very good condition, a bargain at 16/6 each only, plus 3/6 packing and postage.

**RECEIVER TYPE 25/73.** (The receiver section of TR1196.) Supplied complete with full data for conversion to 3-wave-superhet receiver. Unit in complete with 6 valves 2-EP39, 2-EP36, PK39 and EBC33, also standard I.F.T.'s 465 Kc/s. Price 27/6 plus 3/6 p. & p.

**TR1196 TRANSMITTER PORTION.** We can also supply the transmitter portion of the above receiver incorporating valves, EL32, EP50, CV50L. Type 800 relay, transformer, coils, switches, etc. Limited quantity at 12/6 only, plus 2/6 p. & p. **24 VOLT ROTARY CONVERTER.** Input 24 v. D.C. Output 200/250 v. A.C. 100 watts. Complete in black steel box 18 1/2 in. x 11 1/2 in. x 8 1/2 in. Weight approx. 30lb. Completely smoothed incorporates Sodium Lamp transformer. Brand new, 92/6.

## LAST FEW ONLY! EX-NEW ZEALAND ARMY TRANSMITTER/RECEIVERS.

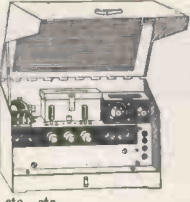


**TYPE ZC1 MK. I.**—Built into substantial steel cabinet mounted on easily removable resilient mountings. The instrument is fully tropicalised. We regret we have sold out Mk. II version previously advertised!! We have few only left. Mk. I general specification 'as for Mk. II, but single waveband only; with frequency coverage 2-6.5 Mc/s. Front panel layout very slightly different to Mk. II illustration. Transmitter output up to 2 watts depending on type of aerial used, gives ranges up to 35 miles on Morse and 30 miles speech, in average country. Considerably greater ranges may be obtained by the use of horizontal aerials. H.T. is supplied by a built-in vibrator pack, requiring 12 volt input. Valve line-up, 2-6V6GT, 7-6U7G, 6K8G and 6Q7GT, 465 Kc/s. I.F.T.'s. Set weighs 58lb. Measurements 22 1/2 x 10 1/2 in. x 10 in. These units are new condition, and price is £5/19/6 only, plus 10/- packing and carriage. This price includes fully illustrated 20-page instruction booklet including full circuit diagrams, suggested aerials, fault-finding, etc. An unrepeatable bargain!!

coverage 2-6.5 Mc/s. Front panel layout very slightly different to Mk. II illustration. Transmitter output up to 2 watts depending on type of aerial used, gives ranges up to 35 miles on Morse and 30 miles speech, in average country. Considerably greater ranges may be obtained by the use of horizontal aerials. H.T. is supplied by a built-in vibrator pack, requiring 12 volt input. Valve line-up, 2-6V6GT, 7-6U7G, 6K8G and 6Q7GT, 465 Kc/s. I.F.T.'s. Set weighs 58lb. Measurements 22 1/2 x 10 1/2 in. x 10 in. These units are new condition, and price is £5/19/6 only, plus 10/- packing and carriage. This price includes fully illustrated 20-page instruction booklet including full circuit diagrams, suggested aerials, fault-finding, etc. An unrepeatable bargain!!

### REMOTE CONTROL UNITS.

These units originally intended for use with the above transmitter/receiver, when inter-connected can be used as ordinary telephones or for practice Morse-working one-to-one. Complete in handsome steel case, can be operated by ordinary torch battery. Has built-in Morse key and buzzer unit. Price for each is 15/-. Suitable headphones can be supplied at 7/6 plus 5/- for carbon hand microphone. The whole plus 2/6 p. & p. Each unit includes full operating instructions—and is brand new.



**OTHER ACCESSORIES AVAILABLE.** Moving Coil Microphones for transmitter 7/6 each, 100 yd. drum twin cable with plugs both ends, 10/-, 70 yd. drum twin, 7/-, etc., etc.

| F.S.D.       | Size           | Type   | METERS Fitting    | Price |
|--------------|----------------|--------|-------------------|-------|
| 50 microamp  | D.C. 2 1/2 in. | M.O.   | R.F.              | 50/-  |
| 100 microamp | D.C. 2 1/2 in. | M.O.   | F.R.              | 45/-  |
| 500 microamp | D.C. 2 1/2 in. | M.O.   | R.F.              | 13/6  |
| 1 mA.        | D.C. 2 1/2 in. | M.O.   | F.R.              | 18/6  |
| 1 mA.        | D.C. 2 1/2 in. | M.O.   | F.R.              | 22/6  |
| 1 mA.        | D.C. 2 1/2 in. | M.C.   | Desk Type         | 27/6  |
| 5 mA.        | D.C. 2 1/2 in. | M.C.   | F. Sq.            | 7/6   |
| 10 mA.       | D.C. 2 1/2 in. | M.C.   | R.F.              | 8/-   |
| 10 mA.       | D.C. 2 1/2 in. | M.C.   | F. Sq.            | 10/-  |
| 50 mA.       | D.C. 2 1/2 in. | M.C.   | F. Sq.            | 8/6   |
| 150 mA.      | D.C. 2 1/2 in. | M.C.   | F. Sq.            | 7/6   |
| 200 mA.      | D.C. 2 1/2 in. | M.O.   | R.F.              | 10/-  |
| 1 amp.       | R.F. 2 1/2 in. | Thermo | R.F.              | 10/-  |
| 3 amp.       | R.F. 2 1/2 in. | Thermo | F. Sq.            | 6/-   |
| 5 amp.       | D.C. 2 1/2 in. | M.O.   | F. Sq.            | 13/6  |
| 6 amp.       | R.F. 2 1/2 in. | M.O.   | Thermo F.R.       | 7/6   |
| 20 amp.      | D.C. 2 1/2 in. | —      | E.P. (with shunt) | 10/6  |
| 25 amp.      | D.C. 2 1/2 in. | M.I.   | F.R.              | 8/6   |
| 30 amp.      | D.C. 2 1/2 in. | M.I.   | F.B.              | 17/6  |
| 15 volt      | A.C. 2 1/2 in. | M.C.   | F. Sq.            | 12/6  |
| 20 volt      | D.C. 2 1/2 in. | M.C.   | F. Sq.            | 7/6   |
| 15-15 volt   | D.C. 2 1/2 in. | M.C.   | F.R.              | 17/6  |
| 150 volt     | D.C. 2 1/2 in. | M.C.   | F.R.              | 15/-  |

R.F. = Round projection. M.C. = Moving Coil. Thermo = Thermo-couple. F. Sq. = Flush square. F.R. = Flush Round. M.I. = Moving Iron.

**EX-W.D. CATHODE RAY TUBES.** Guaranteed full picture. VCB97 at 40/-. VOR570 at 35/-. Also VOR31A—ideal for oscilloscope 2 1/2 in. screen at 55/-. We also have VCB97 with slight out-off, very suitable for oscilloscope, testing purposes, etc., at 15/- only. All these tubes are brand new, in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

**AMERICAN INDICATOR UNIT TYPE BC929A.** Brand new incorporating 3in. tube 3BP1 with mu-metal shield, 2-6SN7GT, 2-6HG0T, 6X5G, 2X2, 8046G, 9 potentiometers 24 v. aerial switch motor, transformer, and a host of small components. The whole unit which measures only 8 1/2 in. x 8 1/2 in. x 1 1/2 in. is brand new, enclosed in black crackle box, and can be supplied at 65/-, plus 5/- p. & p.

**BRAND NEW C.B. TUBES.**—By leading manufacturer. 14KP4A. Latest type 14in. rectangular 6.3 v. heater. 12-14 Kv. in original sealed cartons. Limited quantity only at £13/19/6. Plus 15/- packing, carriage and insurance.

**TRIPLETT RECTANGULAR METER.** 4in. scale. Knife-edge needle. Basic movement 0-100 microamps. At present graduated for multi-range meter. Brand new in sealed cartons, 90/-, plus 2/- p. & p.

### STOP PRESS!!!

2 1/2 in. ROUND FLUSH MOUNTING METER by WESTON, blank scale ready for re-engraving, FSD 650 microamps, brand new, 27/6 only.

**HIRE PURCHASE**  
We are pleased to announce advantageous hire purchase facilities on any single item over £5. Ask for details, mentioning what you are interested in. We regret we cannot extend this facility to kits.

- 32 SET POWER UNIT No. 4MK1 ZA10478.—Complete with 4 metal resistors each 250 v. 60 mA. 2-12 v. 4 pin Mallory Vibrators, transformers, condensers, resistors, signal 1 amp. indicator, etc., etc., in good condition. Complete in metal box size 10 1/2 in. x 6 1/2 in. x 8 in. Weight 19lb. 27/6, plus 5/- p. & p.
- L.T. RECTIFIERS TYPE R.K. A newly manufactured range guaranteed 12 months. 6 or 12 v. 1 a. F.W. bridge type ... 7/6  
6 or 12 v. 1.5 a. F.W. bridge type ... 9/6  
6 or 12 v. 2 a. F.W. bridge type ... 11/3  
6 or 12 v. 2.5 a. ... 12/6  
6 or 12 v. 4 a. F.W. bridge type ... 15/-
- CHARGER TRANSFORMERS. Input 230 v. 8/12 v. 1 a. ... 9/9  
2 6/12 v. 2 a. ... 14/6  
2 6/12 v. 4 a. ... 17/6
- ROTHEMEL. DA1 Crystal Microphone Inserts. Brand new, 7/6 each, plus 9d. p. & p. We also have a limited number of Bonetto Type ZA crystal microphone inserts at 23/6.
- METER SPECIAL. We have a limited quantity of aircraft electrical thermometers Brand new, by Weston. 2in. moving coil meter, dash square fitting. These meters have a luminous scale graduated 0-100 degrees centigrade, but the full scale deflection is approximately 150 microamps! Price 12/6 each only, plus 1/- p. & p.
- VIBRATOR PACK. Brand new, by Mallory. 12 volt input, 150 v. 40 mA. output. Complete with synchronous vibrator, 27/6.
- DECCO LIGHTNING PIGTAILS. Complete with either standard or L.F. Crystal Cartridge inserts. Complete with Rest and Tracking instructions, 32/6 plus 1/6 p. & p. Also their very latest type, as above, but with turn-over head 47/6 only! Plus 1/6 p. & p.
- 8-VOLT VIBRATOR PACK. Ex-W.D. 6-volt input, output 140 v. 30 mA. Fully smoothed and rectified, incorporating Wearite 6 volt 4 pin vibrator type N8B6. Unit size only 6 1/2 in. x 6 in. x 2 1/2 in. Price 15/- plus 1/6 p. & p. New condition. SPECIAL OFFER—RE-SETTING VALVES. These are brand new originally boxed, and guaranteed O.K. Type 813, 80/- per pair. Type 866A, 17/- per pair, both post free. Also type 29C1 at 20/-. 12E1 at 40/-.
- VALVES. We have a very comprehensive stock of surplus valves at competitive prices. A stamp will bring Valve Price List.
- SPECIAL OFFER—METERS. Taken from equipment, but guaranteed perfect. 2in. round, 0-50 amp. 2in. round, 0-40 amp. 2in. round 0-50 volt, 3/9 ea., or 3 for 10/6. 2 1/2 in. round panel-mounting 0-500 mA., 5/-.

All the above plus P. & P. please!  
**R.F. UNITS.** All new condition and complete. Case size 9 1/2 in. x 7 1/2 in. x 5 in.  
Type 24—29-30 Mc/s. 15/-, Switched Tuning. Type 25—40-50 Mc/s. 19/6. Switched Tuning. Type 27—45-86 Mc/s. 45/-. Variable Tuning. Type 28—60-65 Mc/s. Variable Tuning 35/-. We have a limited supply of R.F. units in addition and complete, but tuning dial damaged. Price only 30/- each. All these units Post Free.  
**AVR20—R.O.A. COMMUNICATION RECEIVER.** Absolutely brand new in sealed box, containing all circuit, and fully illustrated instruction booklet. Designed for reception of either speech or Morse. A three-position switch provides either standard variable condenser tuning (calibrated dial) or crystal "lock-in" on either of two frequencies. These two frequencies are determined by the crystals used. For 6 or 12-volt supply. Valve line-up: 6B7, 6K8, 6P7 and 6B8, Superhet, 2.3-6.7 Mc/s. Size only 6 1/2 in. x 7 1/2 in. x 5 1/2 in. Weight only 6 1/2 lb. Price only 59/6. Plus 2/6 p. & p.

**AMERICAN CONTROL UNIT C58/AFT1.** Box measures only 5 1/2 in. x 3 1/2 in. x 2 in. Incorporating 2in. round 0-1 mA. meter 200 ohm. pot. 2 toggle switches, indicator lamp, etc. Price 22/6, post free.

**HEADPHONES.** Brand new, ex-Govt., by S. G. Brown. Type CLR. Low resistance, 12/6 per pair. Type CHR high resistance, 12/6 per pair. We can also supply very special brand new American ex-Govt. lightweight high resistance phones by Trimm at 45/- per pair.

**4 VOLTALYTES** 9 volt 60 amp. ACCUMULATORS MULTI-PLATE Type in celluloid containers. Size 3in. x 3in. x 4 1/2 in. high at 9/6 each plus 2/- p. & p. Or 3 for 23/6, post free.

**No. 38 TRANSMITTER / RECEIVER WALKIE-TALKIE.** Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only, complete with valves at 30/-, in very good condition. **RECORD PLAYER CABINETS.** Specially made to house any type of single record unit. Finish in dove-grey leatherette. Baseboard measures 14 1/2 in. x 12 1/2 in. Clearance above and below board 3in. 45/- plus 3/- p. & p.

Please add postage under £1. C.O.D. or Cash with order. C.O.D. charge extra—open 9 a.m.-6 p.m. Monday to Friday. Sorry but we close at 1.0 p.m. on Saturday.



**OUR NEW "POPULAR" AMPLIFIER, A.C.**

Maine 2/3 ohms. 4 watts output. Suitable for either crystal or magnetic pick-up. Valve line-up, 6V6GT, 6SL7GT, 5Y3GT. Provision for radio feeder unit. Volume and tone controls. Built in chassis. Finished steel box, with chrome carrying handle. Attractive bakelite engraved front panel. Box measures 9 1/2 in. x 7 1/2 in. x 6 1/2 in. Price only £8/12/6 carriage paid. Ready for use.

We have in stock the very latest "Elipco" Feeder Unit type RF720. Superhet for L., M., Short and Trawler Bands. Very attractive illuminated black and gold dial for immediate use with any amplifier. 15 gas. tax paid.

**HIRE PURCHASE**

We are pleased to announce advantageous hire purchase facilities on any single item over £5. Ask for details, mentioning what you are interested in. We regret we cannot extend this facility to kits.

**LATEST 3-SPEED AUTO-CHANGER**, long arm model complete with C. and D. high density heads. Limited quantity at £17/10/- plus 5/- p. & p. H.P. terms available.

**THE R.C. 3/4 WATT AMPLIFIER KIT**—Just released! Compare the advantages! Treble, bass, AND middle tone controls! For crystal or magnetic pick-up! A.C. Mains. 200/250 v. Valve line-up, 6V6GT, 6X5GT, 6X5GT. Negative feedback. Built on Stove enamelled steel chassis, measuring only 8 in. x 4 in. x 1 1/2 in. Four engraved cream knobs are included in the price of the complete Kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus p. & p. Hearing is believing!



**SUPER-QUALITY 6-VALVE RADIOGRAM CHASSIS.**

Very limited quantity by Britain's leading quality manufacturers, 3 waveband, superhet, valve line-up, 6V6G, E240, ECH42, L63, EP41 and EB041. Combined pick-up amplifier and A.F. amplifier on Radio and Gram. Employs a special circuit for gramophone pre-amplification. Large glass dial horizontal tuning measuring 1 1/2 in. x 3 1/2 in. Chassis measurement: 14 1/2 x 9 in. x 8 in. This is a superior chassis designed to sell originally in a Radiogram costing £75. Our price is £12/10/6 only, tax paid, plus 5/- packing and carriage. We will gladly demonstrate this chassis or any other working item from our stocks, to personal callers!

**ARMSTRONG F.C.48.** Their very latest high quality replacement chassis having provision for F.M. feeder unit, 3 valves, four wavebands. Independent bass and treble with unique thermometer visual indicator. Ready for use £23/12/- plus 5/- p. & p. or £5/12/- deposit and 12 monthly payments at 33/8.



Carrying cases in black leatherette finish. An extremely well-made case with chrome locks and corner pieces for extra strength. This cabinet will house any 12in. Hi-Fi speaker, but can be put to a number of uses. Front panel and lid are removable, and the cabinet is packed in a strong cardboard container for carrying purposes. Size: 18 1/2 in. x 10 1/2 in. x 16 1/2 in. 55/- plus 5/- post and packing.

**F.M.!! (Frequency Modulation)**

We are pleased to announce our complete Kit for the "Denco" F.M. Feeder Unit.

This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where triode/pentode output are available. Within an average of 30 miles from a V.H.F. transmitter one I.F. stage should be adequate, but our complete Kit supplied includes all components and valves for an extra I.F. stage if necessary, or if the unit is used at greater distance. Full Constructional details, theoretical circuit and point-to-point wiring diagram can be supplied for 1/6 post free, or the complete Kit right down to the last nut and bolt, at only £8/7/6, plus 2/6 packing and postage. This unit can be supplied if desired ready assembled, aligned and tested, at £9/10/- plus 2/6 packing and postage.

If required we shall be pleased to align this unit for constructors not possessing the necessary equipment, for a charge of 7/6. N.B.—Valve line-up is 6AM6, 12AH8, 2-6BA6 and 6AL5. Chassis measures only 8 1/2 x 5 1/2 x 1 1/2 in. Demonstrations at 18, Tottenham Court Road!



**THE "SUPERIOR" FOUR KIT.** Our new four-valve receiver. A.C. mains. 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 68G7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size, 10 1/2 in. x 10 in. wide. Maximum depth at base 5 1/2 in. tapering to 3 1/2 in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6, post free. Our price for complete kit, £5/9/6 1/11! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage. N.B.—Our kits are even supplied with sufficient solder for the job.



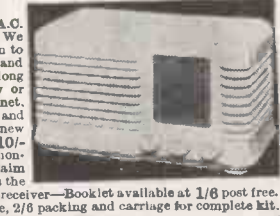
**THE R.O. GRAM REPLACEMENT CHASSIS KIT**

To meet the very great demand for this type of receiver, we have produced this unit. For Long, Medium, and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7 1st Audio, Detector and A.F.C. 6V6 Output, 6X3 Full-wave rectifier. For A.C. mains 200/250 volts. 4 watts output. Excellent quality. High sensitivity. Provision for gram. Attractive illuminated black, red, green and gold dial for horizontal tuning. Four controls are: Tuning, L/M/S/Gram, Vol/on/off, Tone (variable). Chassis size: 13 1/2 in. x 6 1/2 in. x 2 1/2 in. Dial size: 10 in. x 4 1/2 in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Main Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list.

1/6, post free. The main items for this receiver can be supplied separately, as under. Drilled chassis, complete valve-holders, A/E panel, P/U panel, tuning condenser and ready-assembled dial and drive at 39/6. 3 waveband coil pack with gram position, 39/6, tax paid. Pair of 465 Kc/s. I.F. Transformers, 9/6 pair. Half shrouded drop through Main Transformer, 22/6. The total cost of ALL items purchased separately is nearly £10, but we shall be pleased to supply all the required components right down to the last nut and bolt, at a special inclusive price of £5/8/-, plus 2/6 packing and postage. A set of four small brown and cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled, in very limited quantities at £9/19/6, plus 5/- carriage and packing.

**THE "ECONOMY FOUR" T.R.F. KIT**

A three valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up, 6K7, 6J7, and 6V6, Chassis ready drilled—Cabinet size 12 in. long by 6 in. high by 6 in. deep—Choice of Ivory or Brown Bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagram. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later—Please, 2/6 packing and carriage for complete kit.



**DULCI RADIO/RADIOGRAM CHASSIS**

This very popular range of superior chassis can be supplied from stock. We will gladly demonstrate any to personal callers. All incorporate latest type valves 6BE6, 6BA6, etc. Flywheel tuning, negative feedback over entire audio section. Engraved knobs—3 tone position for Radio and Gram. All are built on chassis size 1 1/2 in. x 7 in. x 8 1/2 in. high. All A.C. 100/110 and 200/250 v.—Dial size 8 1/2 in. x 4 1/2 in. for horizontal tuning. Attractive appearance.

- Model B.3, Long, Medium, Short Waves (5 valves). Cash Price £12/12/- H.P. Terms £3/4/- deposit and 12 months at 17/8.
  - Model B.3 Plus Push Pull Stage. (6 valves). Cash Price £15/15/- H.P. Terms, £3/19/- deposit, 12 months at £12/2.
  - Model B.3 Double Feature Push Pull and R.F. Stage (7 valves). Cash Price £18/18/- H.P. Terms, £4/13/- deposit, 12 months at £18/9.
  - Model B.6 (Medium, Long and Four Short Wavebands, hand-operated). Cash Price £15/15/- H.P. Terms, £3/19/- deposit, 12 months at £12/2.
  - Model B.6, Plus Push Pull Stage (6 valves). Cash Price £18/18/- H.P. Terms £4/13/- deposit, 12 months at £18/9.
  - Model B.6, Double Feature Push Pull Plus R.F. Stage (7 valves). Cash Price £22/22/- H.P. Terms £5/15/6 deposit, 12 months at £12/12/6.
- All chassis fully guaranteed 12 months. Please include 7/6 packing, carriage and insurance. Illustrated leaflet available. Suitable speakers available. Ask for speaker list.

**THE R.O. RAMBLER ALL-DRY PORTABLE KIT**

Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet; measuring only 9 in. x 7 in. x 6 1/2 in. Weight less batteries, 4 1/2 lbs. with batteries 6 1/2 lbs. This set really has everything! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 6in. speaker. Valve line-up: 3V4, 1B5, 1B5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. & p. (less batteries). Uses Ever-Ready 90 v. H.T. type B120 at 9/3. Also L.T. 1.5 v. A.D.35 at 1/4.



**RAMBLER MAINS UNIT I**—At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self contained in a metal box measuring 7 in. x 2 1/2 in. x 1 1/2 in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

**THE R.E.P. SINGLE-VALVE BATTERY RECEIVER KIT.** One-valve all-dry battery receiver for headphones, easily built in one evening. All required components including headphones, can be supplied at inclusive cost of 42/- plus 2/- p. & p. Operated by Ever-Ready B114 type battery available at 7/9. Full assembly details available separately at 9d. plus 3d. post.

**THE NEW R.C. HIGH-FIDELITY AMPLIFIER.** P.P. 6V6 output. Freq. 25-18,000 cps—60 db at 6 1/2 watts. Treble boost and cut—Bass boost—L.P. correction. Provision for Feeder Unit Max. UNDISTORTED OUTPUT 8 1/2 watts. Price 14 gns. plus 7/6. NOW AVAILABLE—Kit of Parts, complete with fully illustrated instructions £11/19/6, plus 5/- carriage. Illustrated booklet available separately at 1/6. Attractive metal cover, now available, with built-in carrying handle 19/6.

**STUPENDOUS HALF-PRICE OFFER!** DECCA SINGLE SPEED RECORD PLAYER! DECCA DESES 53A. Easily converted to either Standard or I.F. Price with one crystal cartridge of either type, £4/19/6; or with both cartridges, £5/19/6. Plus 5/- p. & p. We have in stock at our usual competitive prices, ALL the required components for Gram and Mullard amplifiers. Available ex-stock. The LEAK TL10 Amplifier complete. 27 guineas, or H.P. terms available.

We also have in stock—Connors 3-speed motors, pick-ups, Pick-ups and heads by Garrard, Decca, Coltaro, Accos, Chancery, etc., etc., at current prices.

**AMPLIFIER BARGAIN. "THE EMPRESS"** Super quality push-pull 4 valve 4 watt amplifier. Ideal for record or radio tuner reproduction. Measures only 7 1/2 in. x 7 1/2 in. x 3 1/2 in. Valve line-up EL42, EL42, EZ41, EC83, for use with one or two 3-ohm speakers. Price £7/7/- plus 3/- p. & p.

**CLYNE RADIO LTD.**  
  
 18, Tottenham Court Road,  
 London, W.1.

# ALPHA

|               |               |                |               |
|---------------|---------------|----------------|---------------|
| 6G6G ... 6/6  | 807 ..... 8/- | VR137 ... 5/-  | 956 ..... 3/6 |
| 9004 ... 6/3  | 5Z3 ..... 8/6 | VR55 ... 7/3   | 9003 ... 6/3  |
| VR136 ... 7/- | 955 ..... 4/- | 6SA7 ... 9/-   | 2X2 ... 5/6   |
| VR66 ... 3/9  | TT11 ... 6/6  | ATP4 ... 6/9   | VR65 ... 3/9  |
| VUI20A 3/6    | VR116 ... 4/- | VU111 ... 3/6  | 6S57 ... 8/-  |
| 9002 ... 6/3  | VR56 ... 7/-  | VT75A ... 7/6  | 9001 ... 6/3  |
| VR53 ... 7/6  | 954 ..... 2/- | 1A5GT ... 7/6  | VR56A ... 3/6 |
| VR91 ... 6/-  |               | 6S77 ..... 8/- |               |

## OFFER THESE SPECIAL PURPOSE VALVES

**MAINS FLEX.** Plastic Twin flat 3d. yd.

**BAKELITE CASED HAND MICROPHONES,** switch in handle complete with lead, 7/6 each.

**GOLDTONE BUZZERS** in bakelite case, 2/6 each.

**PENTODE OUTPUT TRANSFORMERS,** 2/9 each.

**HIGH TO LOW RESISTANCE HEADPHONE** matching units (insert in lead), 3/6 each.

**COLVERN WIRE WOUND PONTIOMETERS,** 10KΩ, 20KΩ, 2/6 each.

**BLACK 1 mm. SLEEVING,** 1/- doz. yds

**BLACK 4 mm. SLEEVING,** 4d. yd.

**WEARITE 501-502 IF TRANSFORMER,** 10/- pair.

**PHILIPS ROUND CAN IF TRANSFORMERS,** 470 Kc/s, 8/- pair.

**EX-GOVERNMENT PRE-AMPLIFIER,** uses EF50, 6/6 each.

**20-WAY JUNCTION BOXES,** 1/4 each

**BELLING LEE 7-PIN PLUG AND SOCKET,** 1/6 each.

**TWIN FUSE HOLDERS** panel or base-board mounting, state type required (suitable for 1½in. fuses), 1/9 each.

**AMPLIFIER OR CHARGER CASE.** Brown crackle cabinet with removable chassis and bakelite front panel. Size 9½in. width x 7½in. height x 6½in. depth, 8/6 each.

**HEAVY DUTY OUTPUT TRANSFORMER.** Suitable for PX4 or 6L6 valves in push-pull, 12/- each.



**LOUDSPEAKER CABINETS**

This attractive walnut finished cabinet is available for 6½in. or 8in. speaker units. Metal speaker fret, complete with back and rubber feet.  
6½in. type: Measures 8½in. x 8½in. x 4½in. at base. Price 16/6 each.  
8in. type: Measures 10½in. x 10½in. x 5in. at base. Price 20/6 each.

**CHOKE.** Wavox choke, max. current 100 mA D.C. Resistance 125 ohms, 6/- each.

**MICROPHONE STAND.** Folding microphone floor stand, adjustable, 25/- each.

**DEFIANT EXTENSION SPEAKERS.** Extension loudspeaker in attractive pale green cabinet. Volume control fitted, 6½in. speaker unit, 42/- each.

**TABLE MICROPHONE.** Lustraphone type moving coil microphone on table stand. Complete with lead and Jack plug, 24/10/- each.

**NUTS AND BOLTS.** Box of nuts, bolts and washers 4BA countersunk and round head, over 100 items, 1/- box.

**WESTINGHOUSE 1 mA Rectifier wire ends,** 9d. each.

**PERSPEX IMPLOSION GUARDS,** incorporating brown acetone and grey filter drilled ready to fit to cabinet. 12in. type 11/-; 16in. type 12/6.

**EX-MINISTRY BAKELITE DOUBLE POLE TOGGLE SWITCH.** Single hole fixing, 1/6 each.

**6 Volt VIBRATOR PACK** complete with 4-pin Vibrator, 14/6 each.

**ELAC type 1T6 Ion Traps,** 2/9 each.

**GOOD QUALITY, maroon cotton covered** 2 amp. 3 core line cord, 1/9 each.

**TCC type (CE37FE) 100 mfd. 450 V.,** 4/- each.

**MAINS TRANSFORMER.** Input 200/250 v., output 225-0-225 V. 20 mA/6.3 v. 3 a., 11/- each.



### COMPARE THE PRICE THE "EKE" QUALITY 3 WATT AMPLIFIER



This is a complete unit, not a kit of parts.

For use with Hi-Fi Pick-up.

- 3 valves; 6B8, 6V6, 6X5.
- Tone and volume controls.
- Input and output sockets.
- A.C. mains fully isolated.
- Negative feedback.

Price 79/6. P. & P. 2/6.

## CONDENSERS

The following is a selection of our stocks of manufacturers' surplus condensers, all by well-known makers.

### ALUMINIUM CAN TYPES, GLIP FIXING

|                              |          |
|------------------------------|----------|
| 8 x 8 mfd. 450 v. ....       | 4/- ea.  |
| 8 x 18 mfd. 450 v. ....      | 4/- ea.  |
| 8 x 24 mfd. 350 v. ....      | 3/- ea.  |
| 8 x 32 mfd. 475 v. ....      | 3/9 ea.  |
| 12 x 4 mfd. 450 v. ....      | 2/- ea.  |
| 16 mfd. 450 v. ....          | 3/- ea.  |
| 16 x 8 mfd. 350 v. ....      | 4/- ea.  |
| 16 x 16 mfd. 350 v. ....     | 3/3 ea.  |
| 16 x 16 x 8 mfd. 350 v. .... | 3/6 ea.  |
| 20 x 20 mfd. 500 v. ....     | 4/9 ea.  |
| 24 mfd. 450 v. ....          | 2/9 ea.  |
| 24 x 16 mfd. 350 v. ....     | 3/6 ea.  |
| 32 mfd. 450 v. ....          | 3/- ea.  |
| 32 x 8 mfd. 350 v. ....      | 3/3 ea.  |
| 32 x 16 mfd. 350 v. ....     | 4/9 ea.  |
| 32 x 32 mfd. 450 v. ....     | 6/11 ea. |
| 32 x 32 x 8 mfd. 350 v. .... | 5/6 ea.  |
| 25 v. ....                   | 5/9 ea.  |
| 60 mfd. 450 v. ....          | 2/9 ea.  |
| 64 mfd. 350 v. ....          | 2/- ea.  |

### B.R. RANGE

|                                |         |
|--------------------------------|---------|
| B.R. 850, 8 mfd. 500 v. ....   | 2/9 ea. |
| B.R. 1650, 16 mfd. 500 v. .... | 3/3 ea. |
| B.R. 2950, 20 mfd. 500 v. .... | 3/9 ea. |
| 8 x 8 mfd. 500 v. ....         | 4/- ea. |
| B.R. 501 50 mfd. 12 v. ....    | 1/9 ea. |
| 16 x 16 mfd. 600 v. ....       | 5/- ea. |
| 16 x 8 mfd. 500 v. ....        | 4/9 ea. |

### MIDGET METAL TYPES

|                          |         |
|--------------------------|---------|
| 2 mfd. 350 v. ....       | 1/9 ea. |
| 8 mfd. 350 v. ....       | 1/3 ea. |
| 8 x 8 mfd. 350 v. ....   | 3/- ea. |
| 8 x 8 mfd. 450 v. ....   | 4/- ea. |
| 16 mfd. 350 v. ....      | 2/9 ea. |
| 16 x 8 mfd. 450 v. ....  | 4/6 ea. |
| 16 x 16 mfd. 450 v. .... | 4/9 ea. |
| 16 x 24 mfd. 350 v. .... | 2/9 ea. |
| 24 mfd. 350 v. ....      | 2/9 ea. |
| 32 mfd. 350 v. ....      | 1/9 ea. |
| 32 x 32 mfd. 350 v. .... | 4/9 ea. |
| 25 mfd. 12 v. ....       | 1/9 ea. |

### WIRE ENDED TYPES

|                                 |          |
|---------------------------------|----------|
| 8 mfd. 450 v. cardboard covered | 1/11 ea. |
| 30 mfd. 450 v. ....             | 3/9 ea.  |

### BIAS CONDENSERS

|                       |         |
|-----------------------|---------|
| Tag ended metal types |         |
| 12 mfd. 50 v. ....    | 1/- ea. |
| 25 mfd. 25 v. ....    | 1/3 ea. |
| 50 mfd. 12 v. ....    | 1/- ea. |
| 100 mfd. 50 v. ....   | 2/6 ea. |
| 100 mfd. 12 v. ....   | 1/9 ea. |
| 100 mfd. 25 v. ....   | 1/9 ea. |

### WIRE ENDED TYPES CARD-BOARD COVERED

|                    |         |
|--------------------|---------|
| 25 mfd. 25 v. .... | 1/9 ea. |
| 50 mfd. 12 v. .... | 1/9 ea. |
| 50 mfd. 50 v. .... | 2/9 ea. |

## SILICONE COATED WIRE-WOUND RESISTORS

Tolerance plus or minus 10%. Each resistor clearly marked with resistance value and wattage. Available in the following values: 25, 50, 68, 100, 150, 200, 250, 350, 500, 680, 1,000, 1,500, 2,000, 2,500, 3,500, 5,000, 6,800, 10,000 ohms.

|         |         |
|---------|---------|
| 5 watt  | 1/- ea. |
| 10 watt | 1/3 ea. |
| 15 watt | 1/9 ea. |

### VOLUME CONTROLS

|                  |      |      |      |
|------------------|------|------|------|
| WIRE WOUND TYPES |      |      |      |
| 5Ω               | 2KΩ  | 15KΩ | 30KΩ |
| 200Ω             | 5KΩ  | 20KΩ | 50KΩ |
| 1KΩ              | 10KΩ | 25KΩ | 500Ω |
| All 2/6 each.    |      |      |      |

### SUPPRESSORS

|   |                   |
|---|-------------------|
| Metal Case Mains Suppressor inserted in Mains Lead will cut out that interference | 2/6 ea.           |
| Plug Suppressor. Terminal Screw Fitting   | Post 1/1- 1/2 ea. |

## THE COMPACT TELEVISION AERIAL BY ANTIFERRE LTD.

Supplied complete with universal mounting and backplate in neutral brown finish. Overall length 5ft. 6in. Packed in carton 3ft. 4in. long. Complete with full instructions. Cat. No. CD4. Original price 50/- Our price 12/6 each.

## CONDENSERS MOULDED MICA

.0001, .0002, .0003, .0004, .0008, .00027, .0005, .001, .002, .003, .003, .01, 50 PF. 20 PF.

All 4½d. each.



## LOUDSPEAKER UNITS

|  |      |
|--|------|
| 5in. Rola with output transformer          | 16/6 |
| 6½in. Rola Standard Type                   | 17/6 |
| 6½in. Truvox wafer speaker                 | 17/6 |
| 8in. Plessey                               | 20/6 |
| 8in. Plessey                               | 20/6 |
| 6 x 4 Elliptical                           | 21/6 |
| 8½in. Mains energised 600 field            | 17/6 |
| 8in. Mains energised 1,000 and 2,000 field | 21/6 |



## SPRAGUE CONDENSERS

.05 mfd. 500 v.; .01 mfd. 1,000 v.; .1 mfd. 350 v.; .02 mfd. 750 v. All 9/- doz.

### CHASSIS

Aluminium Undrilled with Reinforced Corners. Available in the following sizes:

|                      |          |
|----------------------|----------|
| 6in. x 4in. x 2½in.  | 4/6 ea.  |
| 8in. x 6in. x 2½in.  | 6/3 ea.  |
| 10in. x 7in. x 2½in. | 7/8 ea.  |
| 12in. x 8in. x 2½in. | 8/6 ea.  |
| 14in. x 8in. x 2½in. | 9/6 ea.  |
| 16in. x 9in. x 2½in. | 12/- ea. |

All are four sided—ideal for radio receivers—amplifiers—powerpacks, etc.

## CRYSTAL DIODES

Plastic case, wire ends, 2 for 2/1.

## IRON ELEMENTS

Standard adaptable type 230 v., 450 v.  
Morphy-Richards replacement  
H.M.V. replacement type

|  |         |
|--|---------|
| Standard adaptable type 230 v., 450 v. | 1/8 ea. |
| Morphy-Richards replacement            | 3/9 ea. |
| H.M.V. replacement type                | 3/- ea. |

## DOUBLE TRIMMERS

250/250 pf.; 100/100; 100/50. All 6d. each.

## MAINS TRANSFORMERS

**3-WAY MOUNTING TYPE**

**MT1**  
Primary: 200-220-240 v.  
Secondaries: 275-0-275 v., 80 mA. 0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v. 17/6 ea.

**MT2**  
Primary: 200-220-240 v.  
Secondaries: 350-0-350 v., 80 mA. 0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v. 17/6 ea.

**MT3**  
Primary: 200-220-240 v.  
Secondary: 30 v. 2 amps.  
Taps at 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v. 17/6 ea.

## IF TRANSFORMERS

Radiocraft I.F.S. 465 Kc/s. with compression trimmers, solid construction, a real quality job. Size: 3½in. x 1½in. 100/127 Kc/s. 12/- pr. Philips Round Type, 470 Kc/s. 8/- pr. Wearite Type 501A and 502, 465 Kc/s. 10/- pr. Surplus Type 465 Kc/s. 6/9 pr.

**TERMS:** Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/- unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

## MAIL ORDER ONLY

# ALPHA RADIO SUPPLY CO.

5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

**RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS**



**RECORDING TAPE**

1,200ft. reels, kraft base on Cyldon metal spools. Each, 12/11. Post 1/- extra. Every make and type of Recording Tape stocked. Scotch Boy, E.M.I., Ferrovoice, Grundig, Ferragraph, Puretone, Gaverit and Agfa, etc.

**"SENTERCEL" SELENIUM RECTIFIERS**

|                  |      |
|------------------|------|
| K3/10, 250 v.    | 2/6  |
| K8/40, 3.2 kV.   | 6/-  |
| K3/45, 3.6 kV.   | 8/2  |
| K3/50, 4.0 kV.   | 8/8  |
| K3/100, 8.0 kV.  | 14/8 |
| K3/160, 12.8 kV. | 21/6 |
| K3/200, 16 kV.   | 26/- |

**"SENTERCEL" METAL RECTIFIERS**

|                      |      |
|----------------------|------|
| RM1, 125 v., 60 mA.  | 3/10 |
| RM2, 125 v., 100 mA. | 4/3  |
| RM3, 125 v., 125 mA. | 5/-  |
| RM4, 250 v., 250 mA. | 16/- |

**MAINS TRANSFORMERS**

Special for MT1155, etc. Drop-through chassis mounting, half shrouded. 275-0-275 v., 110 mA. 6.3 v. 4 amps., 5 v. 3 amps. LASKY'S PRICE, each 29/6.

**COLLARO 3-SPEED AUTO-CHANGERS**  
With dual purpose crystal P.U. Limited quantity only. LASKY'S PRICE £9/19/6. Carriage 2/6. Large range of other makes, Garrard, Plessey, B.S.R.

**COLLARO 3-SPEED RECORD PLAYERS**

Complete with P.U. and orthodynamic switched head. P.U. transformer also included. Limited quantity only. £6/19/6. As above, with "Studio" turn-over Crystal Pick Up (O or P), £8/18/4. Post, either type, 3/6.

**TAYLOR JUNIOR TEST METERS**

Type 120A. 0-1,000 v. in 5 ranges A.C. and D.C., 0-500 M/A. with extension up to 10 amps, and two resistance ranges. These Meters have been used but thoroughly tested and in perfect working order. LASKY'S PRICE 79/6. Carr. & Ins. 5/-.

**P.M. LOUDSPEAKERS**

2½in., 16/-, 5in., 18/6, 6½in., 16/6, 3in., 12/6, 8in., 18/6, 10in., 19/11.

**HI-FI SPEAKERS**

Full range of leading makes. Wharfedale, Stentorian, Goodmans, G.E.C., Bakers, etc.

**FILAMENT TRANSFORMERS**

|                    |      |
|--------------------|------|
| 6.3 v., 1.5 amps.  | 5/11 |
| 6.3 v., 1.75 amps. | 6/11 |
| 6.3 v., 3 amps.    | 9/6  |
| 2 v., 2 amps.      | 6/11 |

**THE NEW "LANE" TAPE TABLE MK.VI IN STOCK**

Two speed, 7½in. and 3½in./sec. Three high-grade motors. Record, playback, fast forward and fast rewind (under 1 minute). Takes standard reels up to 1,200ft. capacity. Separate record and crase heads.

PRICE **£18.10**  
Carr. 3/6. Available on H.P. Terms.

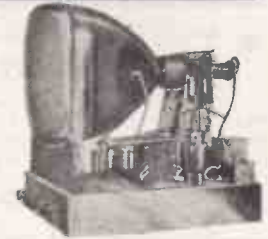
**HIRE PURCHASE**

terms on certain items. Please give details of your requirements.



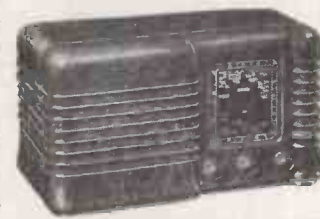
**CONVERT YOUR "VIEW MASTER" TO 14, 16 or 18 inch SCREEN**

Wide Angle Conversion Kit using only W/B components as specified. The Kit consisting of line trans., frame trans., scanning coils, width and linearity controls, focus magnet, ion trap, tube base, 1-K3/100, 1-K3/40, metal rectifiers, 1-6CD6, 1-6U4GT, 3 resistors, 9 condensers. COMPLETE PARCEL including valves and data book **£7.19.6** Post and packing 3/6 extra. 16in. C.R. Tube available at £12.19.6 See next page. "View Master" Wide Angle Conversion Booklet, 3/6, post free.



**INEXPENSIVE RADIO YOU CAN BUILD**

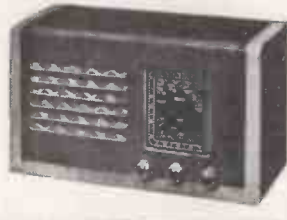
ALL COMPONENTS AND CABINETS AVAILABLE SEPARATELY THIS TRF 3-VALVE RECEIVER CAN BE BUILT FOR **£5.10.0** (Carr. & Pkg. 2/6 extra)



Latest type circuit for 200/250 A.C. Mains, medium and long wave. Uses 6K7G, 6J7, 6V6, and Metal Rectifiers. Handsome Plastic Cabinet, 12 x 6½ x 5½in. deep, Walnut or Ivory finish. If preferred a Wood Cabinet is available (see illus. below). FULL DATA, wiring and circuit diagrams and price list of components, 1/- post free. CABINET only, plastic or wood 17/6. Carr. & Pkg. 2/6 extra.

**THIS 4-VALVE, 3-WAVE SUPERHET CAN BE BUILT FOR £7.19.6** (Carr. & Pkg. 2/6 extra)

Very efficient Superhet Circuit for 200/250 A.C. Mains, long, medium and short wavebands. Uses 6K8 freq. changer, 6K7 I.F. amp., 6Q7 det., A.V.C., AF-amp., and 6V6 output valves. Wood Cabinet, Walnut veneer, size 12 x 6½ x 5½in. deep, or Plastic Cabinet as illus. above. FULL DATA, wiring and circuit diagrams and price list of components, 1/- post free. CABINET only, plastic or wood, 17/6. Carr. & Pkg. 2/6 extra.



**THE "HARROW" BAFFLE RADIO CAN BE BUILT FOR LESS THAN £5.10.0** (Carr. & Pkg. 2/6 extra)



200/250 A.C. Mains, medium and long wave, using 2-6K7, 6V6 and 5Z4 valves. Note the attractive Baffle design Cabinet, outside dim. 17½ x 11½ x 5in. deep, finished satin mahogany veneer. Easy to build and gives fine performance. CIRCUIT DIAGRAM and price list of components, 1/- post free. CABINET only, 32/6. Carr. & Pkg. 2/- extra.

**LASKY'S T.V. CONSTRUCTORS' PARCELS**

**No. 1 WIDE ANGLE PARCEL.** Containing ferroxcube line E.H.T. transformer, ferroxcube scanning coils, frame output transformer, p.m. focus unit, frame blocking osc. transformer, 14-, 16- or 17-inch mask and glass, width and linearity controls. Also the following valves: 6U4gt, 6CD6, 6AL5, 2-6AM5 (N78). 3-12AU7. Full circuit. LASKY'S PRICE COMPLETE £8/15/11 Carriage 3/6 extra.

**No. 2 WIDE ANGLE PARCEL.** As No. 1 parcel but less valves. LASKY'S PRICE £8/11 Carriage 2/6 extra.

**No. 3 PARCEL.** All brand new components by Igranic. Comprises E.H.T. flyback line transformer, 7-10 Kv. with ferroxcube core and rectifier heater winding; scanning coils; frame output transformer; Elac focus unit with vernier adjuster, U.25 E.H.T. rectifier, 12in. mask and glass. LASKY'S PRICE COMPLETE 79/6 Carriage 3/6 extra.



**TRANSCRIPTION MOTORS**

Garrard, Collaro, Connoisseur, in stock.

**EVERY TYPE OF PICK UP**

We stock Pick Ups, P.U. Heads and Stylus by Garrard, Acos, Decca, Chancery, Collaro, B.S.R., etc.

**AMPLIFIERS**

One of the best stocks in London. Leak, Rodgers, Unitelex, Trix, etc.

**SPECIAL PURCHASE OF TABLE RADIOGRAM CABINETS**

Solidly made of half-inch laminated wood finished beautiful Walnut veneer. Panel (3in. x 16in.) for dial and controls baffle for 8in. speaker, gold finish metal grille, fully hinged lid. Overall size 18in. deep, 18in. wide, 13in. high. Slightly soiled, **£4.19.6** Perfect **£5.19.6** Carr. 7/6 extra. Cabinet complete with Collaro 3-speed Autochange and dual purpose crystal pick-up. Brand new, £14/19/6. Carriage 12/6 extra.

**MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE**

# LASKY'S RADIO

## ★ ANOTHER BIG BARGAIN RADIOGRAM CHASSIS

5-valve superhet, 3 wavebands—long, medium, short. Latest type miniature valves, gram. switch, ext. speaker socket. Large full vision dial. Size 12x7x8in.

**LASKY'S PRICE £10.5.0**

Packing and Insurance 10/- extra.

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

## BUILD THE "TELE-KING"

### 5 Channel 16 or 17 inch SUPERHET RECEIVER

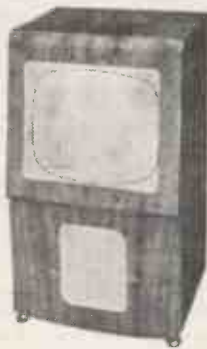
This famous and well tried home constructor set can now be built for £29/10/-. Tube and cabinet extra.

EVERY COMPONENT CAN BE SUPPLIED SEPARATELY.

Full constructional data, wiring diagrams and circuits.

**PRICE 6/- POST FREE**

WRITE NOW FOR OUR NEW "TELE-KING" PRICE LIST. WE CAN SAVE YOU MONEY.



### MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. primary. Finest quality, fully guaranteed.

MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacement trans. 18/-.

MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6.

MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.

MBA/8. SPECIAL OFFER. Drop through type. 235-0-235 v. 60 mA. 6.3 v. 3 a. 12/6.

MBA/9. 400-0-400 v. 60 mA. 6.3 v. 1 a., 4 v. 2.5 a. Price 12/6.

AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watts. Price 17/6.

## HOUSE YOUR TV MAGNIFICENTLY IN ONE OF THESE SUPERB CABINETS!

### THE DE LUXE

Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium, light or dark walnut veneer, with high polish. Suitable for most home constructor TV receivers, including the "Viewmaster", "Practical Television", "Tele-King", "Magnavision", "Wireless World," etc. Can be supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost.

An allowance of 4/6 will be made if the mask is not required. Inside Dimensions: Depth 16in.; width 17in.; height 28in. Overall height 32in. and width 18in.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL? Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

**LASKY'S PRICE £8/10/-**  
Carriage 12/6 extra.



H.P. Terms. Dep. £2/17/- plus carriage. Balance plus charges spread over 12 mths.

### THE ROTHESAY

The last word in outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. The C.R.T. aperture frame is detachable, supplied to suit any size tube to order. Full length doors if required can be supplied with the cabinet. Veneered both sides, polished to match the cabinet, and mounted with full length piano hinges.

NOTE THESE GENEROUS SIZES. Outside dim. 34in. high, 21in. wide, 21in. deep. Inside dim. 18in. wide, 19in. deep. Size of top 22in. x 21in. Thickness 1in.

**LASKY'S PRICE £9/19/6**  
Carriage 15/- extra.

H.P. Terms. Deposit £3/10/- plus carriage charge. Balance plus charges spread over 12 months.



The Rothesay cabinet with doors. Price £14/9/6.

### MANUFACTURERS' SURPLUS

- WIDE ANGLE 38 mm.**  
Line E.H.T. trans., ferro-cube core. 9-16 kv. . . . 25/-  
Scanning Coils, low imp. line and frame . . . . . 25/-  
Frame Output Transformer Scanning Coils low imp. line and frame . . . . . 17/6  
Frame blocking, osc. transformer . . . . . 4/6  
Line Blocking osc. transformer, caslam cored . . . 4/6  
Focus Magnets Ferroxdure P.M. Focus Magnets. Iron Cored . . . . . 19/6  
Duomag Focalisers . . . . . 29/6  
300 mA. Smoothing chokes 15/-  
Electromagnetic focus coil, with combined scan coils 25/-

### TV COMPONENT BARGAINS

- STANDARD 35 mm.**  
Line Output Transformers No. E.H.T. 12/6 Line Output Transformers 6-9 kv. E.H.T. and 6.3 v. winding. Ferro cube. . . . 19/6  
Scanning Coils. Low imp. line and frame . . . . . 12/6  
Scanning Coils. Low imp. line and frame, by Igranic 14/6  
Line blocking oscillator transformer . . . . . 4/6  
Frame blocking oscillator transformer . . . . . 4/6  
Frame output transformer . . 7/6  
Focus Magnets:  
Without Vernier . . . . . 12/6  
With Vernier . . . . . 17/6  
Focus Coils. Electromagnetic 200 mA. Smoothing chokes 10/6

### "TELETRON" SUPER INDUCTOR COILS

Ferrite Rod Aerials, wound on high permeability Ferroxcube Rod, 5/16in. diam. 4in., medium wave . . . . . 8/9  
8in., med. and long wave. . . 12/9  
Full range of all types in stock.

### ION TRAPS. All types, 3/-

### ★ THE MULLARD 10/12 AMPLIFIER KIT

All components, chassis and valves in stock. Available separately. **THE BOOK, 2/6**, post free.

### ★ THE OSRAM 912 AMPLIFIER KIT

All components in stock. Chassis, Partridge trans., chokes, W/B., etc. Available separately. **THE BOOK, 3/6**, post free.

### Super Bargain in Speaker Cabinets



**SPECIAL PURCHASE**  
Attractive design finished in figured walnut veneer. Size 12½ x 8 x 4½in. Will take 6in. speaker.  
**LASKY'S PRICE 17/11**  
Post and packing 2/6.



### ★ SPECIAL PURCHASE OF 16" C.R. TUBES

Famous make offered at nearly Half-Price. Metal cone, .3 amp. heater, e.h.t. required 10-14 Kv.

**LASKY'S PRICE £12.19.6**

Carr. & Ins. 22/6 ex. 16in. FILTER MASK ESCUTCHEON to suit above C.R.T. 15/- Post extra.

### ELECTROLYTIC CONDENSERS ALL BRAND NEW

- |                                |      |
|--------------------------------|------|
| 8 mfd. 450 v.w. . . . .        | 1/9  |
| 16 mfd. 350 v.w. . . . .       | 2/6  |
| 16 mfd. 500 v.w. . . . .       | 3/6  |
| 20 mfd. 500 v.w. . . . .       | 3/6  |
| 30 mfd. 450 v.w. . . . .       | 3/3  |
| 60 mfd. 350 v.w. . . . .       | 3/11 |
| 64 mfd. 450 v.w. . . . .       | 3/11 |
| 150 mfd. 350 v.w. . . . .      | 3/6  |
| 400 mfd. 150 v.w. . . . .      | 2/6  |
| 8 + 8 mfd. 450 v.w. . . . .    | 3/6  |
| 8 + 16 mfd. 450 v.w. . . . .   | 4/3  |
| 12 + 12 mfd. 350 v.w. . . . .  | 2/6  |
| 16 + 16 mfd. 350 v.w. . . . .  | 3/6  |
| 16 + 16 mfd. 450 v.w. . . . .  | 4/6  |
| 20 + 20 mfd. 257 v.w. . . . .  | 2/-  |
| 60 + 100 mfd. 350 v.w. . . . . | 7/6  |
| 32 + 32 mfd. 450 v.w. . . . .  | 5/11 |
- Many other single and multiple condensers.

### HIGH VOLTAGE E.H.T. CONDENSERS

- |                              |      |
|------------------------------|------|
| .1 + .1 mfd. 3.5 Kv. . . . . | 5/11 |
| .1 mfd. 7 Kv. . . . .        | 15/- |
| .001 mfd. 12.5 Kv. . . . .   | 7/6  |
| .001 mfd. 15 Kv. . . . .     | 10/- |
| .0005 mfd. 10 Kv. . . . .    | 3/6  |
| .0005 mfd. 15 Kv. . . . .    | 6/6  |
| .04 mfd. 12.5 Kv. . . . .    | 5/-  |

### C.R.T. MASKS

PLASTIC. Brand New. 14in., 6/6 16in. and 17in. 9/6  
RUBBER, 12in., including fitted armour plate glass.  
Black . . . . 8/6 Cream . . . . 11/6  
Post Extra.

### PERSPEX IMPLOSION GUARDS

Incorporating escutcheon & filter. 12in. . . . . 7/6 16in. . . . 12/6  
12 in. de Luxe . . . . 10/6

### C.R.T. Neck Protectors 2/6.

### SPECIAL TV CONDENSERS

- |                                 |      |
|---------------------------------|------|
| 64 mfd. 450 v.w. . . . .        | 3/11 |
| 100 mfd. 450 v.w. . . . .       | 4/11 |
| 32 + 100 mfd., 450 v.w. . . . . | 7/6  |
| 100 + 200 mfd. 350 v.w. . . . . | 5/11 |

### DENCO F.M. FEEDER UNIT

All components and valves in stock. Uses 6AM6, 12AH8, EB91, and two 6AB6. **THE COMPLETE PARCEL £6/7/6**. Post extra. All components available separately.

**VALVES & C.R. TUBES.** Over 25,000 in stock. Mullard, Brimar, Osram, G.E.C., Ferranti, etc.  
**METROSILS.** 10 Kv. 5/-

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

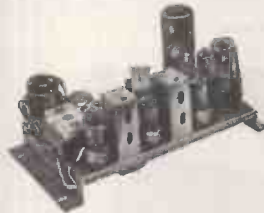
EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

COMPLETE 5-VALVE RADIO CHASSIS

Completely wired and ready for use with the addition of a speaker and output transformer. Two controls: Volume and Station switch. Valves used: 10C1, 10F9 or UF41, 10LD11 or UBC41, 10P14, U404 or UY41.

LASKY'S PRICE, less 69/6 valves, Post 3/6.  
Complete with valves, £5/19/6.

- ★ I.F. 465 kc/s.
- ★ A.V.C.
- ★ 4 watts output.
- ★ 3 Station Pre Set.
- ★ Frame aerial.
- ★ Fully aligned.
- ★ Chassis size only 10in. x 5½ in. Max. height 5½in.



LASKY'S LATEST SUPER SCOOP!  
THE "SOUND MASTER" TAPE DECK KIT

LIMITED QUANTITY ONLY

ORIGINAL LIST PRICE £13.13.0

LASKY'S PRICE £6.15.0 Plus 5/- P. & P.

The only real high-fidelity Tape Recorder for the home constructor. Built from precision-machined parts and standard radio components. Easily wired and assembled without previous experience.

Lasky's now offer the Complete Kit of Brenell components to make this super-quality Deck, including full data, circuit diagrams and stage-by-stage details, for only £6/15/-, plus 5/- post.

Remember, a Deck of this quality deserves the finest motors and heads:—

The Set of three Collaro "Wearite" Heads. Red Seal, £4/4/- pair. Gold Seal, £7/7/- pair.

The cost of building the "Sound Master" Deck complete with motors, heads, switches and sundries is £17/17/-.

If you require the Amplifier and Speaker we can supply all the specified components, chassis, etc., at competitive prices. Cabinet, as illustrated, also available.

When completed this Tape Recorder is comparable with models costing £100 or more.

Data Book, 30 pages, containing full wiring diagrams and stage-by-stage construction details, 6/6 post free. (Credited in full if Deck Kit purchased.)



ARMOUR PLATE GLASS

|                          |      |
|--------------------------|------|
| 16in. (17½ × 15½ × ½in.) | 7/11 |
| 15in. (16½ × 13 × ½in.)  | 6/11 |
| 12in. (13 × 10½ × ½in.)  | 4/-  |
| 9in. (9 × 8 × ½in.)      | 3/-  |

TRIPLEX DARK SCREEN FILTERS

|                  |     |
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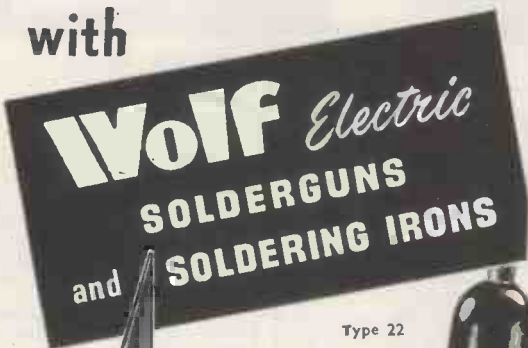
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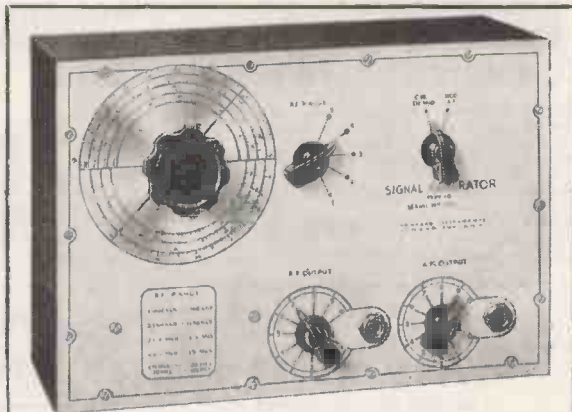


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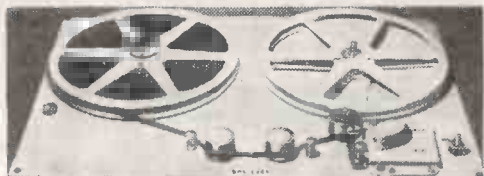
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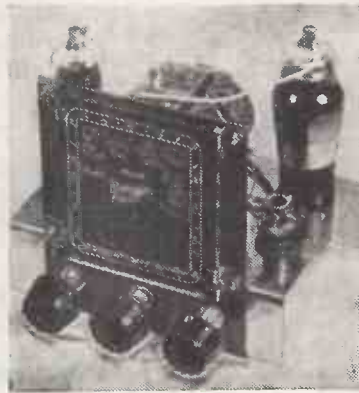
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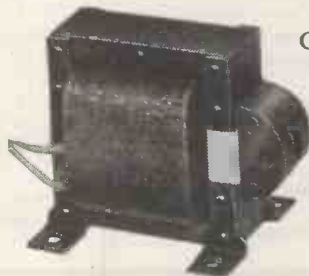
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## NOT A TRACE OF DISTORTION

Trace A shows the waveform of a normal Hartley oscillator. Looks harmless enough, doesn't it? But now examine:

Trace B which is the same waveform but taken through the filter C. Harmonics of a high order are clearly visible and it is these which cause the trouble.

Trace D shows the HATFIELD oscillator waveform. Perfect! And note the greater amplitude over A. Remember that wattage is proportional to the square of the voltage.

Trace E shows the HATFIELD oscillator waveform taken under the same conditions as B, and using the same time-base (Cossor D.B. scope).

**ABSOLUTELY NO FAKING OF ANY KIND.**

Last month we claimed "Less than 1 per cent. distortion," we now claim "Less than 0.4 of 1 per cent. distortion," and ask you to send for copy of National Physical Laboratory report confirming this.

Are you COMPLETELY satisfied with your recordings? Bad waveform in an oscillator can cause DISTORTION due to intermodulation, NOISY BACKGROUND due to D.C. component in an asymmetrical waveform and INTERFERENCE with radio due to HARMONICS beating with incoming signal.

The new HATFIELD oscillator is GUARANTEED to give at least 4 watts output with less than 1 per cent. distortion, and high stability, using only one valve (6V6 or similar). 45 Kc/s to 50 Kc/s. Suitable for high impedance heads. Motek, Lane, Truvox, etc.

Every coil is tested for amplitude AND waveform.

**COIL**, complete with circuit, 10/6 post free. Patent app. for.

### BIAS REJECTOR COILS

Even a small amount of bias frequency getting into the amplifier can cause a lot of trouble, and nearly all tape recorders need a rejector coil to prevent this.

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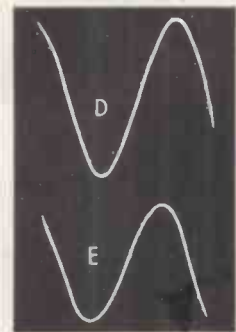
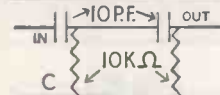
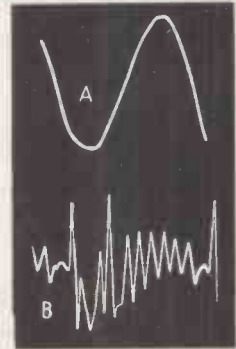
The famous K6 deck; twin track, two speed, with push buttons and electronic braking; is a beautifully finished job at only £19/19/- Post free. Or £3 down and 12 monthly payments of £1/10/-.

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The HATFIELD amplifier is complete with oscillator as above, and magic eye, less speaker, at £12/15/-.

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The HERGA recorder incorporates ALL the above items together with a first-class crystal mike and one reel of SCOTCH BOY tape in an attractive two-tone portable cabinet, absolutely complete at 39 gns. Or £5 down and 12 monthly payments of £3/3/4.



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**HIGH QUALITY  
TAPE RECORDING EQUIPMENT**

**THE MODEL 5D TAPE DESK** (to take 10 $\frac{1}{2}$ in. NAB Reels)  
 Programme Time: 62 minutes at 7 $\frac{1}{2}$  i.p.s.  
 124 minutes at 3 $\frac{1}{2}$  i.p.s.

Panel size: 20in. x 14 $\frac{1}{2}$ in.  
 Two speeds, 3 $\frac{1}{2}$  and 7 $\frac{1}{2}$  i.p.s. Double track heads. Push button control. Fast wind and rewind. Three heavy duty motors. Three separately shielded heads. Complete with NAB reel adaptors.

**PRICE:** (fitted with 6RP heads) £50/-

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Programme Time: 31 minutes at 7 $\frac{1}{2}$  i.p.s.

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**PRICE:** (fitted with 6RP heads)  
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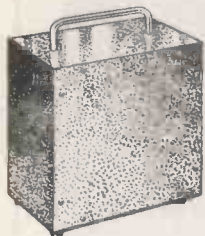
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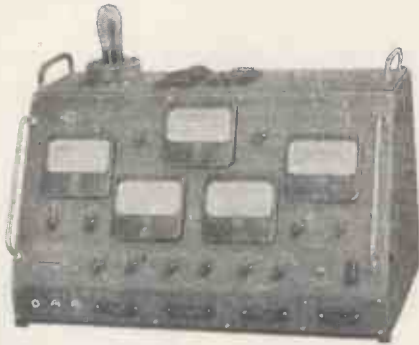
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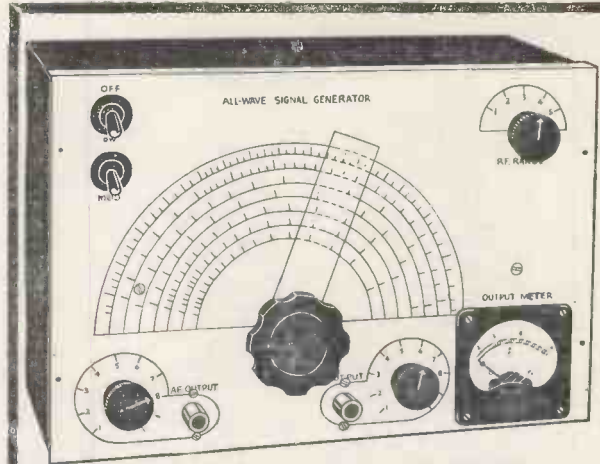
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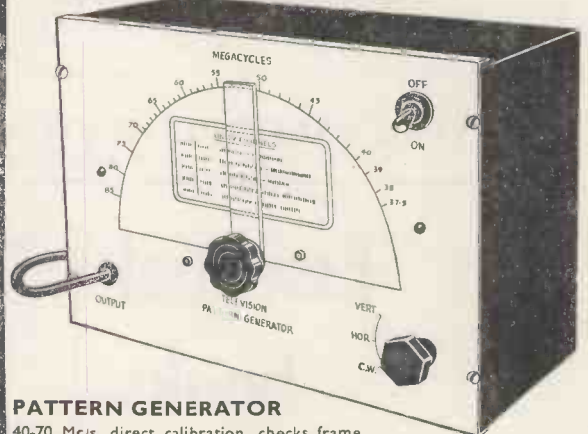
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volume control with switch, 3/6; wave-  
change switch, 2/-; 32 x 32 mfd., 4/-; bias  
condenser, 1/-; resistor kit, 2/-; condenser  
kit, 4/-.

Cyclon 5 channel T.V. Tuner, uses EF80 and 12AT7 less valves, 12/6, post paid.  
Radiogram Chassis, 5 valve A.C./D.C. 3 v. wave-band superb 195-255 v. 10-40, 200-550 and  
1,000-2,000 metres, I.F. 470 Kc. size of chassis 13 x 6 1/2 x 2 1/2 in. size of scale 7 1/2 x 3 1/2 in. Valve  
line-up 10C1, 10F9, 10D11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in.  
P.M., 28/17/6. P. & P. 3/6.

**CR100 Coil packs in first-class condition less oscillator section, complete  
with 4-gang tuning condenser, 19/6. P. & P. 3/6.**

**CR100 465 Kc. I.F.s., types 3, 4 and 5 and F.B.O., new condition, 7/6 each.  
465 Kc. Xtal for CR100, 12/6.**

**4-gang tuning condenser for CR100, 9/6.**

**CONSTRUCTOR'S PARCEL,** medium and long wave A.O. mains 230/250 2-valve plus meta-  
rectifier, comprising chassis 12 1/2 x 4 1/2 x 1 1/2 in., 2 wave-band scale, tuning condenser, wave-  
change switch, volume control, heater trans., metal rectifier, 2 valves and v/holders, smoothing  
and bias condensers, resistors and small condensers, and medium and long wave coil. Litz  
wound, 22/6. P. & P. 2/6 extra. Circuit and point-to-point, 1/3.

**CONSTRUCTOR'S 2 PARCEL**  
comprising chassis 12 1/2 x 8 x  
2 1/2 in., cad. plated, 18 gauge,  
v/b, I.F. and trans. cut-outs,  
back-plate, 2 supporting brack-  
ets, 3 wave-band scale, new  
wavelength stations names.  
Size of scale 11 1/2 x 4 1/2 in.  
drive, sp., drum, 2 pulleys,  
pointer, 3 bulb holders, 5  
pax. I.O. v/b., 4 knobs and  
pair of 465 I.F.s., twin gang,  
16 x 16 mfd. 350 wkg. mains  
trans. 250-0-250 60 mA., 6.3 v.  
2 amp., 5 v. 2 amp. and 6 1/2 in.  
M.E. speaker with O.P. trans.  
39/6. P. & P. 3/6.

**Battery charger, input 230/250 v. output 6 and 12 volt 1 amp. Block  
c-ackle finished case size 10 x 6 x 4 in. Incorporating metal rectifier,  
main on-off switch, and output switch, 21/- P. & P. 3/-.**

**OUTPUT TRANSFORMERS.** Standard type 5,000 ohms imp., 4/9; 42-1 with extra feed-back  
windings, 4/3. Miniature 42-1, 3/3. Multi-ratio 3,500, 7,000 and 14,000, 5/6. 10-watt push-  
pull, 4/6 matching, 7/-, 90-1 300 ohm coil, 6/6.

**FUSE-BACK CONNECTING WIRE.** Box, yds., 1/6. Post paid.

**STANDARD WAVE-CHANGE SWITCHES** 4-note 3-way, 1/9; 5-pole, 3-way, 1/9; 3-pole, 3-way  
1/9; 3-pole 3-way, 3/8; Miniature type, long spindle 3-pole 4-way, 4-pole 3-way and 4-pole  
2-way, 2/6 each. 2-pole 11-way twin wafer 5/-; 1-pole 12-way single wafer 5/- P. & P. 3d.

**POTATO AND VEGETABLE PEELER**  
By famous manufacturer. To suit models A200 and A700. Capacity 4 1/2 lbs., complete with  
water pump. All aluminium construction, white stove-enamelled finish. Originally intended  
for adaptation on an electric food-mixer, can be easily converted for hand operation. 39/6.  
P. & P. 3/-.

**Mains Droppers.** 0.3 amps., 460 ohms.,  
tapped 280 and 410, 1/6; 0.2 amp., 717  
ohms, tapped at 100 ohms, vitreous, 1/6;  
0.3 amps. 950 ohms, tapped 700 and 925,  
2/6; 0.2 amp., 1,000 ohms, vitreous, tapped  
2/6; vitreous, 0.3 amp., 700 tapped 680,  
640, 600, 3/6. P. & P. on each 3d.

T.V. Width Controls, 3/6.

**PERSONAL SHOPPERS ONLY.** 9in.  
Enlarger, 17/6; 13in., 27/6.

Germanium Crystal Diode, 1/6. post paid.

Used 9in. Tube with ion burn, 17/6, post  
paid.

Line O.P. Transformer in aluminium cas.  
mounted in rubber, 12/6.

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**TUNED T.V. UNIT**  
Input 300 ohm bal-  
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54 Mc/s-89 Mc/s and  
174 Mc/s-217 Mc/s.  
Vision I.F.—45 Mc/s.,  
sound 40.5 Mc/s. Uses  
6AK5 RF valve, 6AK5  
as mixer, and 6C4  
oscillator. Provision  
for auto-gain control.  
Dimensions 9in. wide,  
12in. high.

Crystal Set, medium and long wave. in  
plastic cabinet, 16/-.

Headphones, per pair, 8/-.

Speaker Matching Unit on aluminium  
chassis, 3-15 ohms reversible, 12/6.

Line and E.H.T. Transformer, 14 Kv.,  
using ferrocart core, complete with line  
and width control, and corona shields  
U37 rectifier winding, 35/-.

Line and E.H.T. Transformer, 9 Kv.,  
using ferrocart core, complete with  
built-in line and width control. Mounted  
on small all-chassis. Overall size  
4 1/2 x 1 1/2 in. EV61 rec. winding, 27/6.

Scan coils, low line low impedance  
frame coil, complete with frame transformer,  
to match above, 27/6. P. & P. 2/-.

Line and E.H.T. Transformer, 9 Kv.  
ferrocart core, EY51, heater winding,  
complete with scan coils and frame  
output transformer, and line and width  
control. 22/6. P. & P. 3/-.

As above, but complete with line and  
frame blocking transformers, 5 Henry  
250 mA. choke, 100 mfd. and 150 mfd.  
250 wkg. 380 mA. A.C. ripple. 22/19/6.  
P. & P. 3/-.

Valve Holders, moulded octal Mazda  
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Mazda and loctal, 4d. each. Moulded  
B7G, B8A and B9A, 7d. each. B7G  
moulded and B9A with screening can  
1/6 each.

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4 in. dia., 200 wkg. .... 1/3  
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10 x 16 mfd., 500 wkg. .... 4/6  
16 x 16 mfd., 450 wkg. .... 3/9  
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32 x 32 mfd., 350 wkg., and  
25 mfd., 25 wkg. .... 6/6  
25 mfd., 25 wkg. .... 11d.  
250 mfd., 15 v. wkg. .... 3/6  
16 mfd., 500 wkg., wire ends .... 3/3  
8 mfd., 500 v. wkg., wire ends .... 2/6  
8 mfd., 350 v. wkg., tag ends .... 1/6  
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A.C. ripple .... 4/6  
100+200 mfd., 350 wkg. .... 9/6  
16 x 16 mfd., 350 wkg. .... 3/3  
60 mfd., 180 wkg. .... 1/9  
65 mfd., 220 wkg. .... 1/6  
8 mfd., 150 wkg. .... 1/6  
60+100 mfd., 280 wkg. .... 7/6  
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32 x 32 mfd. min. 275 wkg. .... 4/-  
50 mfd., 50 wkg. .... 1/9

Miniature wire ends moulded, 100 pi.,  
500 pf., and .001, each 7d.

T.V. Filter, in lightly tinted Perspex,  
size 13 1/2 x 11 x 3 1/2 in., 4/6.

Combined 12in. mask and escutcheon,  
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100 Hen., 40 mA., 15/- P. & P. 3/-  
2 Henry 150 mA., 3/6; 250 mA. 10 henry,  
10/6; 5 Henry 250 mA., 60 ohms,  
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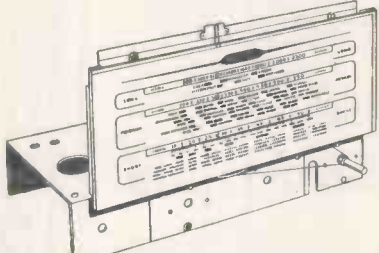
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1 1/2 in. dia. wide, 1 1/2 in. deep by very  
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## R.1155 COMMUNICATION RECEIVERS

Individually aerial tested. BRAND NEW



in original transit cases, £11/19/6 each. BRAND NEW but shop soiled, £9/19/6 each. USED MODELS but in perfect working order, £7/19/6 each. A combined power pack and audio output stage for A.C. mains, can be supplied with a receiver for an extra cost of 79/6 each.

**METERS.** All brand new and boxed. 25-; 0-10 mA., 2½ in. round, F/M, M/coil, 10/-; 0-100 mA., 2½ in. round, F/M., M/coil, 9/6; 0-150 mA., 2 in. square, F/M., M/coil, 7/6; 0-200 mA., 2 in. square, F/M., M/coil, 7/6; 0-200 mA., 2½ in. round, F/M., M/coil, 9/6; 0-20 volts, 2 in. square, F/M., M/coil, 7/6.

**AMMETERS.** 0-1 amp., 2½ in. projecting, R.F., 7/6; 0-5 amp., 2½ in. round, F/M., R.F., 7/6; 20/20 amp., 2 in. round, F/M., M/l., 6/6; 0/30 amp., 2 in. square, F/M., M/coil, 7/6.

**A.C. VOLTMETERS 50 CYCLE.** 0-15 volts, 2½ in. round, F/M., M/l., 8/6; 0-20 volts, 2½ in. round, F/M., M/l., 10/-; 0-300 volts, 2½ in. round, F/M., M/l., 25/-; 0-300 volts, Sin. projecting, M/l., 50/-.

**TELEPHONE TYPE "F."** Complete with hand generator, buzzer and hand set. A pair of these units may be used as a complete telephone system over any distance. Price 45/- each.

**MAINS TRANSFORMERS.** All 230 volt 50 cycle input. 250 x 250 volt 150mA., 4 volt 3 amp., 9/6; 500 x 500 volt, 170 mA., 4 volt C.T., 4 amp., 3,000 volt insulation, 22/6 each; 670 x 670 volt 200 mA., 6.3 volts 4 amp., 5 volts 3 amp., 49/6 each; 1,500 volts 330 mA., 52/6; 2,000 volt 5 mA., 15/6; 4 volt 14 amp., 6.3 volt 1½ amp., 10/6; 6.3 volts 1½ amp., 5/9; 6.3 volts 3 amp., 9/6 each.

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**CHROMIUM PLATED TELESCOPIC AERIALS.** Min. length 12 in. extends to 48 in. Ideal for car radios, etc., 7/3 each.

**HEADPHONES.** Brand new, Canadian "Northern Electric," finest ever produced, Res. 100 ohms, complete with P.O. Jack Plug, 10/6 pair.

**P.O. UNISELECTOR SWITCHES.** 4 bank, double wipers, 25 position, 32/6; ditto, 8 bank, 45/-.

**TELEPHONE HANDSETS.** Ex-American, standard P.O. type, 12/6 each.



**H.R.O. 6 VOLT VIBRATOR POWER SUPPLY UNITS.** Output 165 volts 80 mA., 6.3 volts 3 amp. 6 x 5 rectifier, choke and condenser smoothed, cabinet size 7 in. x 7 in. x 6 in. Supplied brand new, 29/6 each.

**SPECIAL OFFER PACKARD BELL AMPLIFIERS.** These brand new American amplifiers are complete with a 6SL7 and 28D7 valves, condensers, resistors, relay and pot and 8-way midjet plug and socket, 12/6 each with circuit.

**AMERICAN POWER RHEOSTATS.** 8 ohm, 3.3 amp., 8/6 each; 8 ohm, 2.5 amp., 7/6 each; 60 ohm, 1.3 amp., 7/6 each; 90 ohm, 0.74 amp., 7/6 each; 200 ohm, 0.3 amp., 5/6 each. Ideal for train, model or charging control.

**BENDIX RECEIVERS TYPE RA-1B.** 8 valve receiver covering 150 K/c/s-16 Mc/s. on 6 wavebands. 1 R.F. and 2 I.F. stages, and B.F.O., Power requirements 250 volts D.C. and 12 volts D.C. This receiver is an American equivalent to the R.1155 and covering the top band. Supplied brand new and aerial tested, £11/19/6 each.

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**PYE 45 MEG. I.F. STRIPS.** Complete television I.F. strip with 6 EF50 valves. Size 1¼ in. x 3½ in. x 3½ in., finest strip ever produced, 69/6 each complete. Brand new.

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**BATTERY CHARGERS.** 200-250 volts A.C. input, 24 volts 10 amps. output, perfect working condition, fine and coarse controls, £12/10/- each.



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**LORAN INDICATOR APN4.** Supplied brand new with 5CP1 CRT., 14 valves, Type 6SN7, 8 of 6H6, 3 of 6SL7, 1 of 6SJ7, 100 K/c/s. Crystal, and 1,000's of other components, £6/19/6 each.

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| 12BA7GT |       | EM1    | 16/5  |
|         |       | EM4    | 16/5  |
|         |       | EM34   | 19/5  |
|         |       | EY51   | 25/2  |
|         |       | EZ35   | 13/3  |
|         |       | EZ40   | 13/3  |
|         |       | EZ41   | 13/3  |
|         |       | EZ60   | 13/3  |
|         |       | EZ90   | 13/3  |
|         |       | 60L6GT | 16/5  |
|         |       | 80     | 13/3  |
|         |       | AZ1    | 13/3  |
|         |       | AZ31   | 13/3  |
|         |       | AZ60   | 13/3  |
|         |       | CLB1   | 22/1  |
|         |       | CL4    | 20/2  |
|         |       | CY1    | 30/3  |
|         |       | EAS0   | 11/4  |
|         |       | EAB0   | 9/5   |
|         |       | EAF42  | 17/8  |
|         |       | EBB30  | 15/1  |
|         |       | EB41   | 11/4  |
|         |       | EB91   | 11/4  |
|         |       | EBC33  | 15/1  |
|         |       | EBC41  | 15/1  |
|         |       | EBF60  | 18/11 |
|         |       | E3L1   | 22/1  |
|         |       | E3L21  | 20/2  |

DEMOBBED VALVES MANUAL

2/6

Giving equivalents of British and American Service and Cross Reference of Commercial Types with an Appendix of B.V.A. Equivalents and Comprehensive Price List. We have still some Valves left at very old Budget Rates (33%) which are actually sold at the old price. (1951 rate).

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| Bulgin Tag Strip T.17 (2), each | 5       |
| Lab. Resistors and Pots         | £1 12 6 |
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Contains fully smoothed normal A.C. Mains Power Pack, transformer being 345 v.-0-345 v. at 200 mA., 6.3 v. 5 a., 6.3 v. 250 mA., 5 v. 2 a., 6 valves SP61, 3 of EA50, 2 of EB34, and 1 of 5Z4. BRAND NEW IN MAKER'S CASES. ONLY 47/6 (carriage 7/6)

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Tolerance: 1% 2% 5%  
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**VALVE HOLDERS:** Moulded. B9A, 7/6; B7G, 6/-; EF50, Pax., 6/-; EF50, Ceramic, 9/- per doz.; ENGLISH OCTAL, 3/- per doz. SCREEN CANS for B9A, B7G, 6/- doz.

**PAXOLIN** - B7G, MAZDA 4-pin UX 3/- "

Valveholders fitted with lower screens to accommodate cans, 1/6 per doz. extra.

**BELLING & LEE PLUGS AND SOCKETS.** Ex-Govt. BRAND NEW. 5-pin, 1/6; 7-pin, 1/9; 10-pin..... 2/6 pair

**BULGIN.** P74, Plug and Socket, 2/6; P200, Plug and Socket, 2/-; Rotary Switches, S.255, 2/-; Dolly Switches, S.267, 2/-; Standard Switches, Ex-Govt. On-off ..... 1/6 each

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Lamp Covers for same 3/- "

**WESTINGHOUSE KHI HALF WAVE RECTIFIER.** Rating 3.6 v., at 10 mA, 3/6 each; 36/- per doz.

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**VALVE SCREEN CANS** for Standard Valves, 1/- each 10/6 doz.

**DRUM DRIVES,** 4pin. 1/- each

**WESTECTORS.** WX6, WX12, W1, W12, W4, 1/- each 9/- doz.

**ARCOLETRIC (Whitney Lamp),** Red, green, clear, 1/6 each 15/- "

**SIGNAL LAMP HOLDERS P/M,** complete with adjusting lamp holders, 1/9 each 18/- "

**AIR SPACE TRIMMERS.** Preset and spindle types, 5PL, 10PF, 15PF, 20PF, 25PF, 50PF, 75PF, 15/-; 100PF Preset, 1/6 each 15/- "

**JONES PLUG AND SOCKETS.** 4-pin, 2/6; 6-pin, 3/-; 8-pin, 3/6; 10-pin, 4/-; 12-pin ..... 6/- pair

**NUTS,** 8BA, 3/-; 6BA, 2/6; 4BA, 3/-; 2BA ..... 4/- gross

**SOLDER TAGS,** 2/6 gross. **SHAKEPROOF WASHERS** 2/- "

**WASHERS,** 2, 4 and 6BA ..... 1/- "

**SHAKEPROOF SOLDER TAGS,** 4BA and 6BA, 2/-; 2BA... 2/9 "

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Chassis 1 1/2 in. x 7 in. x 2 1/2 in. Scale Bin. Square. Or Chassis 1 3/4 in. x 6 1/2 in. x 2 1/2 in. Dial 10 in. x 5 1/2 in. PRICE £10/5/-.

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600ft. Reels ..... 10/-

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The selected EF50, Red Sylvania, original boxes 10/- each, 90/- for ten.

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Size 1 1/2 in. x 8 in. x 2 in. Complete with 45 Mc/s. Pye Strip, 12 valves 10 EF50, EB34 and EA50, volume controls, and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5. Carriage paid.



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We have purchased large quantity of the above "38" Sets, and can now offer same complete in case with 5 valves 4-VP23 and ATP4, Throat Microphone, Headphones, Junction Box and Collapsible Aerial in absolutely new condition and guaranteed Air Tested. Freq. range 7.4 to 9 Mc/s. Range approx. 5 miles. Voltage 150 v. and 3 v. L.T.

59/6 CARR. 5/-.

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| 200 kc/s, 2 pin, U.S.A.....   | 10/- |
| 465 kc/s, 2 pin, U.S.A.....   | 10/- |
| 500 kc/s, 2-pin, British..... | 15/- |


Holders for U.S.A. Types 1/6.

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Brand New. In original cartons. Valves. Frequency 12/560 metres. Less power unit. Can be adapted for mains at cost of 35/-. £10/10/- Carr. 7/6.

**"426" CONTROL UNIT**  
Containing 4 EF50, 2 SP61, 2 EA50, 1 EB34, 2-single-gang .0005 tuning condensers. W/W volume/controls switches, condensers and resistors. Size 12 in. x 9 in. x 5 in. New condition. 35/-, carr. 3/-.

**T.V. PRE-AMPLIFIER FOR LONDON AND BIRMINGHAM.** Complete with 6AM16. Ready to plug into your set, 27/6. P.P. 2/6.

**CRYSTAL MICROPHONE INSERTS**

8/6 POST FREE  8/6 POST FREE

Ideal for tape recording and amplifiers. No matching transformer required.

**"R.F. 26" F.M. CONVERTOR UNIT— 88/100 Mc/s.**

We can now offer this self-contained Unit comprising 6 Valves—2-8BA6, EB91, VR137, EF54, EF54. Two I.F. stages and separate local oscillator, also Mullerhead graduated vernier drive assuring easy tuning.

**COMPONENTS OFFERED TO COMPLETE F.M. UNIT**

- New RP26 Unit with 3 valves VR137, EF54, EF54, £11/15/-.
- Complete set of all components for conversion including 2 8BA6 and EB91, tuning condenser, I.F.T.'s Osc. and coils. Resistors and fixed condensers, plus wire and tag strips, 24/12/6.
- Instruction Book with technical circuit and complete lay-out diagrams, 2/-.
- Voltage required 250 v. 50 mA. 6.3 2 amps.
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**ALL ITEMS SOLD SEPARATELY**

- Charge for alignment when completed ..... 7 6
- Assembled, aligned and ready for use ..... £8 10 0



Call for demonstration.

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Complete with buzzer, morse tapper and battery compartment on baseboard, 6/-, post paid.

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| .0005 Standard Size, with trimmers.....            | 7/6 |
| .0005 with 4-way push-button assembly.....         | 7/6 |

**NEON INDICATOR LAMP**

Siemens type V1132. Diameter 1 1/2 in. Striking volts 80 v. S.P.B.C. 2/6 post free.

**INDICATOR UNIT TYPE 182A**

Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF60, 4 8P61, and 1 6U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (loss relay) in original packing cases at 67/6. Plus 7/6 carr. "Radio-Constructor" scope circuit included.

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|------------------------|------|
| R.F.24 20/30 Mc/s..... | 15/- |
| R.F.25 40/50 Mc/s..... | 19/6 |
| R.F.26 50/65 Mc/s..... | 35/- |
| R.F.27 60/80 Mc/s..... | 35/- |

Brand new, carr. free.

**U.S.A. PACKARD-BELL PRE-AMPLIFIER**



Complete with 6SL7GT-28D7GT, relay, plugs, condensers, etc. Instruction booklet. Brand new 12/6, p.p. 2/-.

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| VCR139A. 2 1/2 in. O/B Tube. Brand new in original cartons (carr. free).....                   | £1 15 0 |
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ALL PRIMARIES ARE 200/250 v. Half Shrouded.

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| HS63. Output 250-0-250 v. 60 m/a., 6.3 v. at 3 amps., 5 v. at 2 amps. ....           | 16/6 |
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| HS30. 300-0-300 v. 80 m/a. ....  | 19/- |
| HS2X. 250-0-250 v. 100 m/a., 21/-.   | 21/- |
| HS75. 275-0-275 v. 100 m/a. ....   | 21/- |
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| HS3X. 350-0-350 v. 100 m/a. ....   | 21/- |

**Fully Shrouded**

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|---|------|
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| FS2X. 250-0-250 v. 100 m/a., 23/-.  | 23/- |
| FS75. 275-0-275 v. 100 m/a. ....  | 23/- |
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| FS3X. 350-0-350 v. 100 m/a. ....  | 23/- |
| All the above have 6.3 4-0 v. at 4 amps., 5-4-0 v. at 2 amps.   |      |
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| FS5X. Output 350-0-350 v. 250 m/a., 6.3 v. 6 amps., 4 v. 8 amps., 4 v. 3 amps., 0-2-6.3 v. 2 amps. Fully shrouded .....       | 65/- |
| FS160X. Output 350-0-350 v. 160 m/a., 6.3 v. 6 amps., 6.3 v. 3 amps., 5 v. 3 amps. Fully shrouded .....                       | 44/- |
| FS43X. Output 425-0-425 v. 250 m/a., 6.3 v. 6 amps., 6.3 v. 6 amps., 5 v. 3 amps. Fully shrouded .....                        | 63/6 |
| HS6. Output 250-0-250 v. 100 m/a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. For receiver R1355. Half shrouded .....                  | 26/6 |
| HS150. Output 350-0-350 v. 150 m/a., 6.3 v. 3 amps., C.T. 5 v. 3 amps. Half shrouded .....                                    | 27/9 |
| F36. Output 250-0-250 v. 100 m/a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. Fully shrouded .....                                     | 29/6 |
| FS120. Output 350-0-350 v. 120 m/a., 6.3 v. 2 amps., C.T. 6.3 v. 2 amps., C.T. 5 v. 3 amps. Fully shrouded .....              | 29/9 |
| FS256. Output 250-0-250 v. 80 m/a., 6.3 v. at 6 amps., 5 v. at 3 amps. Fully shrouded .....                                   | 28/6 |
| PR1/1. Output 230 v. at 30 m/a., 6.3 v. at 1.5/2 amps. ....   | 21/- |
| FS150. 350-0-350 v. 150 m/a., 6.3 v. 4 amps., 5 v. 3 amps. ....   | 31/6 |
| FS150X. Output 350-0-350 v. at 150 m/a., 6.3 v. at 2 amps., C.T. 6.3 v. at 2 amps., C.T. 5 v. at 3 amps. Fully shrouded ..... | 31/6 |

The above have inputs of 200/250 v.

**OUTPUT TRANSFORMERS**

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| MIDGET OP. 5,000Ω to 3Ω .....                                      | 3/9  |
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All 200/250 v. Input.

|   |      |
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| F4. 4 v. @ 2 amps., 7/6.  | 7/6  |
| F6. 6.3 v. @ 0.3 amps., 5/6.  | 5/6  |
| F12X. 12 v. @ 1 amp. ....   | 8/-  |
| FU6. 0-2.4-5-6.3 v. @ 2 amps., 10/-.  | 10/- |
| F12. 12.6 v. tapped 6.3 v. @ 3 amps. ....   | 16/6 |
| F24. 24 v. tapped 12 v. @ 3 amps. ....  | 23/6 |
| F29. 0-2.4-5-6.3 v. @ 4 amps., 18/9.  | 18/9 |
| FU12. 0-4-6.3 v. @ 3 amps. ....   | 17/6 |
| FU24. 0-12-24 v. @ 1 amp. ....  | 17/6 |
| F5. 6.3 v. @ 10 amps. or 5 v. @ 10 amps., or 12.6 v. @ 5 amps., or 10 v. @ 5 amps. ....   | 34/- |
| F6/4. Four windings at 6.3 v. tapped 5 v. @ 5 amps. each, giving by suitable series and parallel connections up to 6.3 v. @ 20 amps. .... | 51/6 |

Quotations, etc. stamped addressed envelope, please.

C.W.O. (add 1/6 in £ for carriage).

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## G2AK This Month's Bargains G2AK

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**METERS:** 2 1/2 in. Scale Flush Mounting. 0-10 m.A. Ditto 0-30 m.A., ditto 0-100 m.A., 12/6 each. 2 in. Scale Square Flush Mounting 0-50 m.A., ditto 0-150 m.A., ditto 0-3 Amp. Thermo., ditto 0-20 v. d.c., ditto 20/0/20 Amp. d.c., 7/6 each. 2 1/2 in. Scale Projecting Type 0-15 Amp. Thermo. 7/6. 2 in. Scale Round Flush 0-1/2 Amp. R.F., ditto 0-350 m.A. Thermo. 7/6.

**SPECIAL VALVE OFFER:** TZ40, 35/-; 6L6G, 10/6; 5R4GY, 12/6; 829/3E29, 60/-; 100TH, 90/-; 866A, 17/6, or 30/- per pair; 807, 10/- each, or 17/6 per pair; 931A, 45/-; 813, 80/-.

**CONDENSERS:** 802F 600 v. Trop. 750 v. normal condensers. New ex-W.D. stock, 5/6, p. & p. 1/6.

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**SPECIAL OFFER, AR88 SPARES.** Cabinets, complete with base, feet and side strips, £4/15/- each. Pkg. and Carr. 5/-.

Set of 14 valves for "D" or "LF" model receivers, £5/10/-.

Panel escutcheons, 22/6 each. "D" type I.F.S., 12/6 each. Good selection of Spare Coils available for "D" Model, 7/6 each. Output Transformers for "D" or "LF", 37/6 each.

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**COPPER WIRE.** 14G H.D. 140ft. 15/-, 70ft. 7/6, postage and packing, 2/-.

**STREAMLINED BUG KEYS.** By famous manufacturer. List over £4. Our price 45/-.

**AIR SPACED COAXIAL CABLE,** 150 ohm (normal price 3/11 per ft.), 20 yd. coils only. £1 per coil, post free.

**NEW MULLARD QUALITY AMPLIFIER** chassis, and all specified parts available from stock.

Carriage paid on all orders over £1 except where stated. Please include small amount for orders under £1.

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**HEAVY DUTY L.T. TRANSFORMERS.** Standard tapped primary. Type A, 30 v. 35 amp. or Type B, 50 v. 16 amp. Size 6in. x 6 1/2in. x 8 1/2in. high. Weight 24 lb. BRAND NEW, not ex-Govt. Suitable for soil heating, rectifiers, chargers, etc., special offer, 55/- each plus 5/- carriage.

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**EX-ADMIRALTY.** Primary 230 v. 50 c/s. Secondary 620-550-375-0-375-550-620 v. (620 v. at 200 mA., 550 v. at 250 mA.). Two rectifier windings at 5 v. 3 amps, each. Total rating 278 vA. Upright mtg. weight 24lb. BRAND NEW, 42/6.

**E.H.T. TRANSFORMERS.** For VCR97, etc. Mains input. Output 2,500 v., 4 v. 2 a. and 2-0-2 v. at 2 a. Fully guaranteed at 35/- plus 2/- postage. SPECIAL SURPLUS SNIFF. 230 v. 50 c/s. input. 2 kV. R.M.S. output (2.5 kv. when rectified). Size 2 1/2in. x 2 1/2in. x 3 1/2in. high. Upright mtg. ONLY 15/- plus 2/- postage.

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**METAL RECTIFIERS.** Heavy duty, funnel cooled, 2 units required for bridge. Size 12in. x 12in. x 4 1/2in. Input 36 v. R.M.S. Output 50 amps., 27/10/- per pair, plus 6/- carriage. BRAND NEW ex-Govt. RM4, 250 volts, 250 mA., only 12/6 each. Selenium, 300 volts, 100 mA. Brand new, ex-W.D., 6/9 each. 12 v. 1 amp. Full wave bridge, 7/6 each.

**E.M.I. OUTPUT METER.** Desk type incorporating a 2 1/2 in. 1 mA. meter together with instrument rectifier, etc. 2 ranges 0-500 milli-watts and 0-5 watts and decibel scale. Brand new in original manufacturers' boxes with instructions. Price 35/-, post 1/6.

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 15 v. (50~) mov. iron 2 1/2in. pnl. meg. .... 8/6  
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 1 milli-amp. 2 1/2in. barrel desk type .... 25/-  
 100 micro-amps. barrel pnl. mtg. scaled 0-1,500  
 in 15 clear divisions. Only .... 42/6  
 500 mA. Thermo Couple 2 1/2in. sq. pnl. mtg. .... 5/-

**METER RECTIFIERS.** 1 mA. Salford Instruments, 8/6. 5 mA. Salford Instruments, 8/6. 2 mA., S.T.C. as used in E.M.I. Output Meter, 5/6. All are full wave bridge and brand new.

**METAL RECTIFIERS.** R.M.4 250 volts 250 mA. Only 12/6. Selenium 300 volts 100 mA. Brand new, ex-W.D., 6/9 each.

**COMMUNICATIONS RECEIVER R.1155.** World-wide reception is ensured by the R.F. and 2 I.F. stages. Five wavebands, 2 L.W., M.W. and 2 S.W. Magic-eye, large dial and vernier make tuning simple. Contained in attractive black crackled cabinet, its handsome appearance does justice to its superb performance. Supplied with FREE BOOKLET giving circuit data and details of the power pack required for A.C. mains operation. Fully aerial-tested before despatch. Gladly demonstrated to callers. BRAND NEW. "MINT" condition, in ORIGINAL MAKER'S TRANSIT CASES, 211/19/6. Shop soiled models, as new, 29/19/6. A few only used models, 27/19/6. 6/10/6 carriage on each. Send S.A.E. for full details of power packs and receivers, or 1/3 for booklet.

**A.C. MAINS POWER PACKS AND OUTPUT STAGE.** Enable the R.1155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATION WHATSOEVER. All our power packs have heavy duty transformers, are complete with leads and Jones plugs and are guaranteed for 6 months. Type A. In smart black metal case, size 8 1/2in. x 4 1/2in. x 6 1/2in. less speaker, price 24/10/- plus 3/6 carriage. Type B. With built in 5in. speaker in black metal case size 13 1/2in. x 5 1/2in. x 7 1/2in. Price 25/5/- plus 3/6 carriage. Type C. With an 8in. speaker in specially designed beautiful black crackle cabinet speaker to match receiver, size 11 1/2in. x 10 1/2in. x 6 1/2in. A de Luxe job. Price 26/10/- plus 3/6 carriage. NOTE: 10% REDUCTION WHEN PURCHASING ANY OF THE ABOVE POWER PACKS WITH RECEIVER.

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**45 Mc/s PYE STRIPS.** Vision unit for London frequency. Complete with 6 EF50 and EA50. Circuit provided. Brand new. 23/10/- each.

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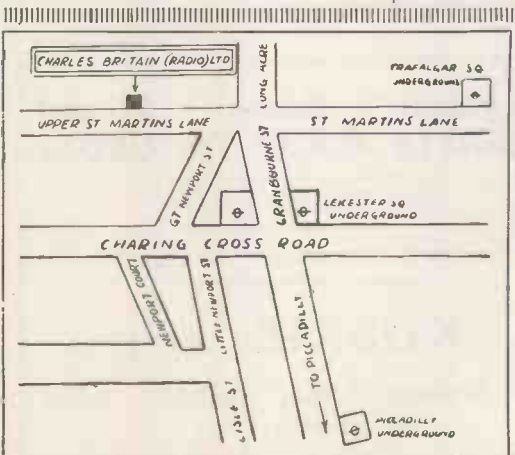
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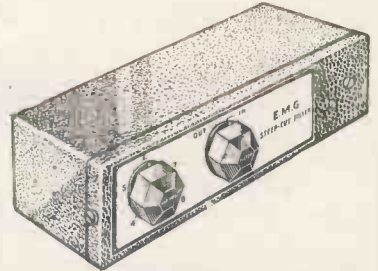
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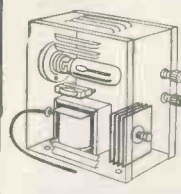
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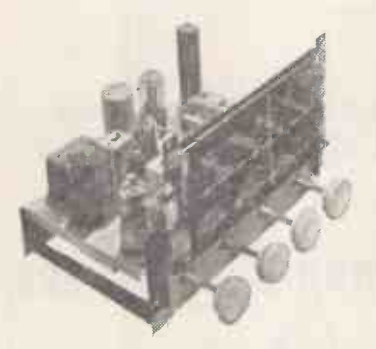
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THE position offered is for experimental work in connection with the editing of polarised relays for special applications.

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WRITE giving full details of education and experience and salary required to Box 3R, P5278, A.K. Advcs., 212a, Shaftesbury Ave., London, W.C.2. [4263]

TELECOMMUNICATIONS (Radio Transmission) Engineer required by large organisation in the North-West to train for position in Technical Publicity Department.

APPLICANTS should be aged between 25-30 years, and should have a good general education, background with the ability to write clear concise English; a sound knowledge of modern telecommunications techniques, including V.H.F. and U.H.F. multi-channel systems and frequency-shift signalling practices.

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MECHANICAL design engineer; young man with flair, own bright ideas, for aerial manufacturers South London; progressive salary.—Write full details Box 1866. [4270]

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APPLICANTS, preferably with a degree or an equivalent qualification should have had at least 2 years' experience in the development and engineering of Service equipment as well as experience in one of the above departments stating age, qualifications and experience to—The Personnel Manager, Ref. RG. [4131]

TELEVISION engineers able to drive required by leading and progressive dealers; good salary conditions and prospects.—Singer's, 350, Edgware Road, W.2, Pad. 7915. [4213]

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RADIO engineer wanted, London; good practical knowledge of disc and tape recording essential; interesting position; permanency; Box 2230. [4357]

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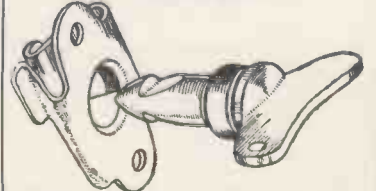
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**ELLIOTT BROS. (LONDON), Ltd.** have vacancies for senior and junior electronic engineers in their expanding activities in the fields of industrial control, measurements and instrumentation.

**SENIOR Engineers** with good academic background and experience in this or similar fields. There is one vacancy for a Chief Engineer to take charge of a Division and several vacancies for leaders of development teams. Ref. E.T.1

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**A. G. ALLEN & Co., Ltd.** have a permanent position for fully experienced television/radio service engineer with good references; able to drive.—3-4, Bridge Rd., Wembley Park, Arn. 2261. [4337]

**MINISTRY OF SUPPLY** requires radio/radar technicians in Buckinghamshire to help equipment investigations and installation design of pulse and C.W. navigational aid systems and long distance and mobile radio installations.

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**DESIGNER/Draftsman** required for Compression, Transfer and Injection Moulding Firm, Cheshire district; only fully competent men need apply.—Write, stating age, experience and salary required, to Box 1759. [4253]

**TELEVISION engineers** required for busy and well-established workshop; must be fully experienced; permanent position; excellent staff amenities.—Apply Personnel Controller, Bentalls of Kingston-on-Thames, Surrey. [4259]

**AIRCRAFT electrical design** draughtsman required, excellent opportunities for advancement.—Apply Personnel Department, Vickers-Armstrongs, Ltd., Hursley Park, nr. Winchester. [4176]

**COMPETENT radio and/or TV serviceman** required; old-established firm; good conditions and prospects; permanent; call or write fully; expenses paid for interview by arrangement.—Nicklins, Square, Barnstaple.

**TECHNICAL assistant** with knowledge of telecommunications or electronics required by London firm of chartered patent agents; 5-day week.—Apply in writing stating age, experience and salary required Box 2210.

**THE Edison Swan Electric Company, Ltd.**, have vacancies in their Special Products Development Laboratory for Engineers for development work on a wide range of electronic instruments and apparatus for Medical, Industrial and Government use.

PLEASE write, stating experience, age and salary required, to 155, Charing Cross Road, London, W.C.2, reference SF/LAB. [1038]

**EXPERIENCED radio testers and inspectors** required for production of communication and radio apparatus, also instrument makers, wiremen and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ecco Works, Malmesbury, Wilts. [1038]

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**CHIEF** maintenance engineer required to direct a team working on development equipment associated with trials programmes on radar projects, and to work in association with development groups and services representatives.

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REPLY stating age and experience to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [4328

**(1) PHYSICISTS** and Electronic Engineers are required for the Chemical and Metallurgical Division of the Plessey Co. Ltd. Attractive posts are available for junior and senior: grades in new, well-equipped and expanding Physics and Electronics Laboratories. APPLICANTS should be interested in the development and application of semi-conductors, dielectric, piezoelectric or magnetic materials.

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POSITIONS are permanent and pensionable and offer considerable scope for advancement; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager, The Plessey Co., Ltd., Towcester, Northants.

**JUNIOR** radio mechanic required; preference given to applicant who has completed National Service; the position is permanent, has good prospects; pension scheme available.—Write details to the Service Manager, Ray Powell, Ltd., Eastern Ave., Ilford, Essex. [4339

**WRIGHT & WAIRE, Ltd.**—Vacancies occur at Simonside Works, South Shields, Co. Durham, for senior and junior radio and electronic engineers, also those with magnetic recording experience; apply giving details of experience. [4223

**BERRY'S (SHORT WAVE), Ltd.**, have vacancies for Sales Assistants with good general radio knowledge. Interesting work. permanency.—Write giving details of experience, age and salary required to 25, High Holborn, London, W.C.1. [4084

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**TRANSFORMER** and filter design engineer required to take charge of design and manufacture; qualifications and experience essential.—Apply to Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [4287

**MICHAEL RADIO, Ltd.**, Slough, Bucks. have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0198

**ELECTRONIC** engineer with wide experience in on video amplifiers reqd. for interesting work in small development dept. degree or similar qualification an advantage; outer West London; salary £700-£800 per annum; pension scheme.—Write full details to Box 1677.

**SENIOR** electronic inspectors required for special work in the radar field; men with good academic background and sound experience are invited to apply for these progressive posts.—Apply immediately, preferably in person, to the Personnel Officer, Decca Radar, Ltd., Shannon Corner New Malden. [4063

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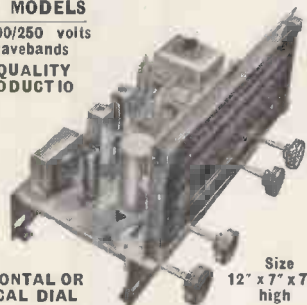
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**TRANSFORMER** Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply stating age, qualifications and experience to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [4260]

**SENIOR** Television Development Engineer with administrative experience required; capable of carrying out development projects with minimum supervision up to production stage, Kingston area; write giving full personal details stating salary required—Chief Engineer, Box 1582. [4208]

**RADIO** testers and mechanical inspectors required (male); must have experience on service equipment and used to working to Government specifications; high rates of pay to first-class men; excellent conditions in modern factory in the West London area; write fullest details to—Box 1631. [4229]

**TELEVISION** field and bench service engineers required immediately for modern service department of leading radio retailers in East London; high rates of pay per week or according to ability; permanent position.—Apply for interview to Leytonia Radio, Ltd., Tel. Leytonstone 1396. [4271]

**LABORATORY** Assistant required for test and calibration of wireless, radar, electronic instruments; excellent conditions; capable of setting up basic calibration and experimental equipment; 5-day week.—Write or tel. Atkins Laboratories, Gowan Avenue, Fulham, Remov 5931. [4320]

**DEVELOPMENT** Engineer required for work on transistor oscillators. Previous experience need not include transistor applications but a fundamental knowledge of time base circuits is desirable.—Applications to, Personnel Manager, Ferguson Radio Corp., Ltd., Gt. Cambridge Rd., Enfield. [4239]

**ELECTRONIC** Engineer required by West E. London company; technical knowledge and practical experience of servo-mechanisms, temperature control, weighing, counting and magnetic amplifiers is desirable. Applicants giving age, experience and qualifications, to Box 1762. [4256]

**RADIO** and television service engineer required for expanding company in Slough area; excellent prospects for rapid advancement for man of proven ability; write, with full details of experience and stating salary required, to—Teleonic Radio, Ltd., 1, Station Approach, Slough. [4290]

**ELECTRONIC** Engineer required for position in an expanding laboratory engaged on the development of electronic equipment including control gear, servomechanisms and special-purpose tape recorders. Applicants should state qualifications, experience and salary required.—Write full details to Box 2057. [4239]

**ELECTRONIC** Engineers and Physicists reqd. for rapidly expanding research Dept. Candidates should have experience of electronic instrument development. Experience in pulse circuits or ultrasonics desirable but not essential. B.Sc. or H.N.C. standard.—Write full particulars to Glass Developments, Ltd., Brixton, S.W.2. [4237]

**ENGINEERS** required for development work on television equipment used in connection with film making. Applicants, who must have had television experience, will be paid a salary in the range £500-£1,000 according to qualifications and experience.—Apply, Chief Engineer, High-Definition Films, Ltd., 98, Highbury New Park, London, N.5. [4236]

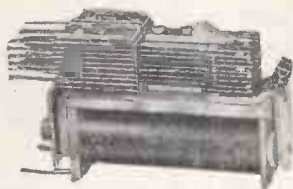
**ENGINEERS** (Radio Valves) are required for all grades of work on development, production and pre-production. Minimum qualifications H.N.C. or B.Sc. for Senior positions—O.N.C. or Inter for Junior, some experience necessary for senior appointments.—TA/6, Personnel Dept., M.O. Valve Co., Brook Green, Hammersmith. [4261]

**ELECTRONIC** engineers required for work on the application of radio valves for future development; work calls for vision and imagination combined with circuit experience; O.N.C. or Inter minimum qualification; weekly or monthly staff vacancies available according to experience.—Quote EE/1, Personnel Dept., M.O. Valve Co., Brook Green, Hammersmith. [4262]

**THE TELEGRAPH** CONDENSER Co., Ltd., require radio and TV engineer with laboratory experience for work in connection with printed circuits, H.N.C. standard for Super-education and experience, age and salary required to Personnel Manager, T.C.C., Ltd., North Acton, W.3. [4311]

**RADIO** (Meteorological) Mechanics required by Meteorological Office; qualifications: basic knowledge of radio and radar and experience in maintenance/operation of radar equipment, including oscilloscopes; successful applicants serve in United Kingdom and overseas; commencing London salary £467/10 s plus 25% or over, rising to £565, subject to deductions for each year below age 25. Provincial salary £20 to £30 lower; overtime, night duty allowance, etc.—Apply at any Employment Exchange, quoting Borough 831. [4117]

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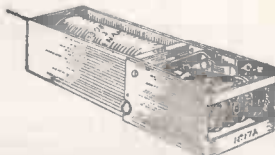
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**ELECTRONIC** Engineers are wanted in large Midland engineering plant, the positions are progressive and interesting requiring qualified and experienced electronic engineers, senior and junior for rapidly expanding laboratory engaged upon measurement and control problems; state age, qualifications, and experience fully in confidence to—Box 1742. [4250]

**A** LIGHT engineering company in West London has vacancies for engineers and physicists in their magnetic recorder design laboratory; preference will be given to applicants experienced in this work and who are capable of accepting responsibility; salary will be according to age and experience.—Write, giving age and fullest details of experience, to Box 2169.

**ENGINEERS,** 25-30, required for electronic and mechanical work by The Plessey Co. Ltd., at Ilford; good prospects of promotion, interesting work, and a pension scheme await suitably qualified graduates or holders of H.N.C.—Apply with full details of past experience to The Plessey Co., Ltd., Vicarage Lane, Ilford. [4358]

**TEST** gear design engineers and maintenance engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these vacancies are permanent and progressive; a company pension scheme in operation; London area.—Please write, in confidence, giving full details of qualifications to Box 2119. [4255]

**ELECTRO-MECHANICAL** inspectors are required by a large and expanding company. Practical experience and sound knowledge of radio component manufacture is necessary. A good salary is offered to suitable applicants who should, in the first instance, state their qualifications and experience, to Box 1094, quoting E.M.1. [4097]

**ASSISTANT** foreman inspector required for an engineering company situated in the eastern suburbs of London; applicants should preferably have a sound basic knowledge of capacity bridges and test gear as applicable to gang condensers; a good salary will be paid to the selected applicant.—Please reply, giving full details of experience to Box 2120. [4324]

**APPLICATIONS** are invited from young physicists possessing honours degree for work on the development of transistors. Post-graduate work on semi-conductors and solid state physics would be an added qualification. Laboratories in ideal country surroundings. Applications to Personnel Manager, Standard Telephones and Cables, Ltd., Thimble Street, [4255]

**SKILLED** radio mechanics and assemblers (male) required; experienced on service equipment preferred but not essential; excellent conditions in modern factory, with good wages for the right type; ex-R.E.M.E. and R.A.F. personnel will also be favourably considered; Acton district; write fullest details to—Box 1630. [4228]

**TEST** gear design engineers and maintenance engineers required with practical experience of this class of work based on sound knowledge of electronic principles; these vacancies are permanent and progressive; a company pension scheme in operation, London area.—Please write in confidence, giving full details of qualifications to Box 1962. [4294]

**TWO** graduate physicists or electrical engineers with an interest in electronic engineering are required for the development of equipment for the measurement of the properties of semi-conductor materials and devices; previous experience in the design and construction of electronic equipment is desirable for one of the vacancies.—Box 1971. [4286]

**PHILIPS** Balham Works, Ltd., 45, Nightingale Lane, S.W.12, requires Graduate in Electrical Engineering or Physics, preferably with experience in electronics, for development of nucleonic instruments. Permanent appointment with excellent prospects.—Applications should be addressed to the Personnel Officer at the above address. [4254]

**ELECTRONIC** Engineer required to test nucleonic instruments. Previous experience of this type of work is not necessary but a thorough knowledge of electronic theory and practical experience in fault finding is essential; 40hr 5-day week; salary range £400-£600 according to qualifications.—General Radiological Ltd., 18, New Cavendish St., London, W.1. [4319]

**ASSISTANT** engineers required for radio communication development work; good prospects for men with H.N.C. and up to 5 years' industrial experience commensurate salary according to age and experience; apply in writing stating age, experience, etc., to—Siemens Brothers & Co. Ltd., Telecom Group, 744-6, Woolwich, London, S.E.18.

**ELECTRONIC** Engineer required by London firm to take charge of measurements laboratory and test gear design; experience of measurement of capacitors or telecommunication cables is essential; position involves direct responsibility to management and will suit engineer aged 25 to 32 who wishes to take up senior position.—Write details of qualifications, experience and present salary, Box 1760. [4255]

**ELECTRICAL/Electronic Engineer**—Vickers-Armstrongs, Ltd., Supermarine Works, require for employment at their experimental airfield, graduate with research and development experience in electronic or electro-mechanical devices and/or recording equipment for interesting work on ground and airborne measuring apparatus; the right man for this post will be keen to suggest and assess new techniques and to design, construct, suitably and workmanlike equipment; permanent pensionable post with good prospects for suitable engineer.—Apply Personnel Department, Hursley Park, Nr. Winchester. [4210]

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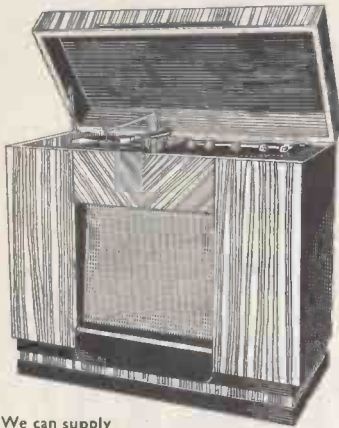
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**RADIO** engineer for Bulawayo, Southern Rhodesia; design and development engineer with at least five years' experience on domestic radio; salary £1,200 per annum, with free air passage to Rhodesia.—Application should be made to Advertiser, 31, Burlington Ave., Kew Gardens, Surrey, with copy to P.O. Box 206, Bulawayo, Southern Rhodesia. Successful applicant will be interviewed in London. [4076]

**INSTRUMENT** maker at Norwood Technical College, Knight's Hill, S.E.27, with experience in radio and electronics duties include maintenance and construction of electronic test gear, laboratory and experimental apparatus; rate, 176/-, rising annually to maximum of 195/- 44-hour week.—Application forms with further particulars obtainable from the Secretary, returnable within 14 days (195) [4522]

**SENIOR** engineer required to be in charge of factory test equipment section, to be responsible for design and maintenance of radio and television test facilities; also junior radio engineer for work associated with production development of radio and television receivers. Telephone or write for appointment: Chief Engineer, Philco (Overseas) Ltd., Romford Rd., Chigwell, Essex, Hainault 4151. [4226]

**CHEMISTRY** and electronics; a scientist or engineer with good qualifications in one of these fields and a strong interest in the other is required to write for appointment: Chief Engineer, Philco (Overseas) Ltd., Romford Rd., Chigwell, Essex, Hainault 4151. [4226]

**RESEARCH** engineer required to be in charge of factory test equipment section, to be responsible for design and maintenance of radio and television test facilities; also junior radio engineer for work associated with production development of radio and television receivers. Telephone or write for appointment: Chief Engineer, Philco (Overseas) Ltd., Romford Rd., Chigwell, Essex, Hainault 4151. [4226]

**LABORATORY** Technician required for the Electrical Engineering Department for work in the electronics field; appointment according to age and experience, in the scale £315X£15-£450 plus London Weighting (max. £30). The successful applicant must join the contributory pension scheme.—Application, giving age and full details of experience, to the Secretary, King's College, Strand, W.C.2. [4316]

**DRAUGHTSMEN**, experienced in broadcast radio and television, are offered exceptional opportunities with a firm of repute in the London area; experience in production drawing of mechanical design would be an asset for a very attractive starting salary.—Applications, which will be treated in strict confidence, should give full details of experience and should be addressed to Box 2166. [4336]

**DEVELOPMENT** Engineer required for work on transistor amplifiers. Previous experience need not include transistor applications but applicant should be conversant with general radio engineering practice, in particular with negative feedback technique, class B amplification and design of detector circuits.—Applications to Personnel Manager, Ferguson Radio Corp., Ltd., Great Cambridge Rd., Enfield. [4275]

**ANALOGUE** computers and instrument servomechanisms; vacancy for an electronic development engineer with experience in the above fields for work on interesting and varied projects; candidates should be of degree standard in physics or engineering, with some years' industrial experience; good prospects with progressive firm in Surrey area; write giving full details of experience and salary required; ref. S.P.D.2.—Box 1878. [4275]

**INSTRUMENT** maker required with experience in electronic wiring, capable of constructing chassis and interpreting wiring diagrams; wages 176/- rising in 3 years to 195/- per week, less superannuation and statutory deductions.—Apply by letter giving details of age, training and experience to the Head of the Electrical Engineering Dept., Battersea Polytechnic, London, S.W.11, as soon as possible. [4348]

**ELECTRICAL** foreman, with wide production experience of small and medium electrical control gear manufacture, test and installation, required by manufacturers of materials handling vehicles in pleasant country district, 1 hour London; good prospects of advancement, housing assistance; car, ten and social facilities.—Please write, giving details of age, past experience, present salary, salary required, married/single, to Box 1972. [4284]

**MINISTRY OF TRANSPORT AND CIVIL AVIATION**—Radio Technicians (men only) required at aerodromes and radio stations in various parts of U.K. Special training courses for keen technicians with basic qualifications. Interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids. Prospects of permanent pensionable posts and advancement. Rates of pay (London) from £342/10 at age 19, to £467/10 at 25, rising (subject to qualifying test) to £565. Rates slightly lower in provinces. Shift and night duty allowances from 1/- to 5/- according to conditions. Candidates aged 19 or over with practical experience in maintenance of radio or radar equipment should apply to any Employment Exchange, quoting Westminster 6627. [4289]

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FIRST-CLASS openings for experienced radio and television engineers will shortly become available with a firm of repute in the London area; engineers able to undertake immediately development work on broadcast radio and television apparatus would be offered an attractive salary; the successful candidates will be eligible for company superannuation and insurance schemes.—Please reply, giving full details of experience, to Box 2165. [4355

SENIOR and junior development engineers required for responsible work in radio and television development laboratories; applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough, Bucks. [3580

ELECTRONIC engineer required for the expanding electronic section of a prominent food organization in N.W. London to construct and maintain factory electronic installations and to assist in the development of new equipment; applicants should possess initiative and be below 35 years of age; salary according to age and experience; pension scheme, 5-day week.—Write Box W.W.908, c/o 191, Gresham House, E.C.2. [4329

PROJECT engineers are required to take charge of microwave electronic and mechanical developments in connection with guided wave and other applications in a company near London; candidates should be graduates or hold H.N.C. and be between the ages of 30 and 40; salaries range from £1,000 upwards according to age and experience; pension scheme in operation.—Full particulars of experience should be addressed in confidence to Box 2233. [4359

ELECTRICAL component manufacturers in N.W. London require keen and energetic man (30-35 years) to supervise small service department; applicants must be able to conduct correspondence, control manual and clerical staff and possess electrical engineering background; no Saturdays, superannuation scheme.—Write, stating age, full details of experience and salary required, to Box 3M, No. 5635, A.K. Ave., 21/2a, Sheppesbury Ave., London, W.10. [4359

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SENIOR and junior design draughtsmen required for interesting work in connection with electronic equipment, commercial radio and television and/or light electro-mechanical engineering; London area; the positions vacant offer ample scope and opportunity for future advancement to men of good ability; salary will be paid to the selected candidates; all recognised staff privileges available.—Please reply giving full details of experience to Box 1927. [4261

NEW ZEALAND calling British ex-Service men and ex-Service women; the Royal New Zealand Air Force has a limited number of vacancies in the ground trades for ex-Service men between 21 and 40 years and for ex-Service women between 21 and 40 years; commencing pay up to £16 per week; free passages to New Zealand and excellent conditions of service.—Write for full information to Dept. W.W., R.N.Z.A.F. H.Q., Adelphi Building, John Adam St., London, W.C.2. [4367

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TECHNICAL assistants required in radar development laboratory; preferably with Higher National Certificate or equivalent qualifications, also experience in electrical testing or construction of test equipment, or service experience on ground radar equipment; excellent working conditions; opportunities exist for upgrading; write stating age and experience to the Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [4148

DIVISIONAL sales and contracts manager required for expanding medium-sized electronics company; applicants should be capable forthwith of inflating and negotiating development and manufacturing contracts in the electronic field and also at a later date establishing a sales organization for a commercial product, good opportunity for a man with initiative; prepared for hard work, and capable of earning £2,000 per annum; salary will include basic payment and commission by arrangement.—Applications invited in confidence to Ref. S.P.D.3, Box 1879. [4274



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**THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry,** requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments for guns, on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259]

**A VACANCY** exists for an electronic instrument development engineer in the Telecommunications Laboratory of British Insulated Callenders' Cables, Ltd., at Kirkby, near Liverpool. Candidates should hold a degree in physics or engineering and have previous experience in the design and development of electronic instruments. Some experience of servo-mechanisms would be an advantage.—Apply by letter, stating age, qualifications, P/49/54, should be addressed to: The Staff Officer, B.I.C.C., Ltd., Prescott, Lancs. [4344]

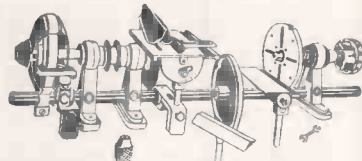
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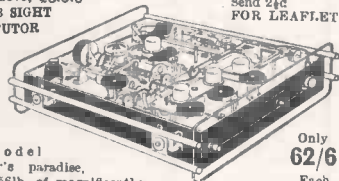
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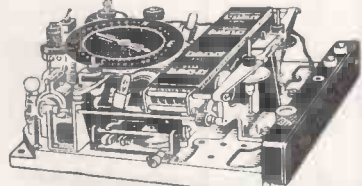
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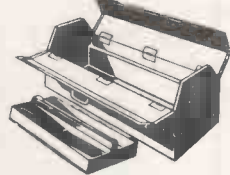
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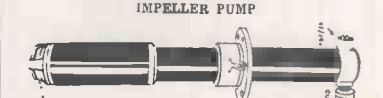
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**EDISON SWAN ELECTRIC Co., Ltd.**, have a vacancy for an engineer to take charge of their Special Products' Development Laboratory; candidates should have an engineering degree or its equivalent, and should have experience in developing electronic equipment ready for factory production.—Please write full particulars, including age and salary required, to 1056, Charing Cross Rd., London, W.C.2. Reference K. S. P.

**PRODUCTION** planning engineer required for factory in Enfield; should have had experience preferably but not essentially in electronic valve production; must be able to break down programmes into component part requirements and raw materials and organise supplies; also must be able to assess plant capacities and organise loading in economic quantities; knowledge of rate fixing and incentive schemes essential; salary £900/£1,000 per annum. Apply Personnel Superintendent, The Edison Swan Electric Co., Ltd., Cosmos Works, Brimsdown, Enfield, Middlesex. [4279]

**MINISTRY OF SUPPLY** require technical authors of chesses, Farnborough and Malvern to prepare instructional handbooks on theoretical and practical aspects (including servicing) of airborne and ground equipments for radio control, communication and navigation including radar. Qualifications: British or British parents, recognised engineering apprenticeship or equivalent; possession of O.N.C. or equivalent desirable. Salary, within £660-£791 according to age and location of post.—Further particulars and application form from A.E.101, London Appointment Office, Ministry of Labour & National Service, 1-6, Tavistock Square, W.C.1. [4245]

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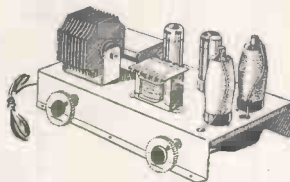
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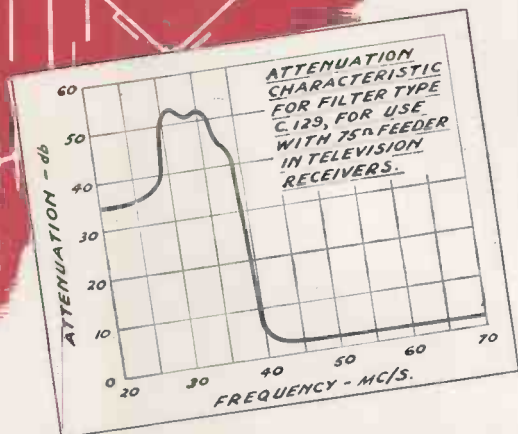
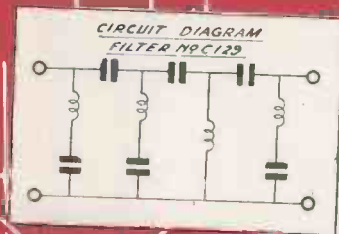
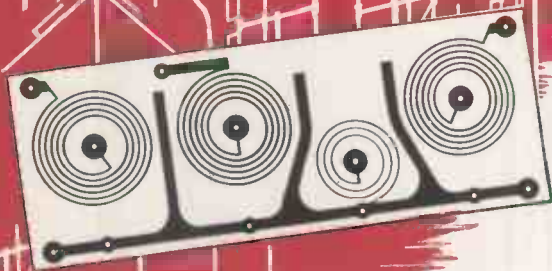
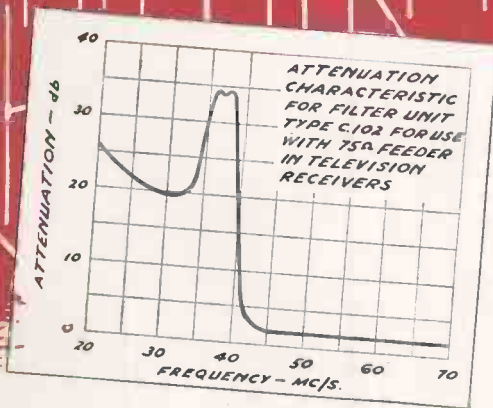
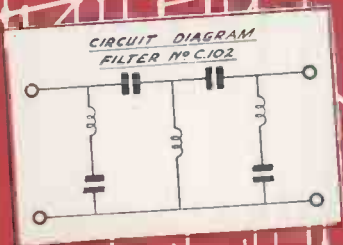
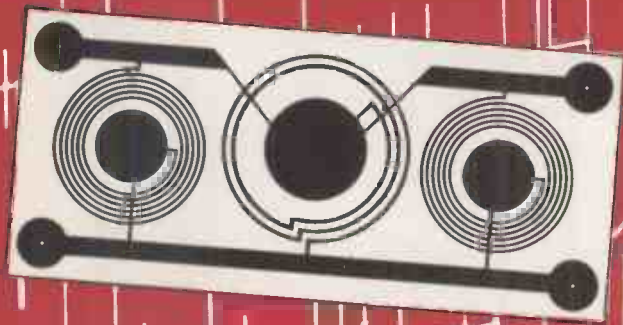
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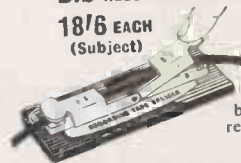
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