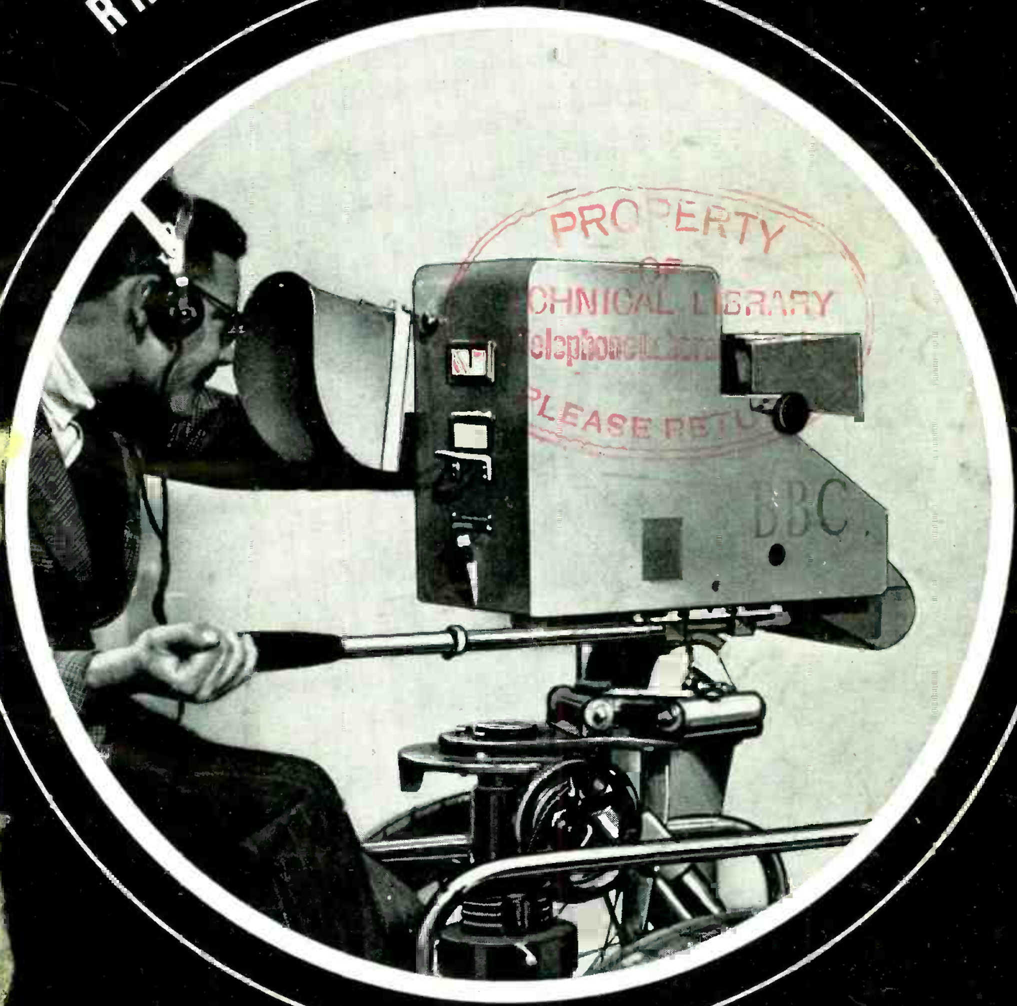
# Wireless World

RADIO AND ELECTRONICS









JULY 1946

1/6

Vol. LII. No. 7


IN THIS ISSUE: MAGNETIC DEFLECTION IN TELEVISION


RUBBER-TO-METAL BONDING
The Problem of Insulating delicate instrument panels from vibration and shock by means of Flexilant Mountings
"FLEXILANT" Mountings : Examples from the SERIES.
The "Flexilant" Mounting of which several varieties are illustrated here is so accurately made that its displacement under load can be calculated to within .010" of requirements. The series is designed to carry loads of from 1 to 45 lbs. per mounting and these may be arranged with bolt axis at 90° to position, or the complete mounting may be inverted. The mountings can be supplied with or without holder and they can be arranged so that two utilize the same bolt.
We should appreciate the opportunity of helping with *your* vibration problems.
RUBBER BONDERS Ltd.
Engineers in Rubber bonded to metal
FLEXILANT WORKS · WATLING STREET · DUNSTABLE, BEDS.
TELEPHONE DUNSTABLE 715
TELEGRAMS: FLEXILANT, DUNSTABLE
A Short Review of FLEXILANT Products is available on enquiry . .
FLEXILANT
R.B.12

# For Peak Performance

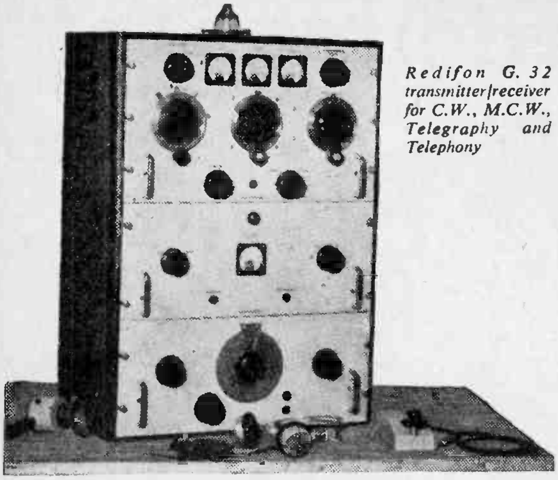

U.I.C. Fixed Ceramic Pot and Plate Capacitors have been primarily developed for use in transmitter circuits. Made only from the highest grade raw materials and subjected to the most rigorous mechanical and electrical inspection, their performance especially with H.F. loads and high voltages is unsurpassed. TYPE APPROVED. Full details on request.

**UNITED INSULATOR CO. LTD.**
**Oakcroft Rd., Tolworth, Surbiton, Surrey.**
*Tel: ELMbridge 5241 (6 lines) Grams: Calanel, Surbiton*

U.I.C.

**CERAMIC**
*High-Voltage*
**CAPACITORS**

THE PIONEERS OF LOW-LOSS CERAMICS



*Redifon G. 32 transmitter/receiver for C.W., M.C.W., Telegraphy and Telephony*

## REDIFON G.32

## *A General Purpose Communications Transmitter/Receiver*

THIS compact, portable transmitter/receiver has been specially designed and manufactured by Rediffusion Ltd. to fulfil the wide demand for this type of instrument in Colonial, trawler, police, geographical research, and harbour communications using C.W., M.C.W., Telegraphy and Telephony.

The transmitter covers 4 to 16 m/cs. (75 to 18.75 metres) in two bands, employing an electron-coupled oscillator operating as an oscillator frequency doubler. The receiver, a very sensitive set with a crystal gate, three I.F. bandwidths, beat frequency oscillator and other features, covers from 150 k/cs to 20 m/cs. (15 to 2,000 metres). Power can be taken from 24 volt accumulator batteries or 180-250v. 50 cycle, single phase A.C. mains, through alternative power units.

The transmitter/receiver unit is contained in a single robust steel housing, finished to service tropical specifications, 28 inches high by 21 inches wide and 12 inches deep. The net weight of this unit is 130 lbs.

This transmitter/receiver is available for almost *immediate delivery*. Further particulars can be supplied on request.

**REDIFFUSION Ltd.**

*Designers and Manufacturers of Radio Communication and Industrial Electronic Equipment*

SUBSIDIARY OF BROADCAST RELAY SERVICE LIMITED

**CARLTON HOUSE, REGENT ST., LONDON, S.W.1**

*A red letter day*

IN THE HISTORY OF

*The Radio Industry*


*on this date as frequently announced*

**Rola - AND - CELESTION**

*finally join forces in the interest of greater Speaker Production for the Radio Industry*

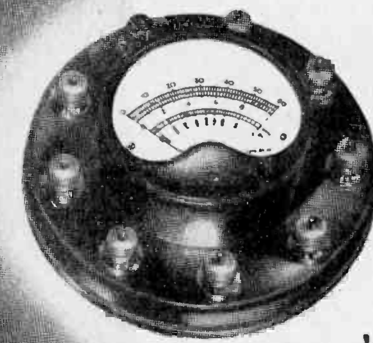
**BRITISH ROLA LTD.,**
Georgian House, Bury St., St. James's, S.W.1.
Factories: Thames Ditton & Devizes.

**CELESTION LTD.,**
Kingston-upon-Thames, Surrey.

CR3

R.T. 10.

*No Hint of Doubt*



D.C. Counter and Service Tester. 3½" Diam. Moving Coil meter. Long Scale First Grade Accuracy. Ranges: 100 mV, 2, 6, 60, 120 and 300 V.D.C. 1, 6, 60, 600 mA, 6 A.D.C. 50,000 Ohms, 2,000 in centre.

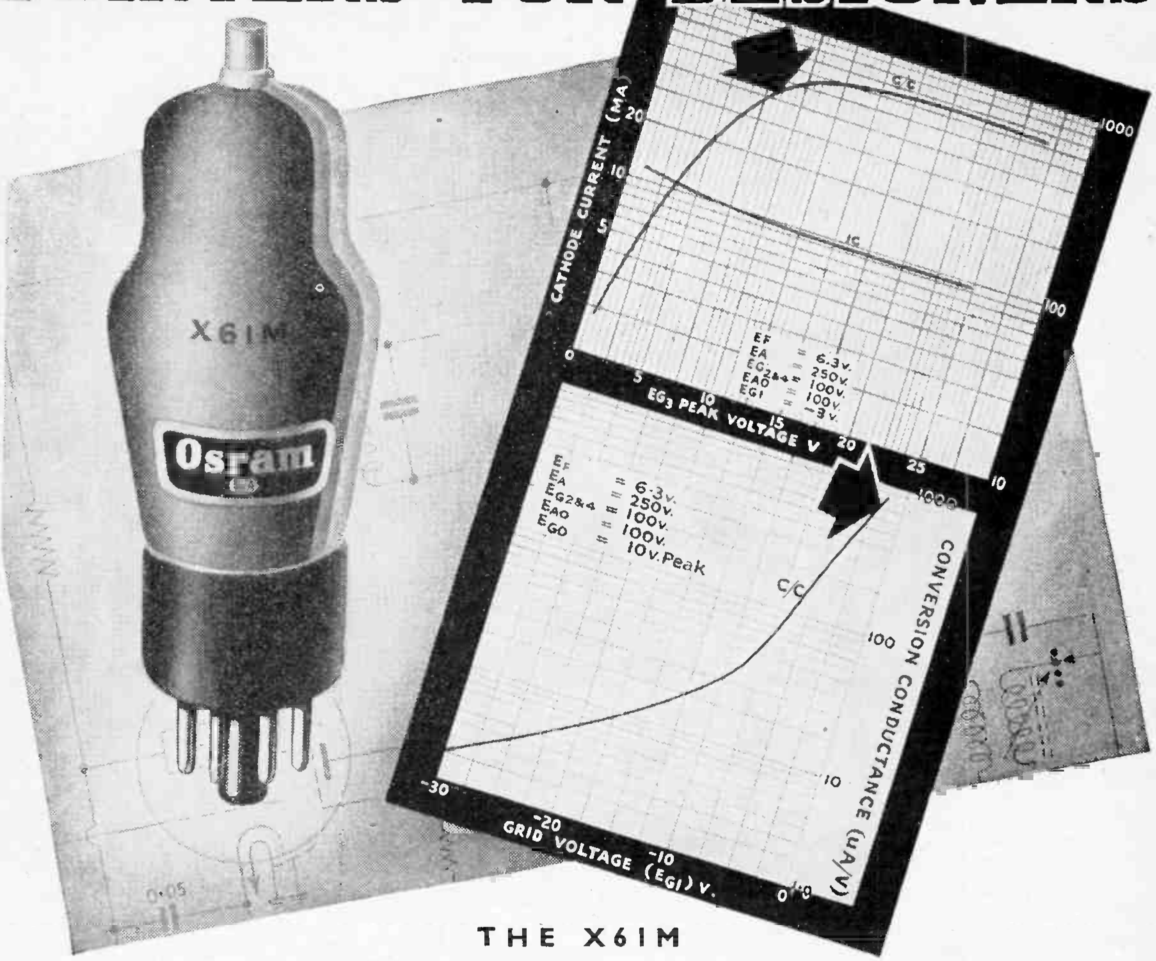
PRICE: £5 0 0 list plus 20%.

*with* **SIFAM**

20 YEARS SPECIALISED EXPERIENCE

ELECTRICAL INSTRUMENT CO., LTD., **TORQUAY**

# POINTERS FOR DESIGNERS




**THE X61M**

An indirectly heated 6.3v. frequency changer of the Triode-Hexode type, the OSRAM X61M is suitable for operation up to 60 megacycles per sec. (5 metres). Outstanding features include :—

- High conversion conductance for comparatively low cathode current, improving signal to noise ratio.
- Signal handling capacity is such that negligible distortion is apparent up to 5 volts R.M.S. on the signal grid.
- Negligible "pulling" when tuned anode oscillator is used, making ganging of tuned circuits easy.
- Control characteristic is designed to work in combination with KTW61 as IF amplifier, giving maximum control on both valves with negligible distortion.

**A detailed technical data sheet is available on request.**

**Osram** PHOTO CELLS | **G.E.C.** CATHODE RAY TUBES | **Osram** VALVES

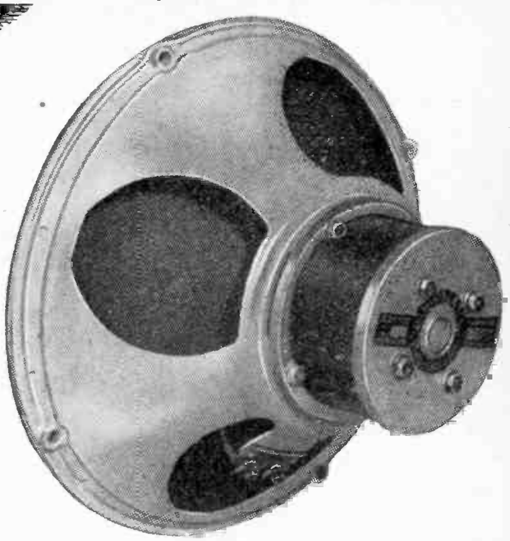
*Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2.*

# TECHNICAL DATA *that* *Speaks for itself!*

Here is one of the most popular of the Goodmans Loudspeakers now available—the T2/1205/15. A medium heavy duty reproducer with a frequency response ideal for small cinemas, Public Address systems and high power radiogramophones. A robust, precision made instrument under all conditions.

BRIEF TECHNICAL DATA

Overall Diam. $12\frac{5}{16}''$ .......... Overall Depth $6\frac{3}{8}''$
Fundamental Resonance .......... 75 c.p.s.
Max. Power Capacity .... 12 w. peak A.C. on 4 ft. baffle
(15 w. horn loaded)
Voice Coil Imp. .......... 15 ohms at 400 c.p.s.
Flux Density .......... 13,000 gause
Net weight .......... $11\frac{1}{4}$ lb.



**GOODMANS** Type T2/1205/15
*Loudspeaker*

Price **£6 15s.** (Subject)
*NOW AVAILABLE*

GOODMANS INDUSTRIES LTD · LANCELOT RD · WEMBLEY · MIDDX

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## Cathode Ray Oscilloscopes
BY
## RADIO-AID LTD.
Electronic Engineers
**29 MARKET STREET, WATFORD, HERTS**

$1\frac{1}{2}''$ TUBE, SELF-CONTAINED POWER PACK, TIME BASE AND AMPLIFIER.

*Type SI.* **£27 . 0 . 0**

RADIO-AID

*Sole London Agents:*
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# INDIA
## WANTS BRITISH RADIO!

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*There is a huge and urgent demand for the following products:—*

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*We offer you the resources of our vast and skilful organisation with retail facilities spread all over India.*

*Excellent bank and trade references. Interested to represent on exclusive basis and will carry stocks for distribution through dealers.*

*Please cable or airmail particulars to:—*

## ELECTRONICS LIMITED
**CONNAUGHT PLACE, NEW DELHI, INDIA**

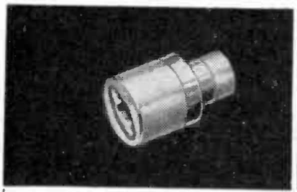
*Cables: "Radiowaves"* *Codes: "Bentley's"*

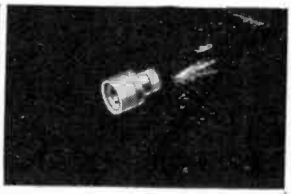
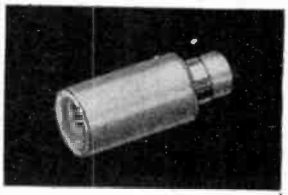
# METALLISED CERAMICS

## for

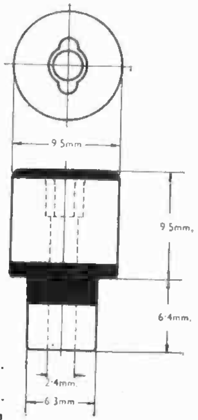
# Hermetic Seals and Soldered Assemblies

### FREQUENTITE BUSHES

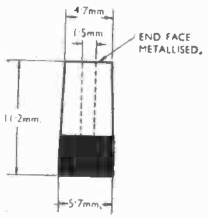


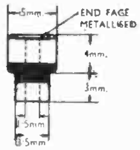
Photographs (above) actual size.
Drawings not to scale.




R 50650.
Code No.
GCTBD01.

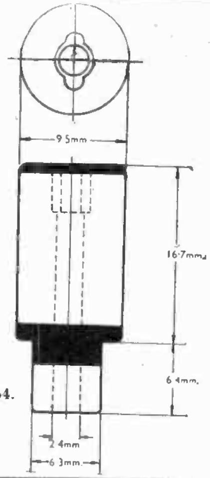



R. 50636.
Code No. GCTBA01.



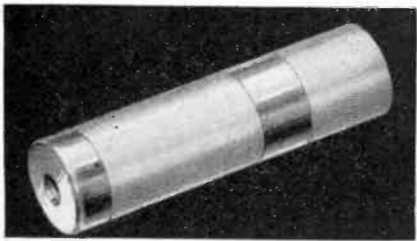

R. 50728.

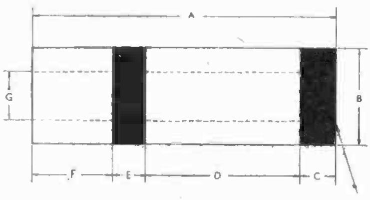
Code nos. are those used in I.S.C.Tech.C.
Specification No. R.C.L./330.11.



R. 50764.

### PORCELAIN BUSHES





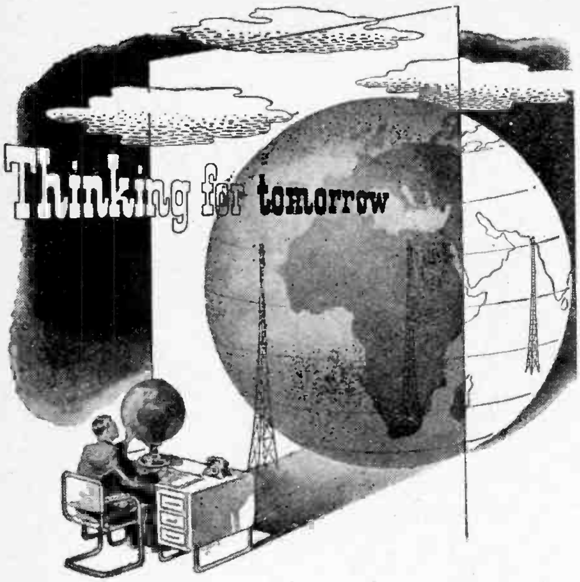

END FACE METALLISED

| TYPE | CODE | A mms. | B mms. | C mms. | D mms. | E mms. | F mms. | G mms. |
|---|---|---|---|---|---|---|---|---|
| R. 50734 | GCTBC01 | 20.3 | 7.6 | 3.8 | 6.4 | 4.6 | 5.5 | 3.0 |
| R. 50768 | GCTBC02 | 20.3 | 12.7 | 3.8 | 6.4 | 4.6 | 5.5 | 5.1 |
| R. 50769 | GCTBC03 | 20.3 | 15.2 | 3.8 | 6.4 | 4.6 | 5.5 | 6.4 |
| R. 50770 | GCTBC04 | 38.1 | 10.2 | 5.1 | 15.7 | 6.4 | 10.9 | 4.1 |
| Q. 2092 | GCTBC05 | 55.9 | 12.7 | 6.4 | 25.4 | 8.9 | 15.2 | 5.1 |
| Q. 1982 | GCTBC06 | 78.7 | 15.2 | 6.4 | 38.1 | 8.9 | 25.3 | 5.1 |

For full information and prices please write to:

**STEATITE & PORCELAIN PRODUCTS LTD.**

STOURPORT-ON-SEVERN, WORCS. T'phone: Stourport III. T'grams: Steatain, Stourport.




In a world whose tempo is governed by the radio wave, it is necessary to think quickly and to think ahead. Marconi engineers have an advantage in this — the advantage of a technical background that takes in the whole history of wireless communications.

In the reconstitution of old services and the development of new ones, that experience will be vital. On land, on sea and in the air, in the future as in the past, communications will be linked with Marconi — the greatest name in wireless.

# MARCONI

*the greatest name in wireless*

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD
THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY LTD
ELECTRA HOUSE, VICTORIA EMBANKMENT, LONDON, W.C.2

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# R&A

## BRITAIN'S FOREMOST REPRODUCERS

*Reproducers and Amplifiers Ltd.,*
WOLVERHAMPTON,
ENGLAND.

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## ? ARE YOU A ONE ROOM RADIO LISTENER—

Now that Stentorian Extension Speakers are coming back to the shops the pleasure of listening again becomes complete. Just plug in one of these superb permanent magnet speakers to your set and you can enjoy its clean, pure tone anywhere in the house: sitting-room, kitchen, bedroom, wherever you happen to be. Supplies are still short, but a Stentorian is worth looking for. Ask your local dealer about them.

*PRICES*

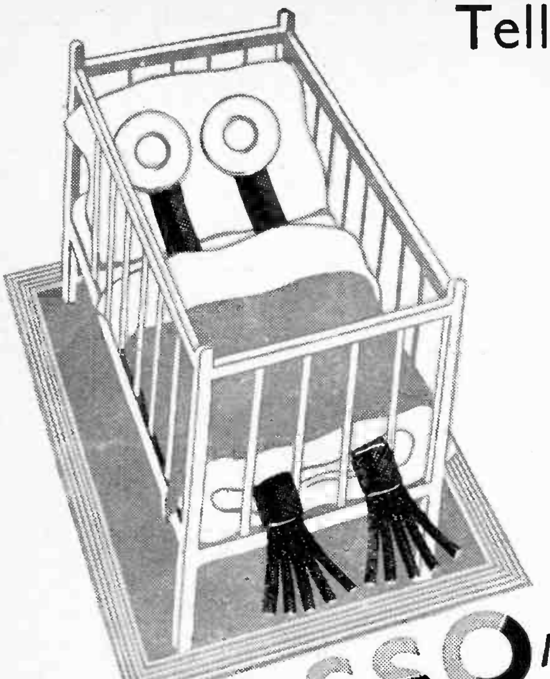
| | |
|---|---|
| *Minor Type MX (for Low Impedance Extension)* - | 29/6 |
| *Minor Type MC (with Universal Transformer)* - | 35/6 |
| *Baby Type BX (for Low Impedance Extension)* - | 43/6 |
| *Baby Type BC (with Universal Transformer)* - - | 49/6 |

WB **Stentorian**

THE PERFECT EXTRA SPEAKER FOR ANY SET

WHITELEY ELECTRICAL RADIO CO. LTD., MANSFIELD, NOTTS.

# Telling t'other from which!

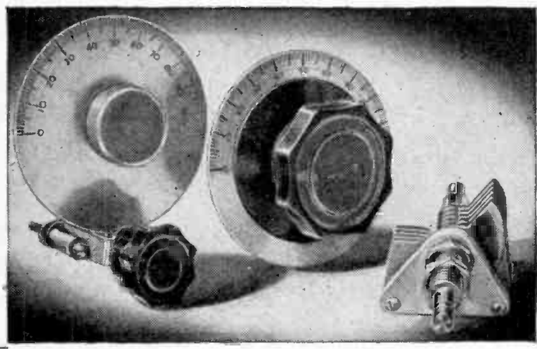


There's no difficulty in sorting out one from another when cables and components are marked with Lasso Identification Tape. Lasso Tapes are self-adhesive, resistant to water, oil, petrol and solvents, and tested for tensile strength, durability and electrical resistance. Manufactured on different bases — transparent film, cotton cloth — they are printed with your own inscriptions at intervals spaced to suit diameters and other measurements. Printing cannot be erased. In 10 yard rolls, Lasso Tapes provide permanent name tabs for containers, furniture, plastics and tools. An interesting booklet is free on request.

LASSOPHANE • LASSOVIC • LASSOLASTIC • LASSOBAND
LASSOTHENE • LASSOTHYL • LASSOFIBRE

**LASSO** *Identification* **TAPES**
REGD. TRADE MARK


*CABLE ASSEMBLIES LTD.* (Subsidiary of Herts Pharmaceuticals Ltd.)
*50 Howardsgate, Welwyn Garden City, Herts. Tel. Welwyn Garden 3783/3929* (C3)



## RAYMART DIALS AND KNOBS

**Raymart** precision dials are noted for their accurate workmanship and non-reflecting satin finish.

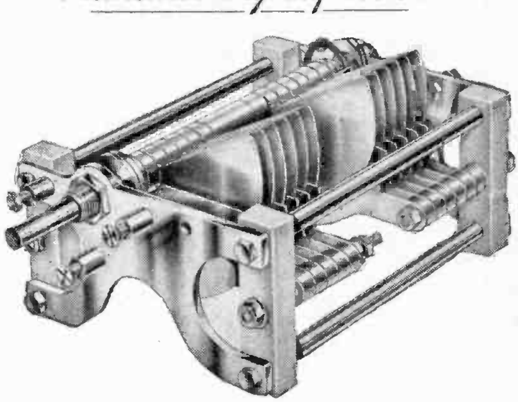
**TYPE TXJ.** 2⅜" Dial, graduated 0-100 complete with indicator. **TYPE TXD.** 4" companion Dial to TXJ with indicator, graduated 0-100. **TYPE TXW.** 2¾" special Dial, without knob, but having solid metal boss and intended for use with our slow motion drive and dial locking device. **TYPE TXO.** 2⅜" Dial, graduated 100-0, with no skirt on knob of this dial. **TYPE SMD.** We manufacture a slow motion drive with dial cursor and locking device for use with the TXW, but it can be used with any of the above dials. This drive works on the edge of the dial by friction, and there is a dial cursor and lock operating at the top of the dial. **KNOBS.** Black bakelite, with and without skirts. Diameters 1⅜", 2 3/16", 3".

RAYMART
CRAFT A CREED

*NOTE: All Raymart products obtainable from — BERRY'S (SHORT-WAVE) LTD., 25 HIGH HOLBORN, LONDON, W.C.1 (Phone: Holborn 6231)*

**48 HOLLOWAY HEAD, BIRMINGHAM 1**

## *"Cyldon" Transmitting Capacitors*



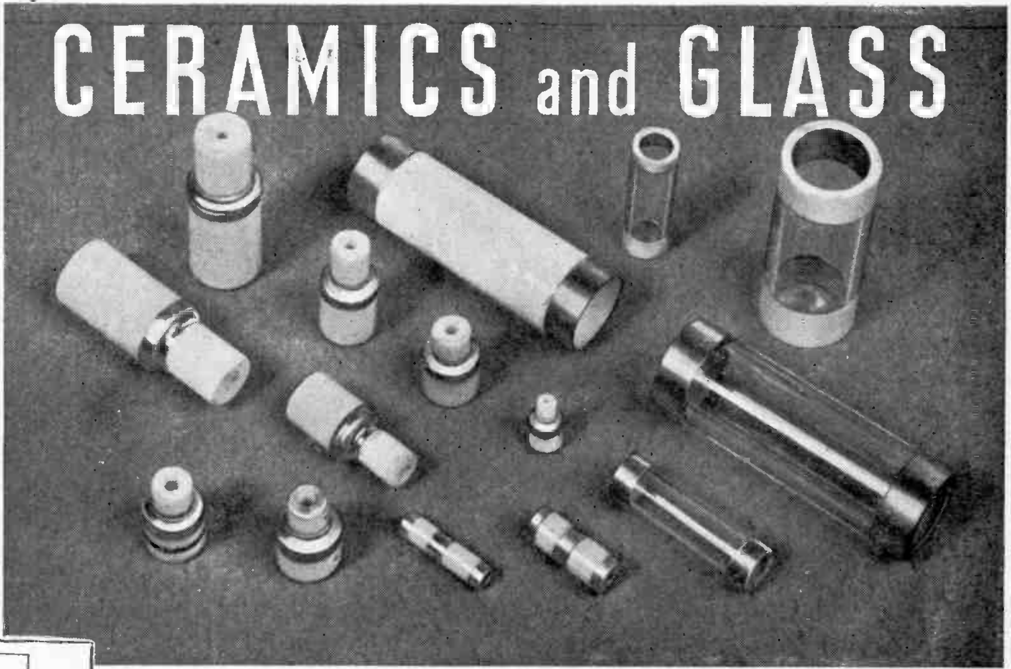
TYPE SSTR. SQUARE LAW.

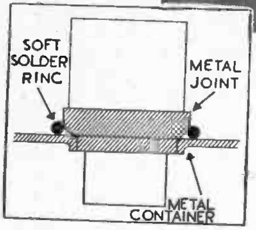
| *Max. Capacity* | *List Price* |
|---|---|
| 100 pF | £1 : 7 : 6 |
| 150 ,, | £1 : 12 : 0 |
| 200 ,, | £1 : 15 : 0 |
| 250 ,, | £2 : 0 : 0 |
| 300 ,, | £2 : 10 : 0 |

***SYDNEY S. BIRD & SONS, LTD.***
*Cambridge Arterial Road, Enfield, Middlesex.*

# COMPREHENSIVE EXPERIENCE PERFECTS

*metallised*




*Method of Assembly :*

**CERAMIC BUSHINGS**

*The holes in the metal container should be plunged to ensure proper seating of the bushings. A ring of flux-cored solder placed round the bushing and melted with a small soft flame is better than the use of a shaped bit.*

## FOR HERMETIC INSULATED SEALS

The extensive experience of Johnson Matthey in the production of precious metal preparations for glass and ceramics on the one hand, and in soldering and brazing techniques on the other, provides a perfect background for these new types of hermetic insulated seals for electrical components. These include a standard range of low-loss ceramic terminal bushings, metallised and tinned ready for use with soft solder. Heat resisting glass tubes with metallised and tinned bands can also be produced for subsequent sealing with soft solder and special bushings can be supplied to individual requirements. Full details are given in J. M. C. publication 2470 which will be sent on request.

*One of the specialised products of*

**JOHNSON, MATTHEY & CO., LIMITED**

73/83 HATTON GARDEN • LONDON • E.C.1

EDXI.B


## DON'T MISS A WORD OF THIS!.. YOU WON'T WITH

# Exide

L.T. ACCUMULATORS

AND

# Drydex

H.T. BATTERIES

*The perfect pair for battery Radio sets*

THE CHLORIDE ELECTRICAL STORAGE CO. LTD., CLIFTON JUNCTION, NR. MANCHESTER

# No Introduction needed!

*Type "A"*

If you were in any section of Radio Communication during the war period you are almost certain to have been introduced to S. G. BROWN Headphones.

The excellent service they rendered in winning the war is now available to all radio enthusiasts.

For quality reproduction and maximum results on all wavebands there are no finer headphones.

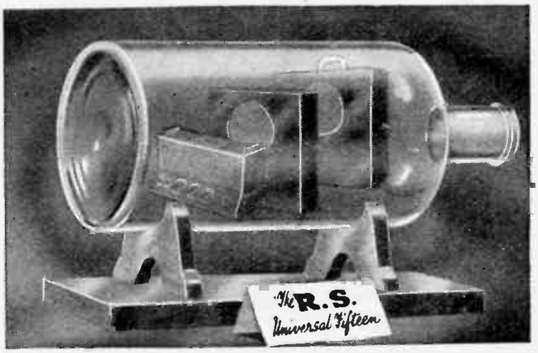
Your Dealer can supply.

| | |
|---|---|
| **TYPE "A"** Adjustable Reed Movement | **57/6** |
| **TYPE "F"** Featherweight | **23/-** |

*Technical details of all S. G. Brown headphones are given in Brochure "W." Free on request.*

**S.G.Brown, Ltd.**

VICTORIA ROAD, NORTH ACTON, LONDON, W.3. *Telephone : ACOrn 1174.*



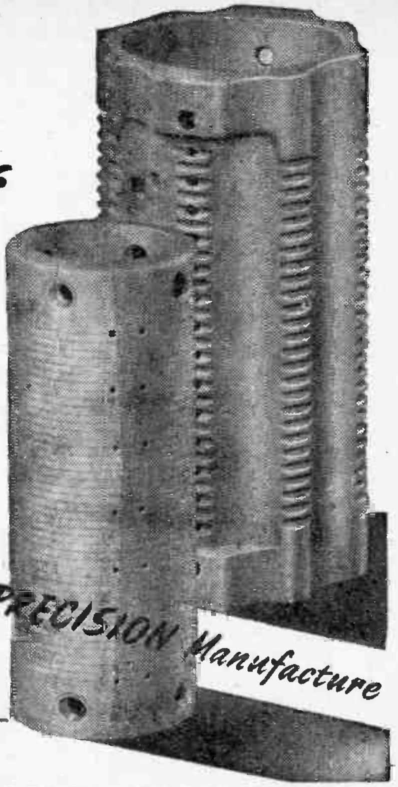

## ...but the R.S. "UNIVERSAL FIFTEEN" will go almost any place & suit almost any circumstance

Unlike ships, you won't find the R.S. Universal Fifteen "sitting pretty" in a bottle. But that's about the only place and circumstance it doesn't suit. Completely and easily portable and operating on any mains either A.C. or D.C., and at all voltages from 200 to 250, the R.S. Universal Fifteen s giving sterling service in all fields of P.A. endeavour everywhere. Supplies are, of course, a *little* easier now but we still cannot build them fast enough to give immediate delivery—we promise however, not to keep you waiting longer than possible. May we send you full information and data on this "truly portable" Portable P.A. Equipment ?

RS AMPLIFIERS

**R. S. AMPLIFIERS LTD., 2-4 HIGHFIELD ROAD, SHEPPERTON. MIDDX.**
Tel. : Walton-on-Thames 1019.

## *The better they are made the more outstanding the results*



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**FREQUELEX.** An insulating material of low Dielectric Loss, for Coil Formers, Aerial Insulators, Valve Holders, etc.

**PERMALEX.** A High Permittivity Material. For the construction of Condensers of the smallest possible dimensions.

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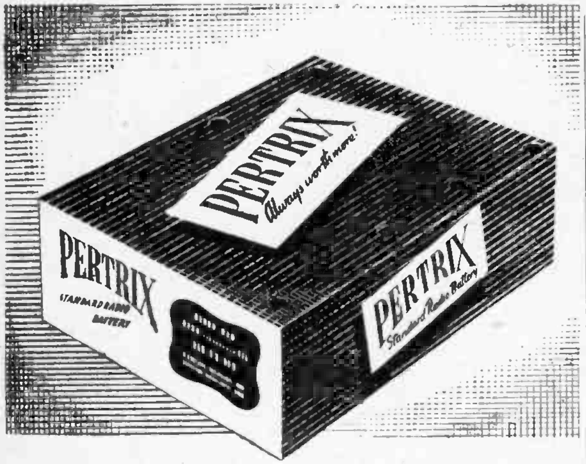
*Specialize in PRECISION Manufacture*

**BULLERS LOW LOSS CERAMICS**

BULLERS LTD., 6, Laurence Pountney Hill, London, E.C.4. Phone: Mansion House 9971 (3 lines)
Telegrams: "Bullers, Cannon, London." Manchester Office: 196, Deansgate, Manchester




**AN OLD FRIEND RETURNS** Pertrix Batteries have emerged from the testing ground of war as more reliable, more efficient than ever before. You will soon see them in the smart new post-war pack shown above. It denotes the finest battery for radio use yet made.

**HOLSUN BATTERIES LIMITED**
**137 Victoria Street London S.W.1**

P.I.C

# For the AMATEUR TRANSMITTER and the DISCRIMINATING EXPERIMENTER

*and all components carry*

# Webb's

## AERIAL EQUIPMENT

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|---|---|
| Pyrex 3¼" strain insulator | 1s. 0d |
| ,, 6" ,, ,, | 6s. 9d. |
| ,, shackle or egg insulator | 1s. 3d. |
| Raymart Ceramic "T" insulator for centre of dipole, etc. | 1s. 2d. |
| Enamelled wire, 14 s.w.g. per 100 foot coil | 4s. 6d. |
| Belling Lee, 80 ohm transmission line, per yard | 9d. |
| Co-axial cable with outer insulation, overall diameter 7/16", impedance 80 ohms, per yard | 1s. 6d. |
| Ceramic feeder spacers : 2" | 8d. |
| 4" | 10d. |
| 6" | 1s. 0d. |
| Lead-through insulator, cone type, Eddystone 1018 | 2s. 6d. |

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**CHASSIS PUNCHES**, double-ended, hardened steel for punching valve holes in up to 16-gauge metal. Available in five sizes :—

| | |
|---|---|
| Diameter of hole 1¼", 1⅛" | 10s. 6d. |
| Diameter of hole 1", ¾", ½" | 9s. 6d |

### SOLDERING IRONS

| | |
|---|---|
| Solon 968, round pencil bit 230/250 v.—65 watts | 15s. 0d |
| Solon 964 oval tapered bit 230/250 v.—65 watts | 13s. 4d. |
| **COUNTER BORES**—for cleaning chassis for perfect earth connections, per set of three, 2, 4 and 6 BA | 5s. 9d. |
| **ELECTRIC DRILLS.** Wolf "Quarter-master" AC/DC operation 230/250 volts. Takes up to ¼" drill, speed 1,800 R.P.M. (*Supplies very limited*) | £7 10s. 0d. |
| **SOLDER** Multi-core, available in 16 s.w.g. per lb. reel | 5s. 3d |

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(No permits now necessary for supply) Q.C.C. mounted crystals to cover new 7 Mc/s and 14 Mc/s bands, also 58 and 28 Mc/s. A large selection of frequencies available from stock ........ £1 12s. 6d.

## UNCONDITIONAL GUARANTEE OF SATISFACTION

## TRANSMITTING VALVES

| | |
|---|---|
| Standard Telephones 5B/250A—(807) Beam power amplifier | £1 10s. 5d. |
| Standard Telephones 2V/400A—(866-866A) Mercury rectifier | £1 7s. 6d. |
| Standard Telephones 4274A Full-wave vacuum rectifier, 5V. 2 amps, 1,000v. 200 ma. | £1 0s. 0d. |
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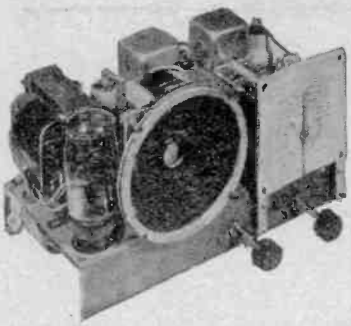

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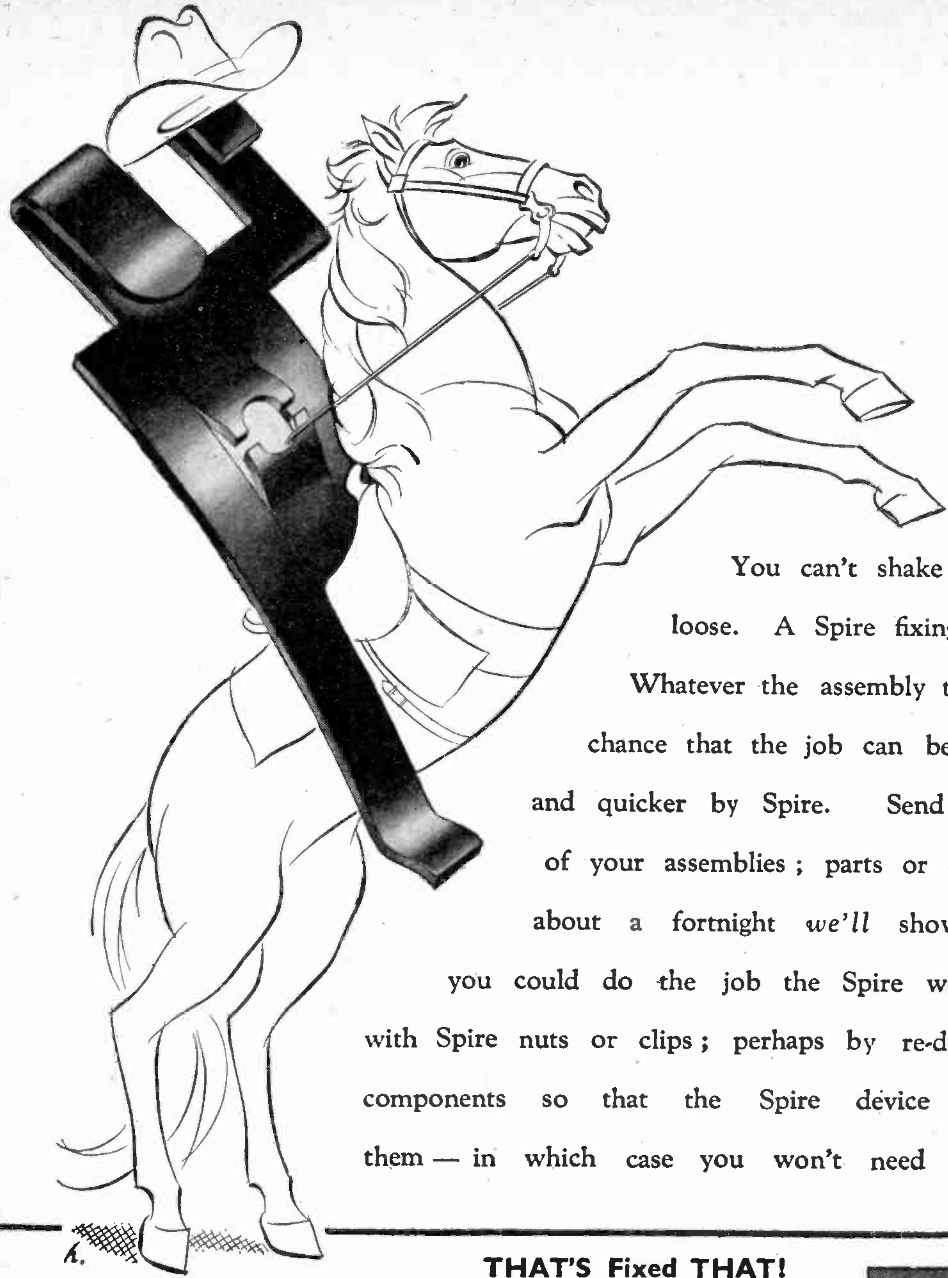

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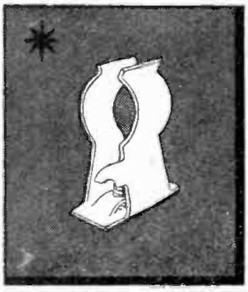

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## Radio and Electronics

**36th YEAR OF PUBLICATION**

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# Wireless World

**Radio and Electronics**

Vol. LII. No. 7 | JULY, 1946 | Price 1s. 6d.

## Monthly Commentary

# *Radio Aids to Navigation*

EVEN before the end of the European War *Wireless World* began to press for immediate international discussion of the problems that must be solved before wartime radio developments can be applied to peacetime uses. Perhaps we should admit to more optimism than subsequent events have shown to be justified, but as excuse for our impatience we can plead that every branch of radio is more or less affected by international agreements. Development work cannot be carried to the final stages without knowledge of at least the frequencies on which the gear is to work.

At long last a beginning has been made. The "International Meeting on Radio Aids to Marine Navigation" held in London from 7th to 22nd May is, we hope, but the forerunner of many other international gatherings in the near future. Though the meeting was not empowered to make decisions binding on the score of nations represented, its deliberations have done much to pave the way for later conferences with fuller powers. Congratulations are due to all concerned, and especially to those who conceived the idea—the Radio Board, we believe—and to Sir Robert Watson Watt for his able chairmanship.

Sir Robert's summing-up showed that a good measure of agreement has been reached on many points. Radar naturally had most of the limelight; the meeting was convinced that it would be of very great value to navigation and for the avoidance of collisions. The kind of equipment envisaged would work on a wavelength not exceeding 10 cm—probably well below—with a Plan Position Indicator as an essential part. Cheap and over-simplified gear was thought likely to be more of a danger than a help, while even "half-price radar" would involve unwarranted sacrifice of performance. The installation of "passive" radar reflectors as navigational marks giving a characteristic geometric pattern was approved, and it was thought that there were occasions where responder beacons would be useful.

Medium-frequency direction-finding on classical principles was concluded to be likely to remain an indispensable aid to the mariner for many years, while shore-based short-wave D.F. is valuable for rescue operations. The Consol system (described elsewhere in this issue) gives us a good deal for comparatively little. Phase-comparison systems were considered to be "unrivalled in the accuracy which they can offer in pilotage operations, but suffer certain inconveniences at greater distances." Pulse-timing systems "fall just short of the existing phase comparison systems." All these position-finding systems would, of course, be used in conjunction with, and not instead of, a P.P.I.

Position finding at very long distances was less thoroughly examined by the meeting, and it was admitted that knowledge on this subject was still inadequate. The feeling was that services of this kind should be shared with aircraft.

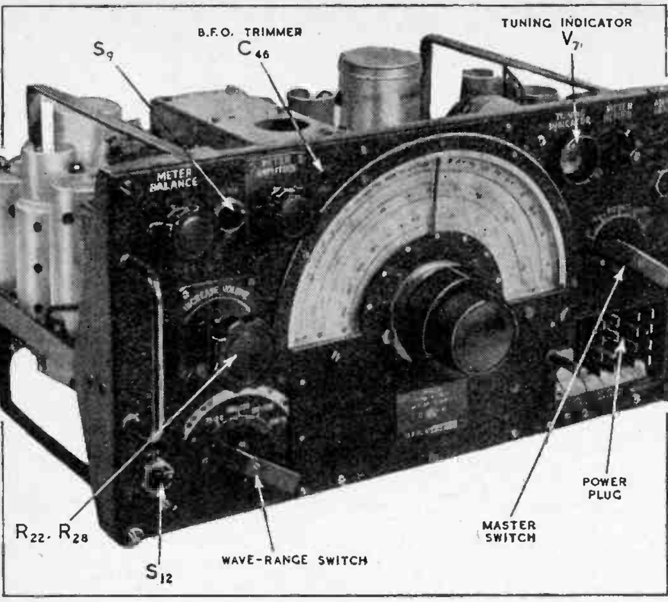
### Preliminary International Discussions

In concluding his summing-up, Sir Robert Watson Watt emphasized the preparatory nature of the meeting, which he described as a sort of pre-digestive apparatus for future conferences. But the work of the meeting is none the less valuable on that account; indeed, radio is now so complex that a similar pre-digestive process might with advantage precede all international conferences. It is certainly a step in the right direction that the radio technicians and organizers of the nations have been able to discuss freely, both formally and informally, matters that will have to be decided internationally when the present antiquated regulations are revised.

The shipowner must now be convinced of the benefits that modern radio technique has to offer him. Much has already been done by the Ministry of Transport, who, with the help of the Admiralty Signal Establishment, have taken energetic steps to evolve and demonstrate mercantile marine radar equipment. It only remains to prove to the shipowner that the new radio aids can pay for themselves in more economical operation of his vessels.

# EX-R.A.F.

## *Type R1155 Described*



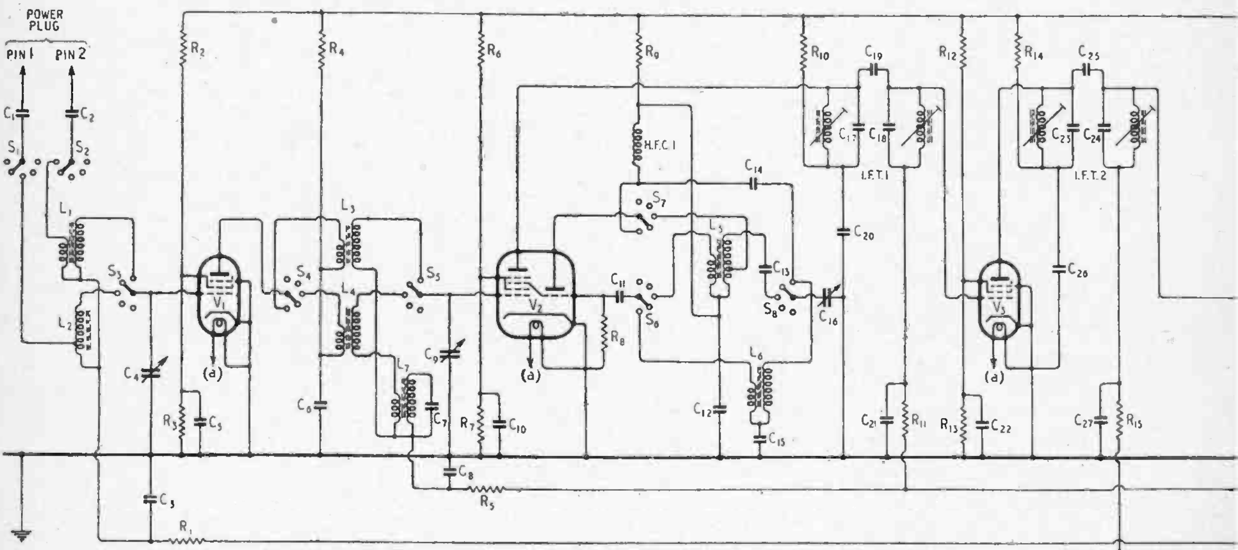

**Front view of the R1155, showing the location of the communication receiver controls and the power plug.**

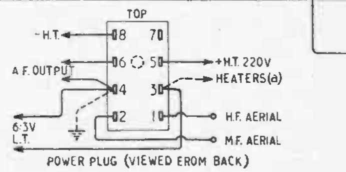
THE R.A.F. receiver Type R1155 was designed for use with the companion transmitter, the T1154, and at one time provided all the radio facilities needed in the air. Several modified versions of the set were produced, such as the R1155A, R1155B, etc., but they all embody the same basic circuit in which a sensitive and selective super-heterodyne receiver is combined with facilities—generally unwanted for civilian ground use—for direction finding.

Its potentialities as a communication receiver have not yet been fully explored, but from the behaviour so far the writer feels confident that very little modification will be needed to satisfy most requirements in this respect. One necessary modification is a standby switch for breaking the H.T. supply to mute the set during transmission periods. This will eventually be fitted when space has been made by removing some of the redundant D.F. components. Fortunately, these circuits are quite independent of the main communication receiver; moreover, the removal of the D.F. valves will result in a considerable saving in L.T. current.

As the highest frequency covered by the set is only 18.5 Mc/s a converter will be required for the 10-metre amateur band, where the high sensitivity and selectivity of the R1155 should prove very useful. Its use may well be extended to take in the 5-metre band also, though the set's narrow bandwidth, whilst a great asset on all other amateur frequencies, may prove a little embarrassing owing to frequency stability problems at both transmitting and receiving stations.

Of the ten valves in the R1155, three are used in the D.F. circuits, one is a "magic-eye" tuning indicator and the remaining six

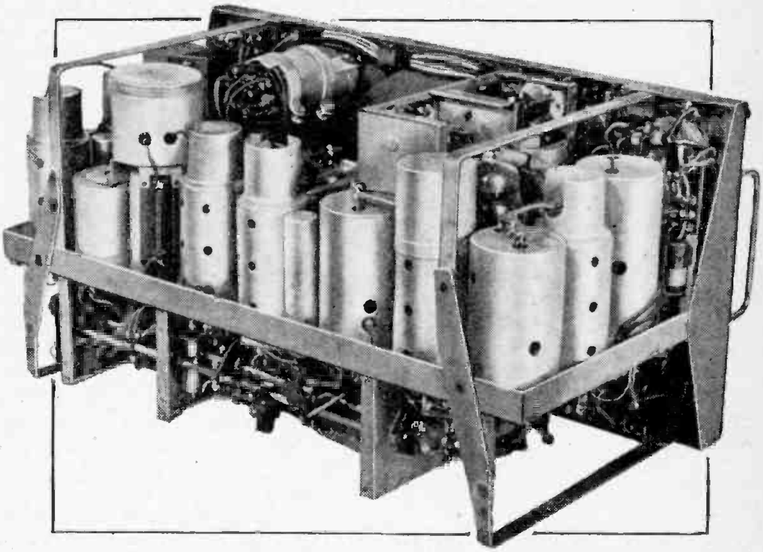


# COMMUNICATION RECEIVER

## Modifications for Civil Use

By "EX-SIGNALS"



The accessibility of all valves is a feature of the receiver.

are in the main receiver. Their functions are: signal frequency amplifier, frequency changer, two I.F. amplifiers operating at 560 kc/s, a double - diode - triode for second detector and output stage and another similar valve for A.V.C. and B.F.O. The B.F.O. incidentally, operates at half the intermediate frequency, e.g., 280 kc/s.

By omitting the D.F. circuits, all the D.F. switching and the less important receiver switching it is possible to produce a reasonably simple circuit showing its main features. This is reproduced here in Fig. 1.

Further simplification has been possible by including the coils for ranges 1 and 3 only, range 2 coils being the same design as for range 1, while those for ranges 4 and 5 are the same as for range 3.

The full coverage of these five ranges is given in an accompanying table.

When used in aircraft the R1155 can be operated on any one of three different aerials. One is a loop, another is a short fixed aerial and the third is a long trailing wire, which is let out only when the aircraft is airborne.

The switching selects the appropriate aerial of these three for the type of operation required; thus the loop is used for D.F., the fixed aerial on ranges 1 and 2, while the trailing wire comes into use on the lower frequency ranges 3, 4 and 5.

From the circuit diagram it will be seen that the two open aerials feed into the set via pins No. 1 and No. 2 on the power plug located at the bottom right-hand corner of the front panel. This is marked "From Transmitter." The position of these pins is as seen from the back, where the identifying markings are to be found. For normal reception the No. 1 and No. 2 pins can be joined together and taken to the aerial.

The simplified circuit

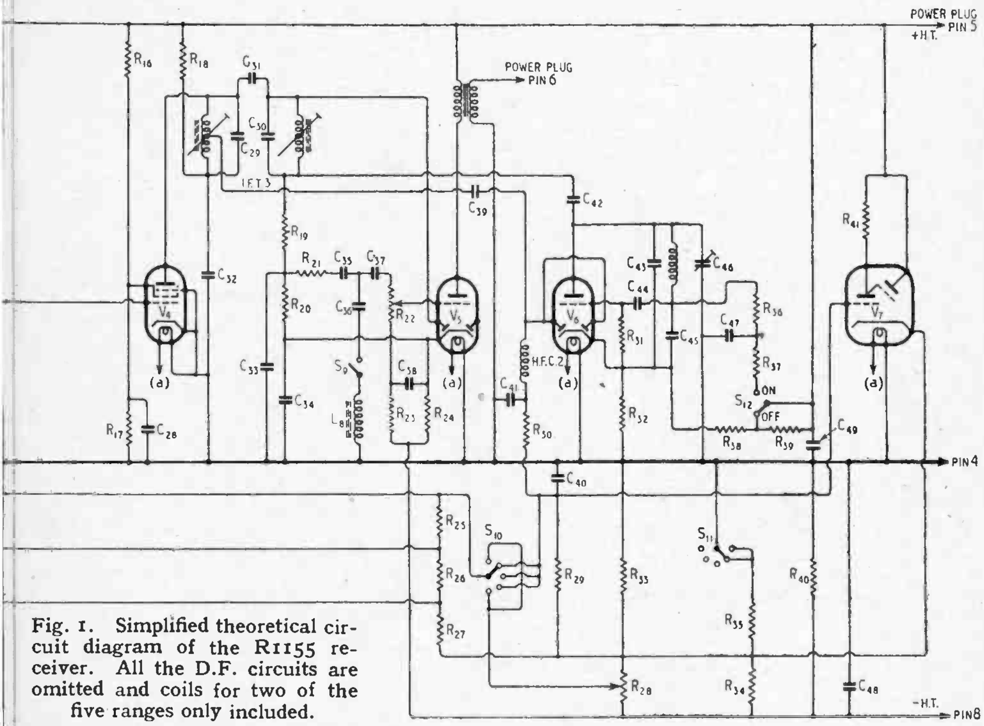



Fig. 1. Simplified theoretical circuit diagram of the R1155 receiver. All the D.F. circuits are omitted and coils for two of the five ranges only included.

**Ex-R.A.F. Communication Receiver—**
diagram is largely self-explanatory although there are a few features that might well be amplified. For example, the tuned circuit $L_7$, $C_7$, which is an I.F. trap, has been included in the R.F. coupling on range 3 to prevent any tendency towards instability due to I.F. feedback via the signal circuits when these circuits are tuned close to the intermediate frequency.

All the R.F. and I.F. coils have iron dust cores with provision for adjustment. In the signal circuits these inductance trimmers are supplemented by small capacitor trimmers, but in the I.F. circuits trimming is effected solely by the adjustment of the cores. Furthermore, the I.F. couplings are mainly capacitative, the coupling capacitors being $C_{19}$, $C_{25}$ and $C_{31}$.

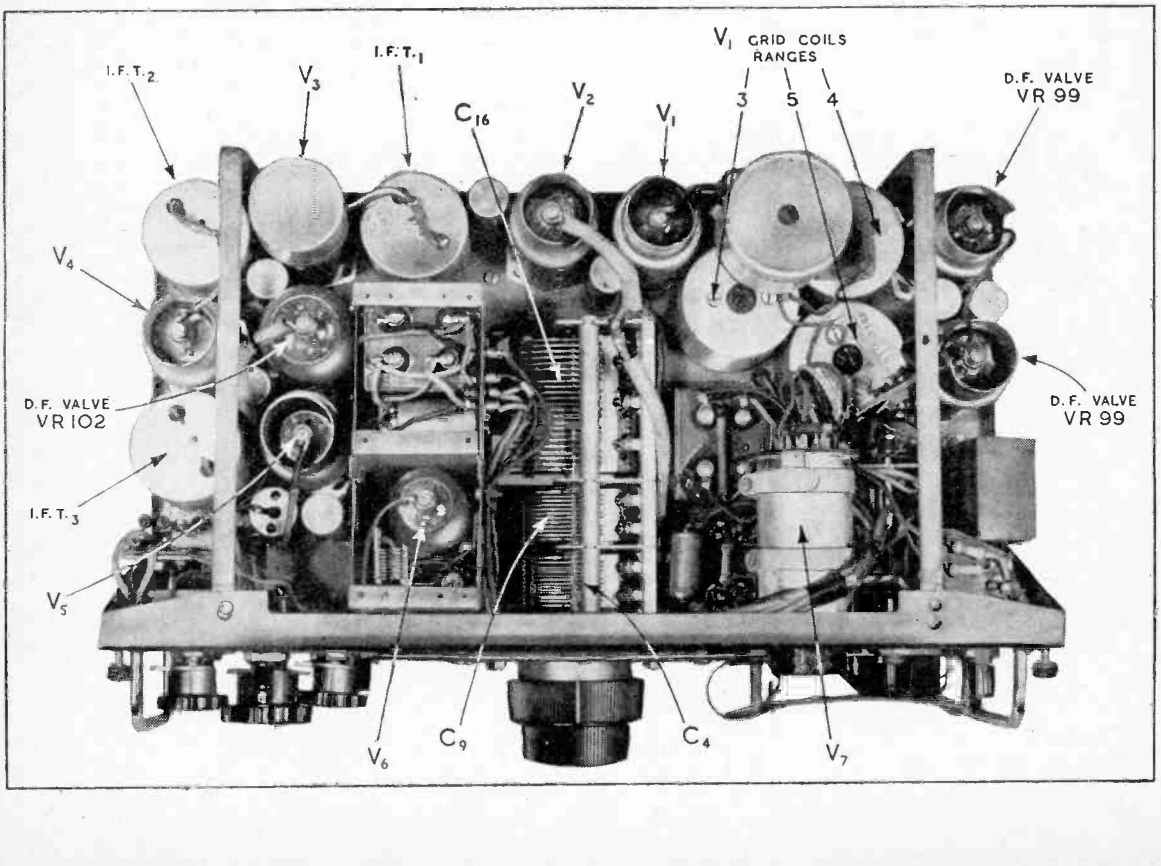
The frequency changer oscillator is a little more complicated than usual, but it can be resolved into a tuned anode circuit with a loosely coupled grid coil. On ranges 1 and 2 the circuit is parallel fed and the associated R.F. chokes are arranged to resonate just outside the low frequency end of their respective bands. Not shown in the circuit, but included in the set, are amplitude limiting resistors. These different circuit arrangements are adopted in order to render the calibration as independent as possible of valve characteristics.

**VALVE POSITIONS**

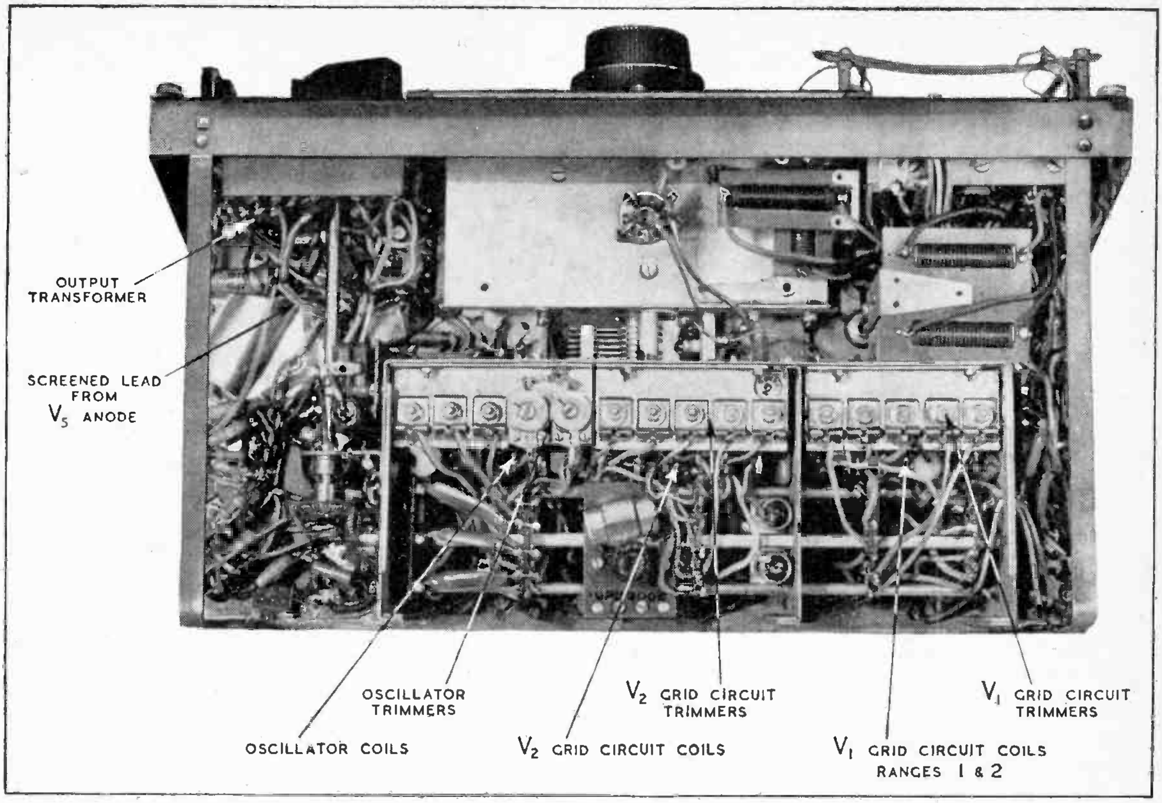
| Circuit Position | Service No. | Type | Function | Nearest Commercial Equivalents |
|---|---|---|---|---|
| $V_1$ | VR100 | R.F. Pentode | Sig. Freq. Amp. | Osram KTW63 |
| $V_2$ | VR99 | Triode-Hexode | Freq. Changer | ,, X65 |
| $V_3$ | VR100 | R.F. Pentode | 1st I.F. Amp. | ,, KTW63 |
| $V_4$ | VR100 | R.F. Pentode | 2nd I.F. Amp. | ,, KTW63 |
| $V_5$ | VR101 | D.D. Triode | Det ; A.F. Amp. | ,, DL63 |
| $V_6$ | VR101 | D.D. Triode | A.V.C. ; B.F.O. | ,, DL63 |
| $V_7$ | VI103 | C.R. Tuning Indicator | Tuning Indicator | ,, Y61 |

Associated with the audio stage, $V_5$, is a low-pass filter comprising the capacitors $C_{35}$, $C_{36}$ and $C_{37}$ and the inductor $L_8$. Its function is to filter out interference generated in the many electrical devices fitted in an aircraft. It has a cut-off at about 300 c/s.

Although there is provision for A.V.C. its use is optional and dependent on the position of the master switch, of which $S_{10}$ is one unit. When in the extreme anti-clockwise position, marked "O," A.V.C. is inoperative and the gain of the R.F. and I.F. stages is controlled by the amount of negative bias applied by $R_{28}$. This bias is graded according to the requirements of these valves




This view of the receiver shows the position of the valves and most of the larger components. The annotation agrees with that on the theoretical circuit diagram.




**With the cover of the coil unit, which is below the chassis, removed the wavechange switches and all the trimming capacitors are accessible. Inductance trimmers are located on the vertical side of the coil box, facing the front panel.**

by the resistance network $R_{25}$, $R_{26}$ and $R_{27}$ and is obtained from the resistor $R_{40}$ connected between the H.T. negative and the earth line.

Ganged with $R_{28}$ is another volume control potentiometer $R_{22}$, which functions on the A.F. signal only.

When the master switch is moved to the "A.V.C." position the gain of the R.F. and I.F. stages is controlled solely by the A.V.C. system, which has a standing delay of approximately 13 volts. The manual volume control then functions on $R_{22}$ only, $R_{28}$ being put out of action by $S_{10}$.

A minimum bias of between 3 and 4 volts is provided by $R_{33}$, but this is reduced slightly on the high frequency ranges 1 and 2 by bringing another resistor, $R_{35}$, in parallel with it. This is effected by $S_{11}$, which is part of the waveband switching comprising $S_1$ to $S_8$ inclusive. There are some additional switches, not included in Fig. 1, for short-circuiting all the idle coils in the signal and oscillator stages.

The remaining three positions of the master switch relate to direction finding so we are not concerned with them here.

When used in an aircraft the

**RECEIVER CIRCUIT VALUES (FIG. 1)**

**Resistors**

| | |
|---|---|
| 120 Ω | $R_{33}$ |
| 200 Ω | $R_{35}$ |
| 1,000 Ω | $R_{24}$, $R_{32}$ |
| 1.2 kΩ | $R_{34}$ |
| 1.5 kΩ | $R_{37}$ |
| 2 kΩ | $R_{40}$ |
| 2.2 kΩ | $R_4$, $R_{10}$, $R_{14}$, $R_{18}$ |
| 10 kΩ | $R_{36}$ |
| 22 kΩ | $R_3$, $R_7$, $R_9$, $R_{13}$, $R_{17}$, $R_{21}$ |
| 27 kΩ | $R_2$, $R_6$, $R_{12}$, $R_{16}$, $R_{27}$, $R_{39}$ |
| 30 kΩ | $R_{38}$ |
| 56 kΩ | $R_8$, $R_{19}$, $R_{30}$, $R_{31}$ |
| 100 kΩ | $R_1$, $R_5$, $R_{11}$, $R_{15}$, $R_{23}$ |
| 150 kΩ | $R_{25}$, $R_{26}$ |
| 470 kΩ | $R_{20}$ |
| 1 MΩ | $R_{41}$ |
| 2 MΩ | $R_{29}$ |

**Potentiometers**

| | |
|---|---|
| 50 kΩ | $R_{28}$ |
| 500 kΩ | $R_{22}$ |

**Capacitors**

| | |
|---|---|
| 2 pF | $C_{19}$, $C_{25}$ |
| 4 pF | $C_{31}$ |
| 15 pF | $C_{14}$ |
| 75 pF | $C_{46}$ (pre-set) |
| 100 pF | $C_{33}$, $C_{42}$, $C_{44}$ |
| 200 pF | $C_1$, $C_{11}$, $C_{40}$, $C_{41}$ |
| 300 pF | $C_{17}$, $C_{18}$, $C_{23}$, $C_{24}$, $C_{30}$ |
| 537 pF | $C_{13}$ |
| 600 pF | $C_{29}$ |
| 0.001 μF | $C_2$, $C_{35}$, $C_{37}$, $C_{39}$ |
| 1,600 pF | $C_{43}$ |
| 0.002 μF | $C_7$ |
| 0.004 μF | $C_{36}$ |
| 4,550 pF | $C_{45}$ |
| 6,170 pF | $C_{15}$ |
| 0.05 μF | $C_5$ |
| 0.1 μF | $C_3$, $C_6$, $C_8$, $C_{10}$, $C_{12}$, $C_{20}$, $C_{21}$, $C_{22}$, $C_{26}$, $C_{27}$, $C_{28}$, $C_{32}$, $C_{34}$, $C_{38}$, $C_{47}$ |
| 2.5 μF | $C_{48}$ |
| 4 μF | $C_{49}$ |
| Tuning Gang. | $C_4$, $C_9$, $C_{16}$ |

**Ex-R.A.F. Communication Receiver**—R1155 obtains its working voltages from a motor-generator, but for fixed station use a conventional-type mains supply unit is more practical.

This unit must give about 4 amps at 6.3 volt L.T. and 230 volts H.T. at between 60 and 70 mA. As the audio output is for headphones only it might be worth while to include a power output valve for operating a loud-speaker.

A saving of about 1.9 amps can be made in the L.T. supply if the three D.F. valves are removed. There will be no corresponding saving in H.T. current as these valves are virtually inoperative until the master switch is turned to one of the three D.F. positions.

The circuit diagram of a power unit found suitable for the R1155 is given in Fig. 2 and it includes a small tetrode for loudspeaker operation. Provision is also made for using headphones when required.

If a metal chassis is used for this power unit some precautions must be taken in its construction. In the receiver H.T. negative is not connected to the chassis as usual, but has the bias resistor $R_{40}$ interposed. Thus if H.T. negative is joined to chassis in the power unit and the two chassis accidentally touch each other this resistor will be short-circuited.

The three smoothing electrolytic capacitors $C_3$, $C_4$ and $C_5$ should be, therefore, either the waxed cardboard type or if assembled in metal cases be of the pattern in which the metal case is not connected to either of the capacitor leads.

It will be seen that two resistors, $R_5$ and $R_6$ are used in parallel for the grid bias supply to the KT63 valve. This is an expedient adopted to enable standard resistors to be employed as the optimum bias resistor value for this valve is 420 ohms.

As shown in this circuit the input for the KT63 is taken from pin No. 6 on the power plug in the R1155. This joins to the secondary of the telephone transformer, which in the writer's receiver has a ratio of approximately 1 to 1. It is to be found on the back of the front panel, between the B.F.O. switch, $S_{12}$, and the spindle operating the wavechange switches and can be identified by the reference number 10K/12139.

**POWER UNIT CIRCUIT VALUES (FIG. 2)**

| | |
|---|---|
| $R_1$ | 25 kΩ ½ W |
| $R_2$ | 5 kΩ ½ W |
| $R_3$ | 25 kΩ var. |
| $R_4$ | 100 Ω ½ W |
| $R_5$ | 680 Ω 1 W |
| $R_6$ | 1,200 Ω 1 W |
| $C_1$ | 0.01 μF |
| $C_2$ | 25 μF (25-V wkg.) |
| $C_3$ | 16 μF (450-V wkg.) |
| $C_4$ | 8 μF (450-V wkg.) |
| $C_5$ | 8 μF (450-V wkg.) |

This may not be the ideal method of connecting a power amplifier stage but it seems to be quite satisfactory from the performance point of view and has the advantage that no modification will be needed. The resistor $R_1$ is included to prevent the grid of the KT63 being "left in the air" when headphones are in use.

**WAVE-BAND COVERAGE**

| Range | Frequency | Wavelength (Metres) |
|---|---|---|
| 1 | 18.5 Mc/s–7.5 Mc/s | 16.2–40 |
| 2 | 7.5 Mc/s–3.0 Mc/s | 40–100 |
| 3 | 1,500 kc/s –600 kc/s | 200–500 |
| 4 | 500 kc/s –200 kc/s | 600–1,500 |
| 5 | 200 kc/s – 75 kc/s | 1,500–4,000 |

A simple form of tone control consisting of $C_1$ and $R_3$ is also included.

Acknowledgment is due to the Controller of H.M. Stationery Office for making available technical literature giving circuit details and component values.

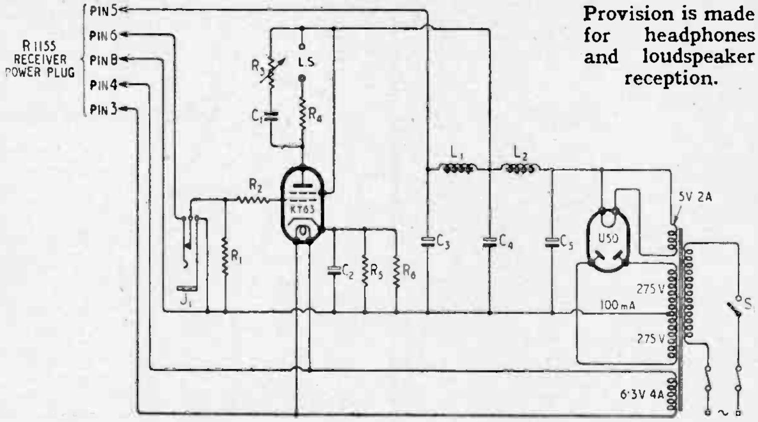



Fig. 2. Circuit diagram of a power supply unit for operating the R1155 from A.C. mains. Provision is made for headphones and loudspeaker reception.

## RADIO MATHEMATICS

THOUGH radio demands more mathematical knowledge than most other branches of electrical engineering it is a fact that students of the subject—and many whose student days, in the ordinary sense, are long past—often lack a sufficient mathematical background. A book just issued by our publishers should go a long way towards remedying this state of affairs.

In "Basic Mathematics for Radio Students"* by F. M. Colebrook, B.Sc., D.I.C., A.C.G.I., of the Radio Division National Physical Laboratory, the basic ideas of algebra, geometry and trigonometry are explained with a sympathetic understanding of the beginners' difficulties. While even very elementary matters receive attention, the principles of more advanced elements are treated in considerable detail.

While the book is written with the radio application in mind, it is almost equally helpful to students of other subjects, for these radio applications are in the main confined to the last chapter. The major part of the book deals with purely mathematical ideas.

*Pp. 270+X: 77 figs. Published by Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 10s 6d.

# ELECTROMAGNETIC DEFLECTION

## Television Line Scanning Amplifier

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

ALTHOUGH it is employed in nearly every television receiver, the electromagnetic line-scanning system has received very little theoretical attention, if the published papers on the subject are any guide, and it is quite difficult to obtain reliable information about it. Most articles on it, and most textbook references to it, are of a purely descriptive character, and many are either incomplete or inaccurate. A notable exception is Jofeh's paper.[1]

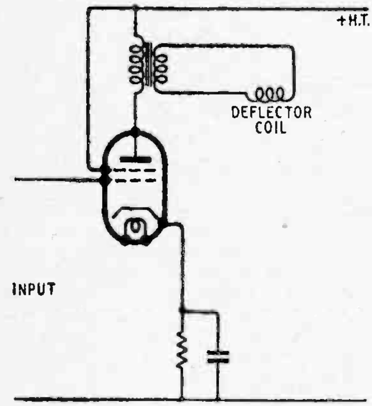



Fig. 1. Typical line scan output stage.

There are many possible circuit arrangements and even modes of operation for the same circuit. It is not possible to treat them all in a single article, and the present discussion will, therefore, be confined to the commonest practical case of a tetrode or pentode amplifier feeding the deflector coils through a transformer. The basic circuit is shown in Fig. 1, and it is assumed that the valve is supplied with a substantially perfect saw-tooth voltage input wave. This can be generated in any conventional saw-tooth oscillator.

By "substantially perfect" is meant a wave in which the voltage rises linearly with time during the 84 $\mu$sec allotted to the scan in the present transmission system and falls back again during the 14.8 $\mu$sec allotted for the fly-back. The precise waveform during the fly-back need not be specified at this juncture.

The requirement is to produce a similar current wave in the deflector coils. The theory usually given is based on a Fourier analysis of a saw-tooth wave into a series of harmonically related sine and cosine waves. On this basis it is shown that the frequency response of the circuit must extend up to 20 times the fundamental, or 10 kc/s to 200 kc/s. Over this range frequency and phase distortion must be very small. As a result it is often stated that special materials are needed for the transformer core.

Now this does not agree with practical experience. It is not difficult to secure a linear scan and an adequate fly-back time using ordinary silicon steel for the transformer core. In actual fact, frequencies much greater than three times the fundamental need not be considered.

The misleading results obtained from the Fourier analysis are caused by the over-idealization of the saw-tooth wave. The analysis is often based on the perfect saw-tooth of Fig. 2 (*a*) with zero fly-back time. More commonly the form of Fig. 2 (*b*) is adopted. This has a finite fly-back time, and consequently the higher harmonics in the series are of smaller amplitude and of less importance. However, the abrupt changes at the start and end of fly-back still give rise to very high frequency components.

In practice the saw-tooth waveshape is much nearer Fig. 2 (*c*). The corners are rounded and very high frequencies are absent. The practical wave during fly-back is roughly that of one-half cycle of a damped cosinusoidal wave. As the fly-back time is 14.8 $\mu$sec, the time of one-cycle is 29.6 $\mu$sec, so that the "frequency" is 33.8 kc/s.

It is much simpler, however, to abandon all thoughts of frequency and to consider the circuit in terms of a combination of inductance, capacitance and resistance acted upon by unit impulses or linear currents at the appropriate intervals.

The circuit of Fig. 1 has the equivalent of Fig. 3 (*a*) in which $E_a$ and $\mu e_g$ represent the A.C. resistance of the valve and the equivalent grid voltage; $r_p$ and $r_s$ represent the series resistances of the primary and secondary of the transformer while $L_p$ and $L_s$ are the primary and secondary inductances and M is the mutual inductance between them. $C_p$ and $C_s$ are the total primary and secondary circuit capacitances, and $R_2$ represents the core losses

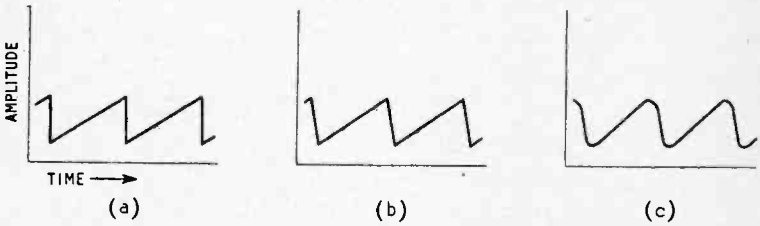



Fig. 2. Perfect saw-tooth waves with zero (*a*) and finite (*b*) fly-back times. A practical saw-tooth wave (*c*) is linear during the scan but curved during the fly-back.

[1] "Electromagnetic Time-Base Amplifiers," by L. Jofeh, *Journ. Instn. El. Engrs.*, September 1939.

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with any additional shunt damping included. $L_L$ and $R_L$ are the inductance and resistance of the deflector coil itself.

By well-known transformation theorems this circuit can be redrawn in the form of Fig. 3 (*b*), which is an exact equivalent of (*a*). Here the valve is represented by the constant current generator $g_m e_g$ where $g_m$ is the mutual conductance. $R_1$ is equal to $R_a$ and $R_2$ in parallel. The ratio of primary/secondary turns on the transformer is denoted by $n$ and $k = M/\sqrt{L_p L_s}$ is the coupling coefficient.

For a period of time which we shall denote by $t_1$, and which is actually 84 $\mu$sec for the present standards of transmission, it is required that the current through the coil $L_L$ shall change linearly with time. The magnitude of the change of current depends on the deflector coil design, the tube and its operating voltage. With a value of 3 mH for $L_L$ the current change is often about 0.6 A; we shall denote this current change by I and the current at any instant of time $t$ by $i_L$. Only times during the scan are of interest at the moment, so that $t$ is limited to the range of values from $t = 0$ to $t = t_1$.

If the scan is to be linear the coil current must be

$$i_L = I\, t/t_1 + I_1$$

where $I_1$ represents any unidirectional unchanging current through $L_L$, and it is necessary so to design the circuit that this is achieved or very nearly so.

In order to simplify matters it will be assumed that in all cases the current taken by $C_s$, the secondary circuit capacitance, is negligible compared with the coil current $i_L$ and that the effect of $r_p$ is also negligible. This is usually true in practice and it enables the circuit to be simplified to the form of Fig. 3 (*c*).

If $i_L$ is linear, the voltage E across L and R is simply $E = (IR\, t/t_1 + LI/t_1)\, k/n$. The first term is a linearly rising voltage, — the voltage drop across R, and the second is a constant voltage across L.

The total current required by the circuit during the scan is given by equation (1) in the Appendix and will be seen to consist of three terms, one constant, one linear with time and one proportional to the square of time. It is usually inconvenient to make the valve supply this last term and the general course is so to choose circuit values that it is always negligible. The coil current is then no longer perfectly linear, but of exponential form. It is to be noted, however, that the normal curvature of the valve characteristics is in the right direction for the valve to supply a current of this form from a linear input. In practice, therefore, there is always some tendency for the valve to produce this component of current. Ignoring this tendency of the valve to correct for the non-linearity produced by a finite primary inductance, the non-linearity can be kept below some 2% if $L_p$ is not less than the value given by equation (9).

In general, it is sufficient to choose $L_p$ from this equation but if R is abnormally low the value obtained may be too low for efficiency. Apart from causing non-linearity the primary robs the coil of some of the linear current. If R is very low, only a low value of $L_p$ is needed for linearity, and the $L_p$ may take too much current for efficiency. Normally $L_p$ should be at least ten times L.

The voltage E developed across the transformer primary has a maximum value of $(IR + LI/t_1)\, k/n$ when $t = t_1$ and it is in such a direction that it makes the valve anode negative with respect to positive H.T. It must not be too great in relation to the H.T. voltage, otherwise the anode-cathode voltage of the valve will be too small and the valve will cause serious non-linearity towards the end of the scan. Objects on the right-hand side of the picture will tend to be squeezed up.

With most valves 80 volts is a suitable minimum anode voltage, so that the minimum H.T. voltage needed is 80 volts plus the maximum scan-period back-E.M.F. across L. Equation (11) enables this to be calculated. It should be noted that the voltage so obtained does not include the drop across any cathode circuit or decoupling resistors.

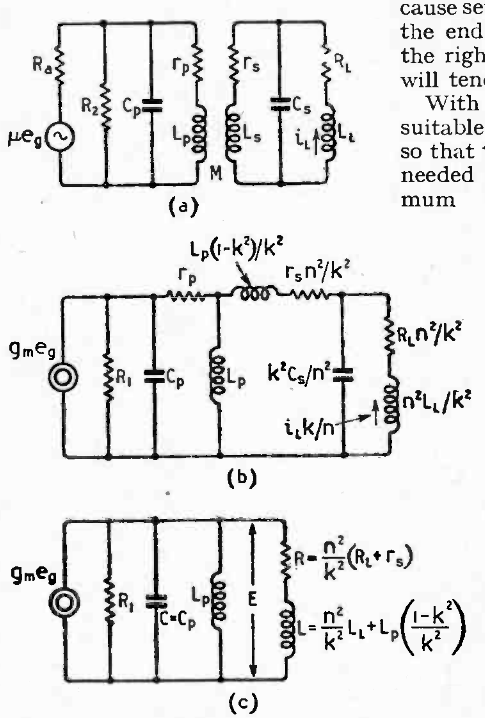


Fig. 3. The equivalent circuit of the amplifier of Fig. 1 is shown at (*a*) and a simplified, but exact, alternative at (*b*). In the latter $n$ is the ratio of primary/secondary turns on the transformer. When $C_s$ and $r_p$ are small enough to be neglected, the simpler equivalent (*c*) can be used.

It is now necessary to consider what happens during the fly-back. At the end of the scan when the anode current has its maximum value the synchronizing pulse in the transmission triggers the time base. As a result the grid of the valve is driven very rapidly negative. In some cases the anode current is cut off completely, in others it is reduced to a low value.

In any case, there is an interval of 14.8 $\mu$sec during which the coil current must change by the full amount I. During the scan of 84 $\mu$sec it increases by this amount. During the shorter fly-back period it must decrease by the same amount.

The valve plays only a small part during this fly-back period. Provided that the fly-back time of its grid voltage is short compared with that of the anode circuit, its only important effect is that of its A.C. resistance in damping the anode circuit.

Time is now reckoned from the start of the fly-back and at $t = 0$, we have a resonant circuit L, C, R and $R_1$ in which there is a current $i_0$ through L and a voltage $v_0$ across C. The current is actually equal to I less the amount of any overswing, of which more later. The voltage is the maximum back-E.M.F. across the circuit during the scan.

The behaviour of such a resonant circuit depends on the damping. In any case, the current must decay with time, but the way in which it does so depends on the damping. There are three possible conditions. One is called the condition of critical damping. The damping is the least possible without rendering the circuit oscillatory, and the decay of the current follows a complex exponential law.

With heavier damping the law of current decay is still more complex mathematically but the general shape of the decay curve is very similar. The change of current takes rather longer to accomplish, however.

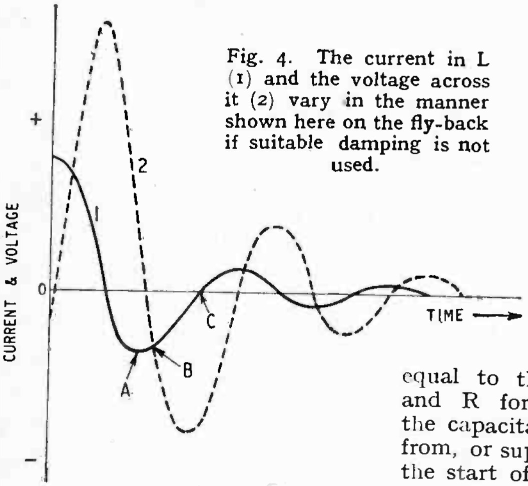


Fig. 4. The current in L (1) and the voltage across it (2) vary in the manner shown here on the fly-back if suitable damping is not used.

When the damping is less than critical the circuit is oscillatory. The coil current falls rapidly to zero, but then reverses and builds up in the opposite direction. Having reached a negative maximum it again falls towards zero. Depending on the degree of damping, it may just fall back to zero, or it may overshoot the mark and swing positively again. The current oscillates at the natural frequency of the circuit and the number of cycles depends on the damping.

Now it is imperative that the circuit shall not be allowed to oscillate in this manner. Oscillations must not occur during the line scan for they would not only cause severe non-linearity of the scan, but through velocity modulation of the electron beam they would produce a series of light and dark streaks to appear on the left-hand side of the picture.

If oscillations were permitted they would have to be kept within the fly-back time. This would necessitate the use of a low value of inductance and the efficiency would be poor.

All this is well known and it is generally stated that the damping must be critical. This is not so, however, and an improved performance is secured with rather less damping than the critical value.

The reason for this is tied up with conditons existing at the start of the scan. The necessary conditions which must exist if the scan is linear have already been given. At the instant of the start of the scan there must be a voltage $IL/t_1$ across L and if the current happens to be zero, also across C. If at this instant C is not so charged that the voltage across it is equal to that needed across L and R for a linear scan, then the capacitance will take current from, or supply current to, L and the start of the scan will not be linear.

With critical or higher damping the voltage across C is about zero at the end of fly-back, so that it must charge during the start of the scan and make it non-linear. This need not cause non-linearity during the actual picture scanning time for it is possible to choose circuit values so that it falls within the period allotted in the transmission for fly-back. However, the fly-back proper must then be more rapid and this entails a lower value of inductance and reduced efficiency.

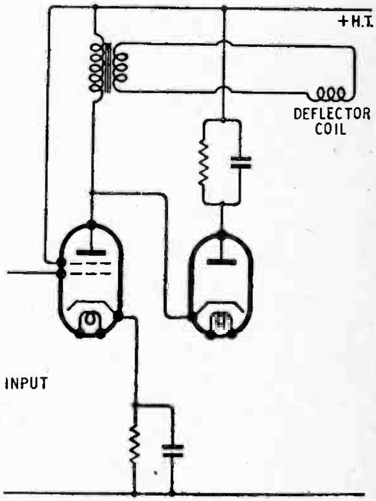


Fig. 5. In this circuit a diode is used to provide damping on the scan but not on the fly-back.

When the circuit is oscillatory and the damping is correct, matters can be so arranged that the overswing charges the capacitance to the correct value to suit the start of the scan.

The general form of the coil current during fly-back when the circuit is oscillatory is shown by curve (1) of Fig. 4. The current falls through zero, reverses and reaches a negative maximum at A. It again passes through zero at C and in fact executes several cycles before finally ceasing. Between A and C, however, there is a point B at which the slope of the curve is the same as that of the scan stroke, so that if the subsequent tendency to oscillation could be curbed this would be the correct point at which to start the scan. As the current slope is the same as on the scan, the back-E.M.F. across L is also the same as on the scan and C is suitably charged to suit the scan conditions.

The subsequent oscillations can be curbed by increasing the damping during the scan. This necessitates the use of a diode connected as shown in Fig. 5. Curve (2) in

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Fig. 4 shows the voltage across C during the fly-back, in the form of the anode voltage of $V_1$ with respect to positive H.T. At the start of the fly-back it is about 100–200 volts below + H.T. It rises rapidly and reaches a maximum of 1,000–2,000 volts above + H.T. when the current is changing most rapidly and then falls back. The diode is non-conductive during this period because the charge on the capacitor in its anode curcuit keeps its anode negative with respect to + H.T. during this time. When the anode potential of $V_1$, and the cathode potential of $V_2$, become negative again however, $V_2$ becomes conductive at the point B and then the capacitance and resistance in the anode circuit of the diode are effectively in shunt with the transformer primary and so increase the damping and prevent subsequent oscillation.

Although so-called damping-diodes are often used, the mode of operation and their purpose is often rather different from this. In this particular case, when the tetrode is providing current throughout the scan period, the advantage of a damping diode is insufficient to justify the difficulty of supplying its heater current.

By a critical choice of circuit values it is possible to achieve a similar result without a diode. It was shown earlier that for linearity on the scan the total current must comprise a constant and a linear current, that is, it must be a combination of a pulse and a saw-tooth. It was tacitly assumed that this would be supplied by the valve.

It need not be, however, for the overswing at the end of the fly-back can be utilized to provide the constant current and the valve need supply only the saw-tooth. This is an important simplification. The requirement is that at the time when the rate of change of current is equal to the slope of the scan current, and the voltage across C is equal to that needed at the start of the scan, the magnitude of the negative coil current shall also equal the steady current needed by $R_1$ and C during the scan. These equalities can be secured by the proper choice of circuit values.

In order that this small amount of overswing may be permitted, it is also necessary that the valve should not start to drive the linear current through the circuit until the end of the fly-back. A quick fly-back on the input voltage, a pause, and the start of the scan is the correct sequence of events.

It is not usually difficult to arrange this and in many cases it is obtained automatically, for the large peak voltage on the anode is fed back to the grid circuit in some degree through the grid-anode capacitance and is sufficient in many cases to inhibit the start of the scan.

Another way of looking at the matter is to consider the oscilla-

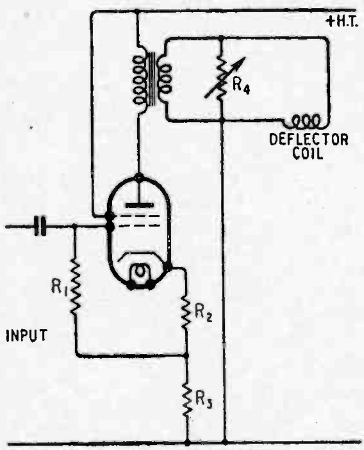



Fig. 6. Damping is provided by the resistance $R_4$ and negative feedback for linearizing the valve characteristic by $R_2$ and $R_3$.

tion at the end of the fly-back as being cancelled by an equal and opposite oscillation produced by the shock of starting the scan at the correct instant.

An exact relation between the circuit values is difficult to obtain because of the complicated form of some of the circuit equations. However, an approximate solution is adequate for most requirements and is given in equations (6) to (12) in the Appendix.

It is necessary to measure or estimate certain quantities in order to employ them. These are the coupling coefficient $k$ of the transformer, the secondary resistance $r_s$, and the primary circuit capacitance. The most difficult to estimate is $k$. It depends chiefly on the method of winding the transformer, and there are certain approximate formulæ which are helpful in estimating it. As a rough guide, it tends to be about 0.99 when the primary and secondary are each adjacent or coaxial single sections. When they are two primary sections with one secondary interleaved between them it tends to be around 0.995.

The secondary resistance can only be estimated roughly until the transformer is designed, but one is not far wrong as a rule if it is taken as about one-half of $R_L$. The primary circuit capacitance depends largely upon the method of winding the transformer. In the interests of reducing the mean anode current of the valve it is important to keep it as small as possible. The inductance L is inversely proportional to C and $n$ is approximately proportional to the square root of L. Consequently the saw-tooth current needed from the valve is nearly proportional to the square root of the capacitance.

The valve and wiring may be expected to give a capacitance of about 12 pF. In one transformer which the writer constructed, the measured primary capacitance was 130 pF. This is very high, and was caused by three factors; there was no sub-division of the primary, it was evenly layer wound with a winding length greater than the winding depth, and a plastic tape of fairly high dielectric constant was used between layers. This transformer was a first model, constructed before the importance of a low primary capacitance was fully realized.

A second transformer was wound on three concentric bobbins, the primary being split between the inner and outer, with the secondary on the middle one. In addition, each half-primary was sub-divided into three sections. In these sub-sections the primary was evenly layer wound with paper interleaving between layers. This form of construction reduced the self-capacitance from 130 pF to 39 pF and increased $k$ from 0.99 to about 0.995.

With the first transformer the total primary circuit capacitance was 142 pF and with the second it was 51 pF. The effect of this on the other circuit constants is shown by the figures given in Table I, for $I = 0.6$ A, $L_L = 3$ mH, and $R_L + r_s = 10\,\Omega$. The most important difference lies in the values of the current outputs required from the valve. The mean anode current of the valve must be one-half of $\Delta i_a$ plus the minimum anode current permissible for reasonable linearity. This is usually 10–20 mA, so that with the first transformer the mean anode current must be of the order of 90–100 mA, whereas with the second it need be only 55–65 mA.

TABLE I

| | | | |
|---|---|---|---|
| $C$ | = | 142 pF | 51 pF |
| $k$ | = | 0.99 | 0.995 |
| $L$ | = | 63.5 mH | 176 mH |
| $R_1$ | = | 16.4 k$\Omega$ | 46.6 k$\Omega$ |
| $n$ | = | 4.06 : 1 | 7.2 : 1 |
| $L_p$ | = | 0.69 H | 2.16 H |
| $\Delta i_a$ | = | 162 mA | 91 mA |
| $E_{HT}$ | = | 216 V | 298 V |
| $V_{max}$ | = | 1,280 V | 1,980 V |

A disadvantage of the low capacitance winding is the higher peak voltage developed during the fly-back, and it calls for correspondingly better insulation. There is nothing that can be done about it, however, and it is inevitable that a reduction of the current should increase the voltage.

Some words about $R_1$ may be advisable. The value calculated is not the value of a resistance to be connected across the transformer primary, for it includes the A.C. resistance of the valve as well as transformer iron losses. In practice a variable resistor is connected across the transformer and adjusted for the best linearity. The adjustment is fairly critical.

It can be across either primary or secondary, but the latter is usually preferable since the voltage is lower. The resistance needed will be higher than $R_1/n^2$, but how much higher depends on the iron losses. In an example above, $R_1$ was 46.6k$\Omega$ with $n^2 = 51.5$, so that the minimum value of the secondary shunt resistance would be 910$\Omega$. A variable resistor with a maximum value of 5 k$\Omega$ would probably be about right.

The final circuit is, therefore, as shown in Fig. 6, in which $R_2$ is the bias resistance of the valve and $R_3$ provides additional feedback; $R_4$ controls the damping. The circuit is most easily adjusted with an oscilloscope connected across a resistance of some 10$\Omega$ inserted in series with the deflector coil.

With excessive damping the picture obtained takes the form shown in Fig. 7 (*a*); the end of the fly-back is slow and rounded. With inadequate damping (*b*) there is overshoot. With the correct damping the wave takes the form (*c*) with quite an abrupt transition from the fly-back to the gentle slope of the scan.

This adjustment is best carried out in the first instance with quite a small input to the valve. The other adjustments are best carried out by looking at an actual picture. The input should be increased until the picture width is correct. If there is non-linearity on the left-hand side, so that objects appear increasingly compressed as they tend to the left, the most probable cause is valve curvature. Negative feedback should be increased by increasing $R_3$, more input also being used to keep the output constant. As this increases the A.C. resistance of the valve, $R_4$, may have to be reduced slightly to avoid overshoot.

If this fails to bring about adequate linearity, the standing current in the valve should be increased by raising the screen voltage if this can be done without exceeding its rating. When the compression is abrupt rather than gradual, however, an inadequate anode voltage is the most probable cause and the H.T. voltage should be raised.

If the non-linearity is on the right-hand side of the picture, however, then provided that the input voltage to the valve is linear, the most probable cause is an inadequate anode voltage and this should be raised.

(a) (b) (c)

**Fig. 7. The current waveforms with excessive and inadequate damping are shown at (*a*) and (*b*) respectively, while the wave with correct damping takes the form (*c*).**

APPENDIX

When $r_p \ll R_1$ and $CR/2 \ll L/R_1$ —the usual practical case—the current required by the circuit during the scan time from $t = 0$ to $t = t_1$ is:—

$$i = \frac{I}{n}\left[\frac{L/R_1}{t_1} + \frac{t}{t_1}\left(1 + \frac{R}{R_1} + \frac{L}{L_p}\right) + \frac{t^2}{2\,t_1\,L_p/R}\right] \quad .. \quad (1)$$

If $L_p$ is large enough to make the term in $t^2$ negligible in comparison with the others, and the optimum circuit conditions exist, the linear current to be supplied by the valve is:—

$$i_a = \frac{I}{n}\cdot\frac{t}{t_1}\left(1 + \frac{R}{R_1} + \frac{L}{L_p}\right) \quad .. \quad (2)$$

and the total peak-to-peak anode current is:

$$\Delta i_a = \frac{I}{n}\left(1 + \frac{R}{R_1} + \frac{L}{L_p}\right) \quad .. \quad (3)$$

On the fly-back the coil current is

$$i_L = n\,i_0\left[\cos\omega t + \left\{\frac{1}{\omega CR_1} - \frac{\alpha}{\omega} - \frac{v_0}{i_0\omega L}\right\}\sin\omega t\right]\epsilon^{-\alpha t} \quad .. \quad (4)$$

and the back E.M.F. across the transformer primary is

$$v = v_0\left[\cos\omega t + \left\{\frac{\alpha}{\omega} - \frac{1}{\omega CR_1} + \frac{i_0}{v_0\omega C}\right\}\sin\omega t\right]\epsilon^{-\alpha t} \quad .. \quad (5)$$

where $\alpha = \frac{1}{2}\left(\frac{1}{CR_1} + \frac{R}{L}\right)$

$\omega_0^2 = (1 + R/R_1)/LC$

$\omega^2 = \omega_0^2 - \alpha^2$

$i_0$ = peak primary current at end of scan.

$v_0$ = peak primary voltage at end of scan (negative).

$I$ = peak-to-peak deflector coil current.

**Electromagnetic Deflection—**

In the above equations, the fundamental units apply, i.e., volts, amperes, ohms, farads, henrys, seconds, and $k$ has been assumed to be negligibly different from unity.

The following approximate formulæ enable circuit values to be determined for the conditions given in the text and a fly-back time of 14.8 μsec and a scan time of 84 μsec.

$$L = 9{,}000/C \quad (\text{mH, pF}) \quad \ldots \quad (6)$$

$$R_1 = 2{,}330/C \quad (\text{k}\Omega\text{, pF}) \quad (7)$$

$$n = \sqrt{\left[\frac{L/L_L}{1 + 8.4(1-k)(R_L + r_s)/L_L}\right]} \quad (\Omega\text{, mH}) \quad \ldots \quad (8)$$

$$L_p = 4.2\, n^2(R_L + r_s) \quad (\text{mH}, \Omega) \quad (9)$$

$$\Delta i_a = \frac{I}{n}\left(1 + \frac{R}{R_1} + \frac{L}{L_p}\right) \quad (\text{mA}, \Omega\text{, mH}) \quad (10)$$

$$E_{HT} \geqslant 80 + \frac{I}{n}(R + 11.9L) \quad (\text{V, A}, \Omega\text{, mH}) \quad (11)$$

$$V_{max} = E_{HT} + \frac{I}{n} \cdot \frac{1.025 \times 10^6}{C} \quad (\text{V, A, pF}) \quad (12)$$

where

$L$ = effective primary circuit inductance

$L_p$ = transformer primary inductance.

$L_L$ = deflector coil inductance.

$R_L$ = deflector coil resistance.

$r_s$ = transformer secondary resistance.

$R_1$ = shunt damping resistance on primary.

$k$ = coupling coefficient of transformer.

$n$ = turns ratio of transformer.

$\Delta i_a$ = peak-to-peak anode current of valve.

$I$ = peak-to-peak deflector coil current.

$E_{HT}$ = voltage of + H.T. with respect to the valve cathode.

$V_{max}$ = maximum anode-cathode voltage of valve during fly-back.

# SHORT-WAVE CONDITIONS: *Expectations for July*

*By T. W. BENNINGTON*

*(Engineering Division, B.B.C.)*

DURING May the *average* daytime maximum usable frequencies for this latitude were a little lower than during April, whilst the night-time M.U.F.'s were somewhat higher. This was in accordance with the normal seasonal trend. Frequencies up to 15 Mc/s were *regularly* usable over most circuits up to midnight, but long-distance communication on frequencies of the order of 28 Mc/s was relatively infrequent, except to places well to the southward of this country. *Medium*-distance communication on very high frequencies, though occasionally possible, was less frequent than had been anticipated, sporadic E having been less prevalent than was expected.

As was expected, short-wave conditions were less disturbed than during previous months. A few ionosphere storms did, however, occur, the main disturbance periods being 6th-7th, 9th, 11th, and 21st-24th.

**Forecast.**—Conditions for general long-distance short-wave communication during July should be much the same as during June; i.e., daytime M.U.F.'s will be rather low and night-time M.U.F.'s high. There should, in fact, be less difference between day and night frequencies than at any other time of year, and 15 Mc/s ought to be usable over many circuits till well after midnight. The possibilities of *long-distance* communication on *very high* frequencies should continue to be rather remote, except to places well to the south of this country. *Medium-distance* communication will be controlled by the E layer during a good part of the day, and so the tendency in this case will be for daytime as well as night-time M.U.F.'s to be high. Communication to distances up to about 1,400 miles on *exceptionally* high frequencies should continue to be frequently possible by way of sporadic E.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during July, for four long-distance circuits running in different directions from this country. In addition, a figure in brackets is given, this indicating the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the *regular* layers.

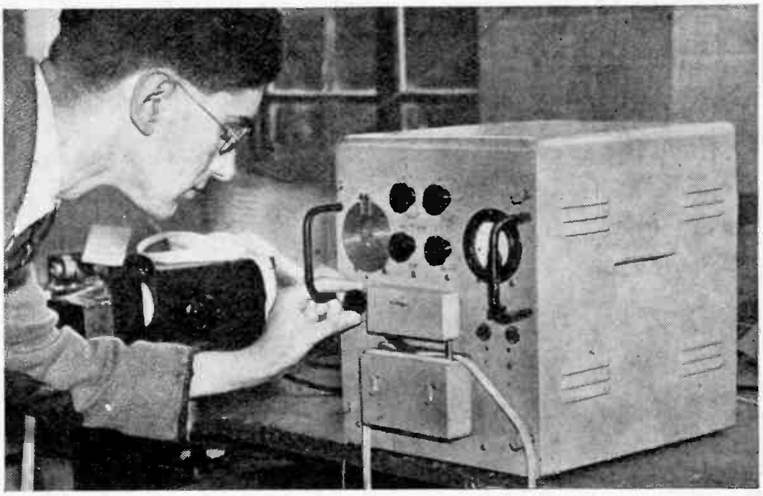
**Montreal:** 0000, 15 Mc/s (20 Mc/s); 0200, 11 Mc/s (18 Mc/s); 0900, 15 Mc/s (22 Mc/s); 1200, 17 Mc/s (25 Mc/s); 2300, 15 Mc/s (22 Mc/s).

**Buenos Aires:** 0000, 15 Mc/s (20 Mc/s); 0200, 11 or 9 Mc/s (15 Mc/s); 1000, 17 Mc/s (25 Mc/s); 1600, 21 Mc/s (27 Mc/s); 2000, 17 Mc/s (25 Mc/s); 2300, 15 Mc/s (20 Mc/s).

**Capetown:** 0000, 15 or 11 Mc/s (18 Mc/s); 0200, 11 Mc/s (15 Mc/s); 0600, 17 Mc/s (25 Mc/s); 0900, 21 Mc/s (32 Mc/s); 1400, 26 Mc/s (34 Mc/s); 1600, 21 Mc/s (31 Mc/s); 1900, 17 or 15 Mc/s (23 Mc/s); 2100, 15 or 11 Mc/s (18 Mc/s).

**Chungking:** 0000, 15 M/cs (20 Mc/s); 0600, 17 Mc/s (24 Mc/s); 2000, 15 Mc/s (22 Mc/s).

During July short-wave conditions are usually relatively stable, ionosphere disturbances not being very frequent or severe at this time of year.



HIGH-SPEED ELECTRONIC KEYING.—This photo-electric automatic transmitter, developed by Marconi's in collaboration with Cable and Wireless, is designed for a speed of over 850 w.p.m.

# AERIALS

## Things Usually Taken for Granted

By "CATHODE RAY"

IT seems to be generally agreed that aerials don't get anything like their fair share of explanation. They should really get a very large share, because they are absolutely necessary in any radio system (otherwise it wouldn't be radio), and they deal with radiation, which is always a difficult thing to understand. Yet some quite substantial books on radio don't devote even one whole chapter to aerials. It was undoubtedly this ignorance that nourished the rampant growth of superstition in pre-war days, so that charlatans were able to get away with the most fantastic claims for their "patent aerials" until the shortage of metals stopped them. I am glad to see that so far it appears to be only the genuine types of proprietary aerials that have survived the war.

All the same, there is still need for more on aerials, especially as all sorts of interesting new types have cropped up during the war. I hope a good book on aerials will appear. The most I can try to do in a few pages is to help readers with an elementary knowledge to make sense of some of the things usually taken for granted by writers, such as radiation and induction fields, polarization, aerial gain, polar diagrams, and so on.

The first point is that there is no need to consider transmitting and receiving separately, because the properties of any aerial are the same—in reverse—for both. That is a rough way of stating what is called the reciprocity theorem for aerials. For example, if an aerial radiates a narrow beam in a particular direction, it will also confine its reception to that direction, given the same frequency in both cases.

The next thing to keep in mind is that electromagnetic radiation, as its name implies, is composed of travelling electric and magnetic fields. A good deal of the early stages of radio theory is given to the ordinary electric and magnetic fields produced respectively by potential differences (or voltages) and currents. Coming later to radiation—which itself is difficult enough to grasp—one can hardly fail to be confused by the impression that its fields are the same, but different from those already studied. So let's get this clear now.

The ordinary (or induction) fields and the radiation fields *are* the same, as fields, but differ in the ways they are started and maintained. The induction fields are maintained by circuit voltages or currents; a constant current causes a constant stationary magnetic field of proportionate strength; and similarly for voltage and electric field, say, between the plates of a condenser—beg pardon, capacitor. Now an electric current is really a stream of moving electric charges, that is to say, centres of electric field. So a moving electric field generates a magnetic field. And (as may be confirmed by a visit to any electric power station) a moving magnetic field generates an electric field. So if you can persuade both sorts of field to move along together in the right sort of way, each will keep the other going, on a sort of "I'll scratch your back if you'll scratch mine" arrangement, and they become entirely independent of any circuit for their maintenance.

### Velocity of Propagation

There must obviously be equal quantities of each field, and they can only exist so long as they keep moving. They have to move at 186,000 miles or so per second in air or empty space, but in material that multiplies the electric or magnetic lines by its permeability or permittivity, a rather slower pace is sufficient.

Another essential is that the two fields are at right angles to one another and to the direction of motion. If you imagine a piece of graph paper travelling face forwards at 186,000 m.p.s., the "X" lines could represent the magnetic lines of force, the "Y" lines the electric force, and the paper itself any particular wave crest.

As I have already said, a constant current causes a constant stationary magnetic field. But it produces no radiation field at all. What is wanted is movement, change. Radiation is proportional to the rate at which the strength of the current is changing. The most practical way of making it keep on changing all the time is to use oscillating currents, which, of course, need oscillating voltages to drive them. The higher the freequency the faster they change. So the strength of radiation is proportional to:

(i) the peak or r.m.s. value, and

(ii) the frequency

of the current and voltage. (ii) is the reason why high frequencies are called radio frequencies, and why very low frequencies are no good for radio.

The radiation fields leave home and are independent of the parental currents and voltages the moment they are born, because of their mutual assistance pact. Another feature resulting from these circumstances is that their strength falls off only in proportion to their distance from the source, whereas the induction fields decrease as the *square* of the distance. So whereas the induction fields are relatively strong close to the source, they are negligible at distances over which the radiation fields can be used for communication.

As the two radiation fields are always equal, it doesn't matter which is used for specifying strength; but the electric field is nearly always chosen. If the field at any particular place is, say, 2 millivolts per metre, it means that each metre of receiving aerial wire parallel to the electric field at that place will have 2 millivolts induced in it.

At the sending end it is convenient to consider the radiation as being due to the current. A

**Aerials—**

given alternating current passing through 2in of wire radiates twice as much as the same current through 1 in. That doesn't necessarily mean that the field at any point outside will be twice as

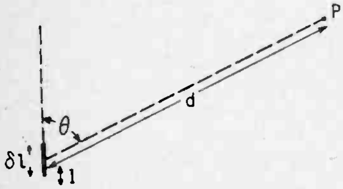



**Fig. 1. The various things that decide how strong the radiation from a short length ($\delta l$) of aerial will be at any point P.**

great. The whole of the 2 in can't be at exactly the same spot, and therefore the radiation from the different parts of it may have to travel slightly different distances and so not arrive in phase. If 2 in is negligible compared with the wavelength, this isn't worth quibbling about; but if the wavelength is, say, 10 centimetres, then 2 in. is about half a wavelength and the radiation from different parts of it will be considerably out of phase in some directions.

That is the basis of directional aerials; but before getting on to that important part of the subject, let us just finish listing the things radiation is proportional to. They can be put like this:

Field strength at any point P (see Fig. 1) is proportional to

$$\frac{I f \delta l \sin \theta}{d}$$

where

I = current flowing in the aerial. If the r.m.s. value is used, then the field strength will be r.m.s., too.

$f$ = frequency of I.

$\delta l$ = length of wire in which I is flowing. The $\delta$ indicates that the length must be very small compared with the wavelength. The question of how to reckon a whole aerial comes later.

$\theta$ = angle that $\delta l$ makes with the line joining $\delta l$ to P.

$d$ = distance of P from $\delta l$.

We have already dealt with all these factors except sin $\theta$. That comes in because field strength is one of those things known as vector quantities, which have direction as well as magnitude. The direction of the electric field is parallel to $\delta l$, and the magnetic field is at right angles to it. That goes for both induction and radiation fields, and as the fact that the magnetic field makes rings round the current is impressed on us in our electrical ABC it is easily remembered. Getting back to the electric field, however, it would make no difference, so far as P could tell, if $\delta l$ were replaced by two bits of wire (carrying the same current, I) at right angles to one another, as shown magnified in Fig. 2. Both bits radiate at right angles to themselves and so the bit end-on to P contributes nothing to P, whereas the other bit, $\delta l$ sin $\theta$ in length, radiates directly towards P, and therefore is the one included in the formula.

It need hardly be mentioned that $\delta l$ and P are assumed to be in empty space with nothing else anywhere near to complicate the problem. The inevitable complications, notably the earth, come later.

To calculate the actual field strength at P it is necessary to put into the formula some constants such as the inevitable $\pi$ and others depending on the units used. I don't think it is worth going into farther, because in practice actual field strengths are so much messed about by the earthly complications just alluded to that this one formula is seldom of much use. So far as the aerial

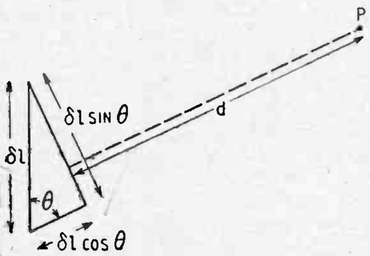



**Fig. 2. The radiation from $\delta l$ can be resolved into two parts, only one of which ($\delta l \sin \theta$) is any use to P.**

itself is concerned, one is not so much interested in the absolute field strength anywhere as in the relative strengths in different directions.

The best way of showing these is by a polar diagram, in which a line is drawn around a point that represents the position of the aerial, the distance of the line away from that point in any direction representing the relative radiation (or reception) in that direction. The polar diagram ought really to be a 3-dimensional model, to show all directions in space; but publishers are so unaccommodating in this matter that one has to be content with showing a single plane at a time.

For example, as the radiation from $\delta l$ is proportional to sin $\theta$ (Fig. 2) all we have to do to make

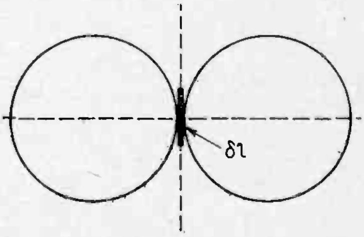



**Fig. 3. Polar diagram of a small section of aerial ($\delta l$) by itself, in the plane containing $\delta l$.**

the polar diagram for it is to take a good many values of $\theta$ and plot points along those directions at distances equal to sin $\theta$. The result of joining up the points (as a little geometry would indicate without the bother of actual plotting) is a "figure 8" consisting of two circles touching at the aerial position (Fig. 3). This indicates zero radiation end-on and maximum broadside-on, with maximum much less "sharp" than the zero. It is one cross-section of the polar model, which is like a doughnut (American pattern). The polar diagram in the plane at right angles to $\delta l$ is a circle with $\delta l$ as centre—$\delta l$ is omni-directional in that plane.

So far there has been a lot of emphasis on $\delta l$, considering that it is a figment of the imagination, quite unrealizable in practice. The current, I, can't just cease to exist after it has passed through $\delta l$. The time has come, then, to talk about whole aerials, in which the length is enough to provide capacitance paths for I to leave by, as suggested in Fig. 4. So far we have found how the radiation field around any very small bit of aerial is calculated. The field from the whole aerial is determined by adding up the contributions of each little bit, taking account of their phases and directions. For simple aerial shapes this isn't quite so hard as it may sound, but it does involve the integral calculus. When applied to a half-wave dipole aerial, which is one of the simplest kinds that forms a complete oscillating circuit by itself, and consists of a rod or wire half a wavelength long (less a small percentage for "end effect"), the resulting polar diagram is only slightly different from Fig. 3. The circles are a trifle elongated, as if the doughnut had been lightly sat on.

This dipole is not only very useful as a practical aerial; it is a good theoretical starting

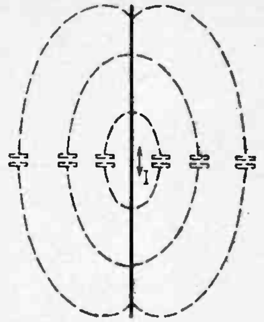


**Fig. 4. The current in a dipole is greatest at the centre and tapers off at the ends because of distributed capacitance, as suggested by the dotted lines.**

point for working out (next month) what more complicated aerials do.

## MANUFACTURERS' LITERATURE

ILLUSTRATED lists and technical data relating to "Variac" transformers and "Ceramite" embedded resistance units, from the Zenith Electric Co., Villiers Road, London, N.W.2.

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Descriptive leaflet dealing with the "Op-Timer" electronic process timer made by Process Control Gear, 56, Victoria Street, St. Albans, Herts.

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Illustrated leaflet giving particulars of interchangeable instrument panels and racks from Sound Sales, West Street, Farnham.

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Publication No. E.E.2 from Westinghouse Brake and Signal Co., Pew Hill House, Chippenham, Wilts, dealing with the frequency-compensated "Stabilistor" A.C. voltage stabiliser.

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Illustrated supplement (1946) to "Modern Soldering" giving notes on the selection of suitable alloys and gauges, from Multicore Solders, Ltd., Mellier House, Albemarle Street, London, W.1.

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# AUTO RADIOGRAMOPHONE

*Comprehensive Specification in R.G.D. Post-war Model*

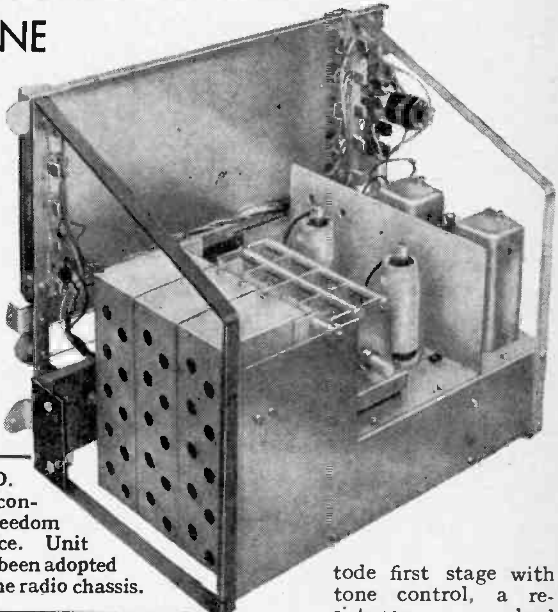
FROM a preliminary inspection of the details of the new Model 1046G there seems little doubt that it will worthily uphold the pre-war R.G.D. reputation for high quality radiogramophones. The radio chassis is of unusually clean design and all trimmers are readily accessible. Unit construction has been adopted and the R.F. coil unit and switch, I.F. coil unit, etc., can be removed separately for service.

In addition to the usual medium- and long-wave ranges there are three short-wave ranges covering 13.8 to 52 metres and a split rotor tuning condenser gives bandspread tuning on the short waves. The frequency changer is preceded by a tuned R.F. stage and followed by one stage of I.F. amplification with three degrees of selectivity. The triode section of the double diode triode second detector is used as a pre-amplifier for the gramophone pick-up. A "magic eye" tuning indicator is included.

The amplifier and power supply unit comprises a pentode first stage with tone control, a resistance coupled "concertina" phase splitter and two PP3/250 triodes in push-pull giving 8 watts with less than 3 per cent total harmonic distortion. The loudspeaker is a 12-inch duplex cone with a frequency response of 40-10,000 c/s.

On the gramophone side, the Garrard record changer is fitted with a new lightweight pick-up using a permanent sapphire stylus.

The price of the Model 1046G is £148 1s. plus £31 13s. 4d. purchase tax, and the makers are The Radio Gramophone Development Co., Bridgnorth, Shropshire.

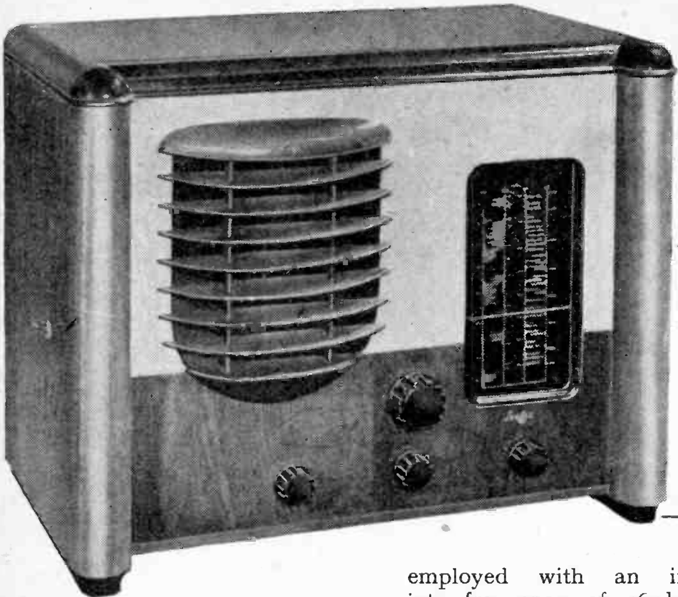


**The cabinet of the R.G.D. Model 1046G is of rigid construction to ensure freedom from bass resonance. Unit construction has been adopted in the design of the radio chassis.**

## Test Report

# SOBELL Type 615

## *A.C. Table Model Superhe*
## *(Five Valves + Rectifier)*



*WAVERANGES*

| | | |
|---|---|---|
| Short (1) | - | 11.2 to 25.2 metres |
| Short (2) | - | 24.8 to 53 ,, |
| Medium | - | 194 to 578 ,, |
| Long | - | 880 to 2,100 ,, |

*Price: £19 19s. plus £4 5s. 10d. tax*

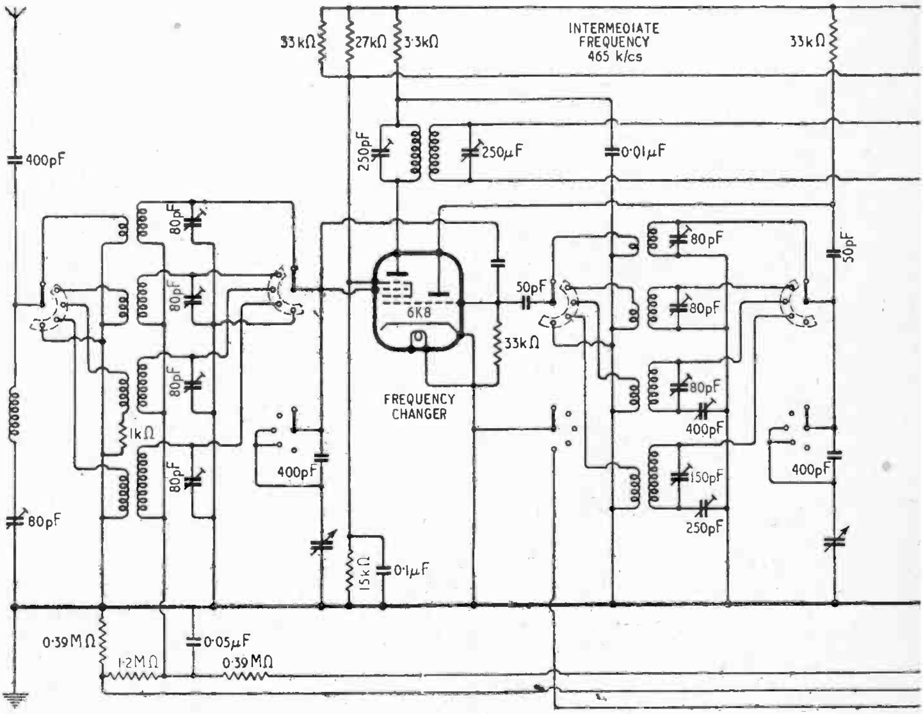
THE receiver is housed in an imposing looking cabinet which has this technical justification that the effective baffle area is increased and the quality of reproduction is decidedly above the average for a table model.

The set is backed by a comprehensive free maintenance scheme for two years. In the event of breakdown the fault will be remedied or the chassis changed on the spot by one of the maker's servicemen.

**Circuit.**—The frequency changer, which is neutralized, is coupled to the aerial by tuned coupling transformers with a damped high - inductance primary on medium waves. An I.F. rejector circuit is connected across aerial and earth. On the two short - wave bands fixed condensers are connected in series with both sections of the main tuning condenser to give an extended scale.

Two I.F. stages are employed with an intermediate frequency of 465 kc/s. A double-diode-triode follows the I.F. amplifiers and the A.V.C. diode is fed from the primary of the output I.F. transformer. The full A.V.C. voltage is applied to both I.F. valves, a fraction to the mixer stage and a smaller fraction to the first A.F. stage. Both tone and volume control is effected in the coupling between the signal diode and the grid of the first A.F. stage, and the values are chosen to give both bass and top lift automatically when volume is reduced.

A beam tetrode is used in the output stage with negative feedback from the secondary of the output transformer to the cathode of the preceding stage. The feed-

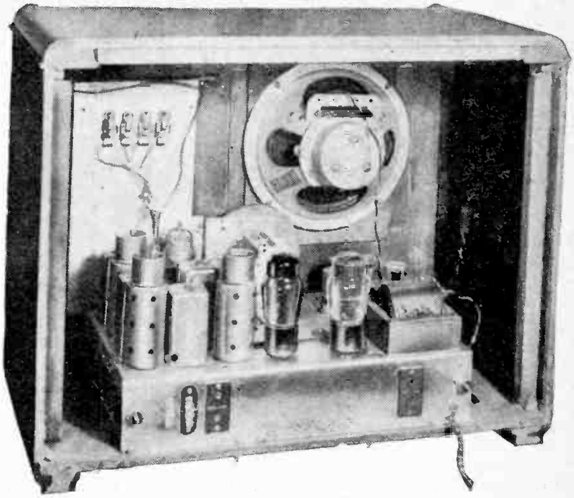



Complete circuit diagram. Two stages of I.F. amplification are provided and negative feedback is applied in the output stage.

back is increased when reproducing gramophone records.

Bias for the output stage, for the A.V.C. delay and the initial bias on the mixer and I.F. stages is derived from the volt drop in a resistor in the −H.T. return. Alternative values of initial bias give two degrees of sensitivity.

**Performance.**—The quality of reproduction at once creates a favourable impression. In keeping with the size of the set, it is "spacious" and does not appear to emanate from a point source, as in many table models. The lower register has breadth and an extended top response gives clarity and brightness without being shrill. The top cut available in the tone control is not as drastic as usual and it is virtually impossible to extract really muffled speech or music; there is just enough cut to deal with background noise on weak distant stations. However, the average listener will find all the entertainment he wants in the wide choice of stations above threshold level. With two I.F. stages there is no lack of sensitivity and the selectivity is exceptionally good. The division of the short-wave range into two parts gives a degree of band spread which makes for ease of tuning and both ranges provide a wide choice of stations. The sensitivity is well maintained at the high-frequency end.



**The loudspeaker is small, but the baffle area provided by the large cabinet gives "console" quality.**

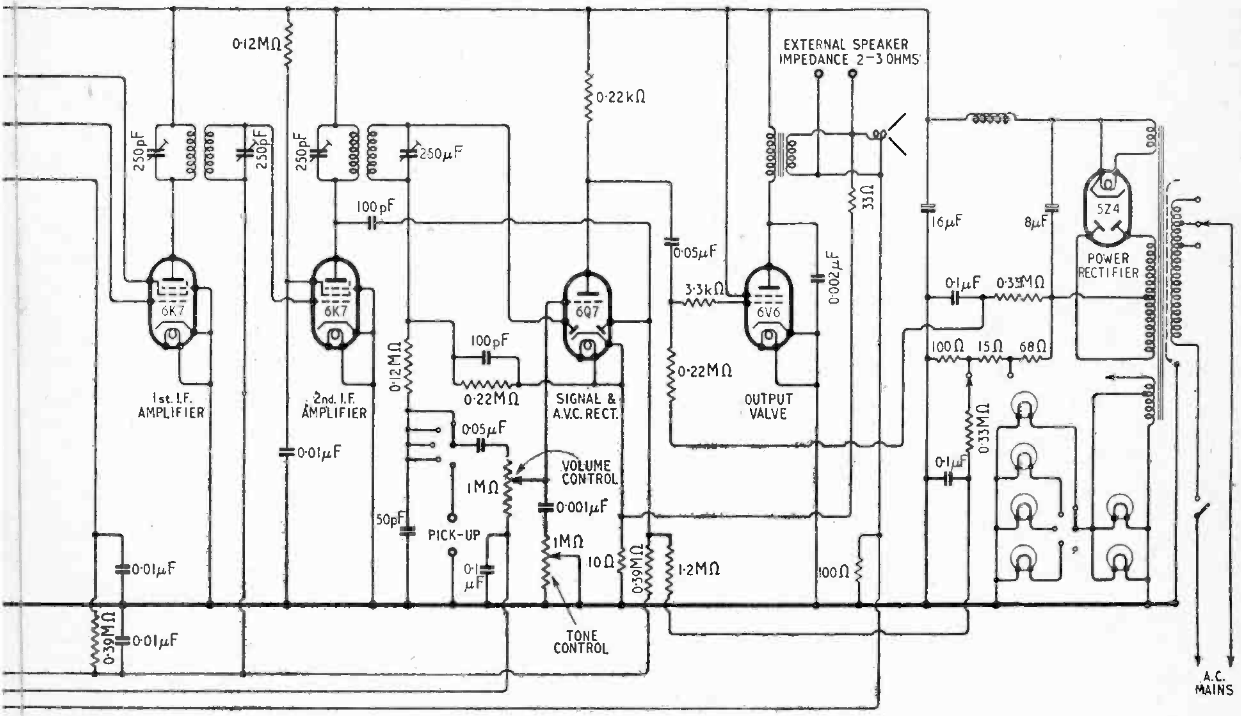
A few whistles are distributed throughout all waveranges, but are not likely to cause any trouble. The only one of any consequence was on long waves and well clear of any stations.

**Constructional Details.** — The chassis is of ample size and components are well spaced. Inspection of the underside can be carried out, without removing the chassis from the cabinet, by removing a panel from the base.

A two-speed tuning drive is provided and the scale length is 7 in.

The finish of the cabinet work is of a high order and the only criticism we have to offer is that the on-off switch on the left-hand side is rather prominent and might have been recessed.

**Makers.** — Sobell Industries, Ltd., Amersham, Bucks.



# WORLD OF WIRELESS

## DEATH OF BAIRD

IT is with deep regret that we have to record the death, on June 13th, of John Logie Baird at the age of 57. Baird died within a week of the post-war restarting of the British Television Service, for which he did so much to pave the way. His greatest contribution to television may be summed up in the words: "He was the first to make it work." His first real picture, with gradations of light and shade, was produced in 1926, though his earliest technical writings had appeared in *Wireless World* in 1924. Baird 30-line television was used experimentally by the B.B.C. in 1929.

## NEW PICTURE TRANSMITTER

A VERY high standard of definition is reached in the Muirhead-Jarvis picture transmission system recently demonstrated. The quality of the prints with 100 or 150 lines per inch is indistinguishable from the original without the aid of a magnifying glass.

Mechanically the transmitting and receiving mechanisms are similar and have interchangeable parts. The drum is 10 in long and has an effective circumference of 10⅜ in; it is driven by a phonic motor assisted by a D.C. motor. The picture to be transmitted is floodlit and elements are selected by means of an objective lens and fixed aperture; the reflected light is directed on a photocell. At the receiving end a Muirhead-Duddell oscillograph is arranged to form an image on the sensitized paper and tones are defined by the movement of the reflected beam over a shaped aperture.

A conventional scanning system is used except that the carriage is moved in discrete steps by means of a ratchet. This results in a reduction in the number of gears.

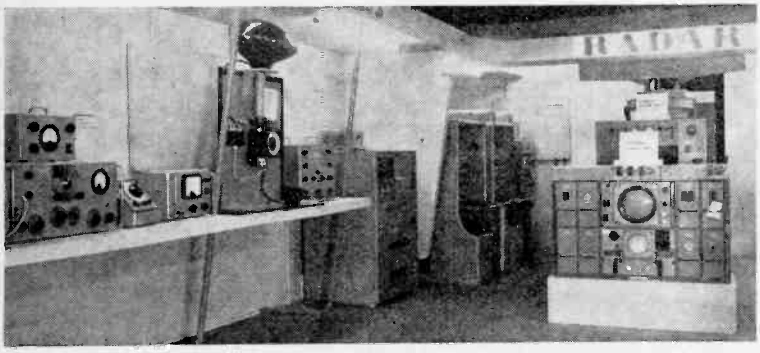
## NATIONAL HEARING AIDS

"A STATE production, a State monopoly," was the summary of Lord Walkden when announcing in the House of Lords the Government's scheme for the production and distribution of national hearing aids. He added: "We are not going to throw this invention over for exploitation."

This new aid, which was evolved by the Medical Research Council, with the assistance of the G.P.O. Research Station, will be supplied free to all who need it when the National Health Service comes into operation in 1948. Facilities for the servicing and maintenance of the hearing aid, including the provision of new batteries, will be provided.

It was stated by his Lordship that if the hearing aids are available before the National Health Service comes into operation they will cost about £10. In the meantime the Government "will do their best to make arrangements for the supply of hearing aids."

The Hearing Aid Manufacturers' Association takes exception to the Ministry of Health's all-embracing charges of commercial exploitation of the deaf, made earlier, and points out that in 1943 the Association co-operated with the National Institute for the Deaf to evolve a specification for a standard aid which would have sold at 10 guineas. Wartime shortages and lack of Government support to the scheme prevented it coming to fruition.




MARINE RADIO AND RADAR GEAR was displayed in great variety at a recent London exhibition arranged by the Marconi International Marine Communication Co., for the benefit of the delegates to the International Meeting on Radio Aids and Marine Navigation. Marconi Instruments—a subsidiary company—also displayed their products.

## LICENCE FEES

ANY ambiguity in the statement in the House on the introduction on June 1st of the increased charges for broadcast and television licences has been cleared by a G.P.O. statement.

The increased annual licence charges of £1 for "the reception of sound only" and £2 for "the reception of television and sound for domestic use" will not become payable by holders of the 10s broadcast receiving licence until their licence becomes due for renewal.

A television set may therefore be installed in a home without extra charge during the currency of an existing 10s licence, but when that licence expires the renewal charge will be £2.

A statement on the conditions applying to licences for other than domestic use is expected from the Postmaster-General shortly.

## PROVINCIAL TELEVISION

WHEN re-opening the London television service on June 7th the Earl of Listowel, Postmaster-General, stated that "preparations were now being made for the installation of a special cable to relay television programmes to Birmingham." On enquiry at the G.P.O. it was learned that this cable is in addition to the existing co-axial cable between London and Birmingham, which, although capable of being used for television, is now fully loaded by telephone traffic.

It must not be inferred from this statement that the possibility of employing a radio link has been abandoned, for it was learned on enquiry that experiments in this direction are still proceeding. The question of the best form of link, left open by the Advisory Committee, has not finally been decided.

## EMPIRE COMMUNICATIONS

CONCLUSIONS drawn by Cable and Wireless after a thorough study of the recently issued White Paper in which the Government has summarized the Bermuda agreement are:—

London's position as the principal centre of world telegraphic traffic may be endangered and the British taxpayer faced with heavy financial burdens as a consequence of the agreement concluded at Bermuda between the Empire and United States Governments. Britain's loss will be largely America's gain.

The financial loss to the British overseas telegraph services is estimated, on the basis of present traffic, to be in the region of £2,500,000 a year.

In an analysis of the major points in the agreement the company points out that the proposal to continue the direct circuits between the Empire and the U.S., introduced as a wartime measure, will deprive British interests of the revenue previously accruing from the circulation of the traffic via London. It is emphasized that tests have shown that traffic is not more expeditiously handled over the direct circuits.

It is also pointed out that the encouragement of the opening of direct circuits between the U.S. and Greece and Saudi Arabia, where C. & W. has developed the countries' external communications, will deprive the company—and its successor, the Government—of a reasonable return on the capital expended. The British taxpayer will have to carry the burden.

## CITIZENS' RADIO

SOME relaxation in the P.M.G.'s attitude towards the use of radio for communication purposes is foreshadowed by the reply to a recent enquiry at the G.P.O. regarding the use of walkie-talkie sets to control crowds at sports meetings. It is understood the P.M.G. *will* issue a licence for radio communication between two points in exceptional circumstances and is considering extending the facility to other users.

An official of the G.P.O. states that very high frequencies "above 25 Mc/s" will be allocated for any such service.

## R.A.F. RECRUITMENT

OWING to the length of training for many of the technical trades in the R.A.F., it is considered wasteful and uneconomical to use conscripts; a campaign has, therefore, been launched to recruit 100,000 N.C.O.s and men for regular service in technical ground trades by the end of this year.

In addition to the scheme for extended service for men still in the Forces, men from 17½ to 33 years of age are invited to make application for almost any one of the 100 ground trades, among which are R/T operator, wireless operator, radar mechanic and radar operator—listed in priority of importance.

Details of the scheme, which is open to skilled, semi-skilled, or in some cases unskilled men, are obtainable from the Inspector of Recruiting, Royal Air Force, Victory House, Kingsway, London, W.C.2, or from the R.A.F. Sections of the Combined Recruiting Centres.

Details of recruitment for the R.A.F. Reserve Command will be announced later.

## MERCHANT SHIP RADAR

THE Ministry of Transport has now published a booklet, "Radar for Merchant Ships," in which is included, as an appendix, the specification for a general-purpose marine radar set, which the Government hopes will be generally adopted by manufacturers.

It prescribes, among other matters, for a minimum range "at which accurate ranges can be obtained" of 300 yards, and that at which "a small object (e.g., a second-class buoy) ceases to be visible," 50 yards. The set must also give "a clear indication of coastlines at 20 miles when the ground rises to 200 feet" and at 7 miles when rising to 20 feet.

An amending slip is included in the booklet to bring the specification into line with decisions reached at the recent International Meeting on Radio Aids to Marine Navigation.

It is pointed out that radar sets which do not provide adequate safeguards may come within the scope of the existing measures preventing the use of instruments which will create added dangers at sea.

"Radar for Merchant Ships" has been edited by L. S. Harley, head of the Central Radio Bureau, and can be obtained from all branches of His Majesty's Stationery Office, or through booksellers, price 9d.

## AIRCRAFT RADIO

A MICROPHONE in the pilot's cabin and loudspeakers in the main compartment of the new Handley Page "Hermes" aircraft will enable the pilot to point out places of interest as the aircraft passes over them and also to issue any necessary instructions to the passengers. The microphone control equipment and 14-watt amplifier, which operates from the aircraft 24-volt D.C. supply, a rotary converter providing the H.T., are installed in the pilot's cabin.

For the purpose of relaying broadcast programmes to individual passengers without interfering with the comfort of others in the 'plane a small loudspeaker is fitted into the head-rest of each chair. Volume is adjusted individually from a control fitted in the arm of the chair.

The equipment has been specially designed for the "Hermes" by the G.E.C.

## INDIAN AMATEURS

IT is announced by the R.S.G.B. that, as a result of discussions between the Society and members resident in India, it is proposed to form a Radio Society of India. It is planned to operate the Society through Branch Managers, one for each of the main centres of activity.

Readers in India interested in the project are asked to communicate with J. S. Nicholson, VU2JP, Munnar P.O., Travancore, who is acting as organizer for the South, or J. McIntosh, VU2LJ, Doom Dooma P.O., Assam, organizer for the North.

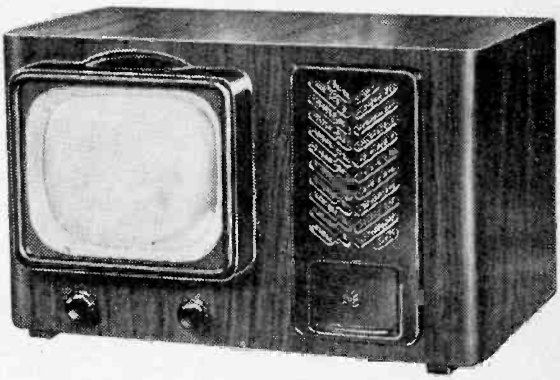
## *PERSONALITIES*

**Dr. C. C. Paterson, O.B.E., F.R.S.,** Director of the G.E.C. Research Laboratories, was created a Knight Bachelor in the Birthday Honours. He is a past president of the I.E.E.

Among those created Commanders of the Order of the British Empire in the Birthday Honours are:—**Prof. P. I. Dee, O.B.E.,** lately Superintendent, Telecommunications Research Establishment, M.A.P.; **J. Joseph,** Managing Director, Aeronautical and General Instruments; **Dr. W. B. Lewis, F.R.S.,** for services as Superintendent T.R.E.; **R. E. Relfe Luff,** Managing Director, Cable and Wireless; and **Dr. T. Walmsley,** Chief Radio Engineer, Air Ministry.

**Dr. R. H. Barfield** is relinquishing his appointment on the research staff of the National Physical Laboratory to join the research and development staff of Wild-Barfield Electric Furnaces.

**B. W. Beswick** and **C. H. Davis** have resigned from the staff of the Admiralty Signal Establishment, where they have supervised the production of Admiralty radar gear, in order to



**PYE Table Model television receiver with 9 in tube. The sound channel covers television sound only. The two panel controls are brilliance and sound volume. The occasional controls—contrast, focus, line and frame holds—are behind a sliding panel under the speaker grille. The price is £35, plus £7.17.3 purchase tax.**

**World of Wireless—**

devote their full time to the Dorland Electric Company, of which Mr. Davis is a director and technical adviser.

**Sydney S. Bird** has retired from the post of managing director of the company bearing his name, but is remaining on the board as technical adviser. He is succeeded by **S. E. C. Bird,** who has been works manager since the inception of the company.

**Dr. Percy Dunsheath, C.B.E.,** Director and Chief Engineer of W. T. Henley's Telegraph Works Company, has been elected by the London University Engineering Graduates to the University Senate for the period 1946-1950.

**A. H. Reeves** has taken up an important appointment with Standard Telecommunication Laboratories—the Standard Telephones research subsidiary. He joined the "Standard" organization in 1923 and was prominently associated with the 1931 micro-ray cross-channel two-way radio-telephony experiments between St. Margaret's Bay and Blanc Nez.

**Sir Henry Tizard, K.C.B., F.R.S.,** was the guest of honour at the 23rd Annual Dinner of the British Wireless Dinner Club, when **Major Gen. L. G. Phillips, C.B., C.B.E., M.C.,** was elected president, and **A. J. Gill,** vice-president.

## *OBITUARY*

It is with regret we record the death of **Admiral Sir Charles Kennedy-Purvis,** G.B.E., K.C.B., on May 26th, at the age of 62. Throughout his naval career, on which he entered as a cadet in 1899, rising to Deputy First Sea Lord, Sir Charles had always been closely associated with the wireless branch. In 1915 he was promoted Commander and transferred to the Signal School when that establishment took over wireless telegraphy from the Torpedo School. He was later promoted Captain and given command of the School for two years. From February, 1927, he was for three years Director of the Signal Division and was chairman of the I.E.E. Wireless Section in 1929-30.

## *IN BRIEF*

**972 Radio Officers** of the Marconi International Marine Communication Co. lost their lives during the war. This was made known by the chairman of the company at the annual meeting, when he also stated that 165 won decorations and awards for war service.

**B.B.C. Transmitters.**—East Anglia is to have a new broadcasting station. The B.B.C. is to erect a new transmitter at Postwick, some four miles east of Norwich. A site has also been secured for the erection of a new transmitter for the Edinburgh area.

**The Thames Chain** of Decca Navigator stations, with the master at Puckeridge, Herts, and slave stations near Norwich and Lewes, has been in operation experimentally for the past few weeks and will be working on a 24-hour schedule by the end of June.

**Civil Aviation.**—The meeting of the Special Radio Technical Division of P.I.C.A.O. (Provisional International Civil Aviation Organization) announced in our May issue to be held in Montreal on July 1st has been postponed. The demonstrations of gear in this country and the U.S. have also been postponed. They will now be given from September 9th-30th and early in October, respectively. The first meeting of the Radio Technical Division will be held immediately after the latter.

**Television Tax.**—Television receivers are chargeable with Purchase Tax at 33⅓ per cent of the wholesale price—the same as broadcast receivers and radiogramophones.

**Channel Islands.**—The G.P.O. has announced that the prefix GC will be used by amateurs in the Channel Islands.

**Soviet Amateurs** are again operating on 160, 40, 20, 14 and 10 metres. The amateurs' journal *Radio Front*, which ceased publication at the beginning of the Russo-German war, has resumed publication under the new title *Radio*. It is published by the Committee for Radiofication and Broadcasting.

**3,000,000** sets in the next five years is the target of the Soviet radio industry. Over 1,600 radio relay centres, serving nearly a million subscribers, have been put into operation in the Union since the end of the war.

**Import Duty** on radio equipment entering the Irish Free State has recently been revised. A duty of 75 per cent or £7 10s, whichever is the greater, is now charged on complete receivers. Other charges are:—Loudspeakers 15s and iron-cored transformers 7s 6d.

**B.S.R.A.**—It is announced in the latest Bulletin of the British Sound Recording Association that it is hoped to arrange for an exhibition of sound-recording gear in the autumn.

**Demonstrations** of the Valradio moving-coil pick-up used with the *Wireless World* Quality Amplifier are to be given each Monday at three, from July 1st, at Valradio, 57, Fortess Road, Kentish Town, London, N.W.5, in response to requests by readers, who are invited to bring test records.

**Export Enquiry.**—The Norwegian Co-operative organization wishes to hear from large-scale producers of British broadcast receivers and components. Address: Norges Kooperative Landsforening (Elektrisk avdeling) Rivierstredet 2, Oslo, Norway.

**Vidor Miniature.**—In the description of this set on page 160 of the May issue the H.T. voltage was given in error as 120. Actually a 67½-volt layer-built battery is employed. This receiver and the Vidor "Riviera" portable have been entered for the "Britain Can Make It" Exhibition.

**A New Drive** has been launched by the Waste Paper Recovery Association to raise an additional 100,000 tons of waste paper this year to alleviate the acute shortage of packing materials.

**"Front Line Radar"** is the title of a 40-page booklet by Sqn. Ldr. C. A. Martin which is a personal narrative of the R.A.F. Mobile Signals Units who were responsible for the operation of Eureka-H Beacons throughout the campaign in North-West Europe.

## *INDUSTRIAL NEWS*

**Addison Electric Co., Ltd.,** 163, Holland Park Avenue, London, W.11, has recently been formed to provide consultant services in electronics and telecommunications, and to undertake the design and development of instruments, radio components, prototypes, etc.

**B.T.H.**—A double jubilee was celebrated by the British Thomson-Houston Co. in May. It was in May, 1896, that the company was formed from the original London firm of Laing, Wharton and Down which started trading in 1886.

**Marine Radio Equipment** is now being manufactured by the Crampin Steam Fishing Company, of Fish Docks, Grimsby.

**Ekco.**—What seems to be the first post-war mains broadcast set with a built-in frame aerial has just been introduced by Ekco. It is a 3-valve (+rect.) superhet for A.C./D.C. of the compact semi-portable type and costs £13 13s, plus £2 18s 8d tax.

**Ferranti** broadcast and television receivers, hitherto distributed through radio wholesalers, will in future be distributed through a limited number of dealers appointed by district representatives.

**Linaglow** have moved to "Linaglow House," 34, Osnaburgh Street, London, N.W.1. Tel.: EUSton 8406/9.

**Philips Southport Works, Ltd.,** is the name given to a new company in the Philips group formed to operate a factory in the North of England which will produce machinery for valve and lamp manufacture.

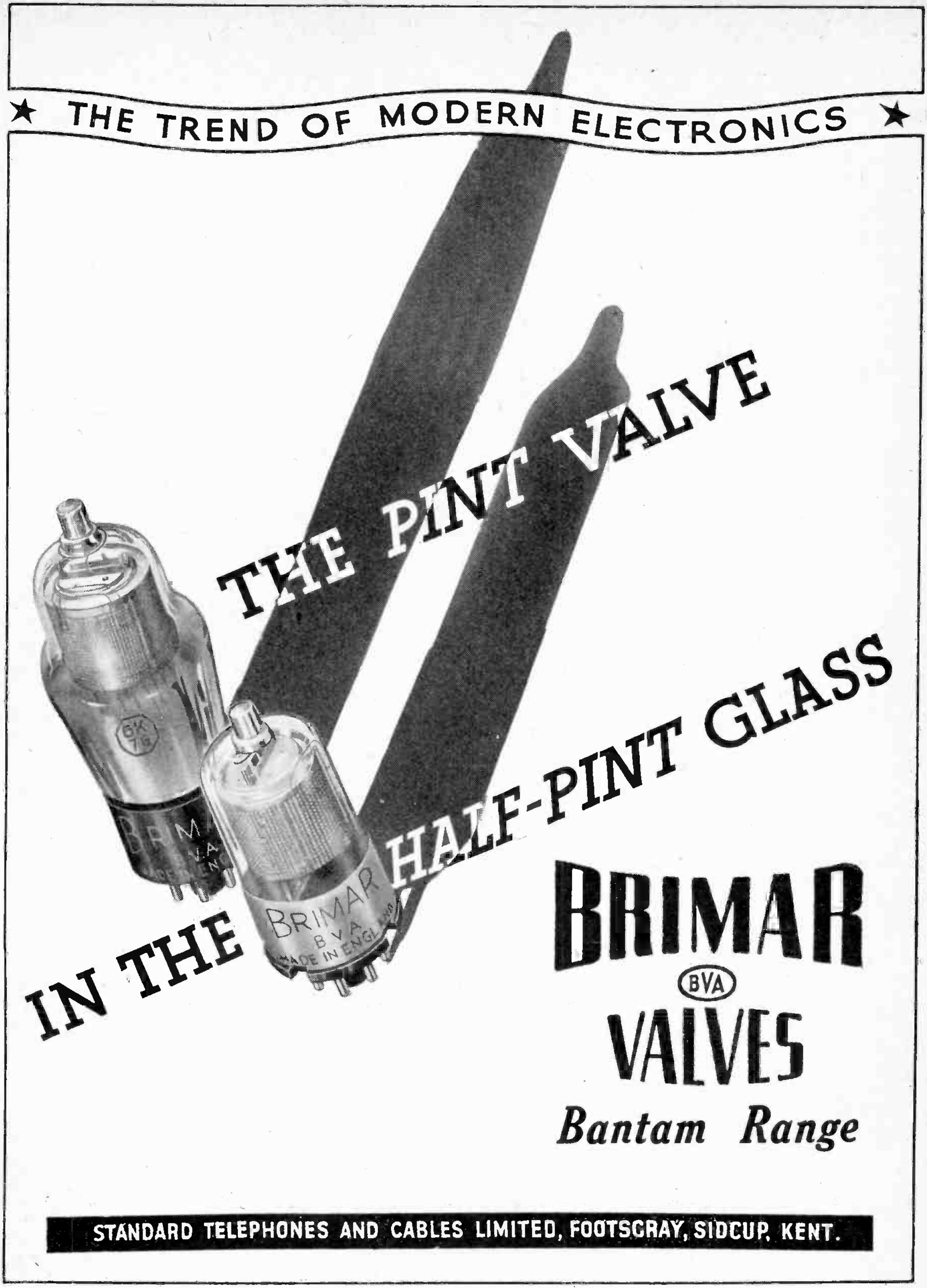
**Westinghouse Brake and Signal Co.** announces that the Commercial Branches of the Company, which were evacuated to Pew Hill House, Chippenham, Wilts, are returning to London. On and after June 29th all correspondence should be addressed to 82, York Way, London, N.1. Tel.: TERminus 6432.

## *CLUBS*

**Bradford.**—Meetings are held each Monday at 7.30 in the Temperance Rooms, Harewood Street, of the re-formed Bradford Short-Wave Club. Negotiations are being made for premises for the erection of the Club's transmitter (G3NN). V. W. Sowen (G2BYC), of 6, West View, Eldwick, Bingley, Yorks, is secretary.

**Manchester.**—A meeting of the pre-war North Manchester Radio and Television Society is to be held in the Stand Grammar School for Girls, Higher Lane, Whitefield, on Monday, July 8th, at 8, to discuss the future of the Society.

**Stourbridge.**—Future meetings of the Stourbridge and District Radio Society will be held on the first Tuesday of each month in the Lecture Room, King Edward's Grammar School, Stourbridge, at 8. D. Rock (G8PR), "Sandhurst," Vicarage Road, Amblecote, Stourbridge, Worcs, is Hon. Sec. of the Society, which has succeeded the pre-war Stourbridge and Dudley Radio Society.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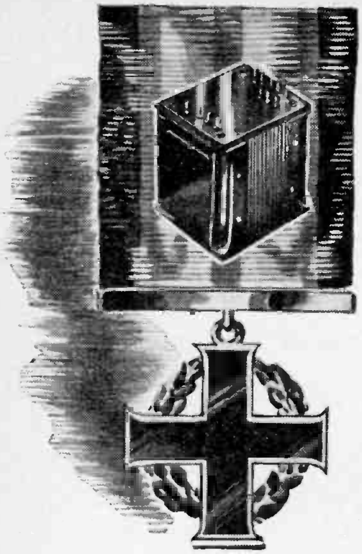

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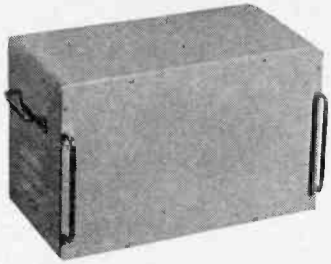

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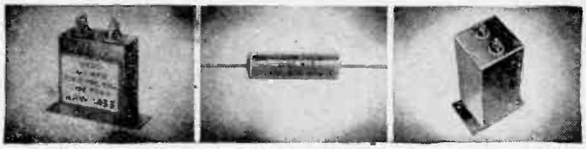


## Design Data (6)

# DIFFERENTIATING CIRCUIT

## *Choosing Component Values*

THE usual analysis of a differentiating circuit is based on the assumption that the input wave is truly rectangular. This leads to the conclusion that the output wave has the same peak amplitude as the input whatever the circuit values. Very little practical experience is needed to assure one that this is not true and that the output amplitude does depend on the values assigned to the components to quite a marked degree.

The reason is that the input never is rectangular but takes a finite time to change its amplitude. The way in which it varies differs in different cases, and it is impracticable to cover all the possibilities. The most useful assumption is that the input to the differentiator is of exponential shape; it is a rectangular wave previously distorted by passing it through an integrating-type circuit of time constant $T_1$. The performance of a differentiator with such an input has been dealt with by G. P. Ohman in *Electronics* for August, 1945, and the curves given here are reproduced from this paper.

It is convenient to relate the exponential input to the frequency response of the preceding circuits by the somewhat arbitrary method of assuming that this frequency response is obtained by a single R.C. circuit. In general, this is not true, but it does enable one to obtain some sort of correlation between frequency response and the input waveshape to the differentiator. The response of an R.C. circuit is $-3$ db when $\omega T_1 = 1$; therefore, on this basis $T_1 = 1/\omega$ where $\omega = 6.28$ times the maximum input frequency.

As an example of the use of the data consider the design of a differentiator for television line synchronizing pulses. These have a duration of 10 $\mu$sec, and the input frequency response will be taken as 2.5 Mc/s for $-3$ db. Therefore, $T_1 = 1/6.28 \times 2.5 = 0.0636$ $\mu$sec.

It will usually be required that the output of the differentiator be negligible compared with the input at the end of the pulse. In this case, therefore, $t_2$ can be taken as the input pulse duration of 10 $\mu$sec, and $t_2/T_1 = 157$.

From Fig. 3, $T_1/T_2 = 0.03$ about, for an output of 1 per cent at $t_2$; hence $T_2 = 0.0636/0.03 = 2.12$ $\mu$sec. From Fig. 4 $\eta_2 = 0.9$, $t_1/T_2 = 3.6$, hence the maximum output occurs at $t_1 = 3.6 \times 0.0636 = 0.228$ $\mu$sec after the onset of the pulse.

If R = 0.05 M$\Omega$, then $(C_1 + C_2) = 2.12/0.05 = 42.4$ pF, and if $C_2 = 10$ pF, $C_1 = 32.4$ pF. Then $\eta_1 = 0.766$ and so $\eta = 0.69$.

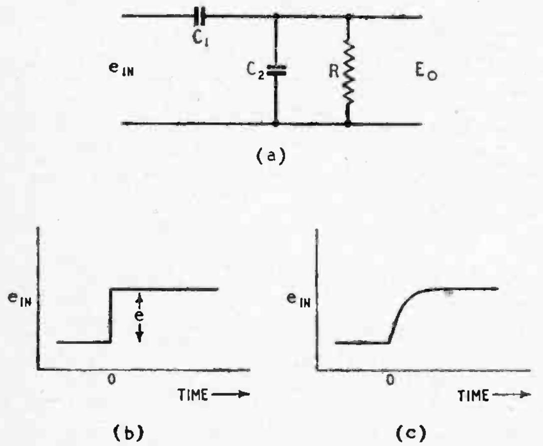



Fig. 1. A differentiator is shown at (*a*), with a step input voltage wave at (*b*) and an exponential wave at (*c*).

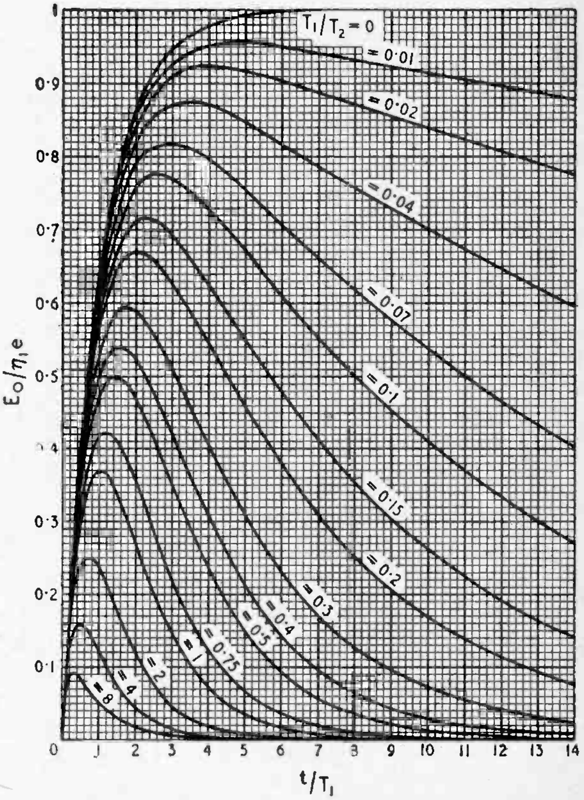



**Fig. 2. These curves show the output waveform for an exponential input wave; $T_1$ denotes the characteristics of the input and $T_2$ that of the differentiator itself.**

**Differentiating Circuit—**

For television purposes, it is not usually necessary for the response at the end of the pulse to be as low as 1 per cent, and a somewhat higher value is usually tolerable. The more or less standard values for a differentiator are $C_1 = 50$ pF and $R = 50$ k$\Omega$. With $C_2 = 10$ pF, $T_2 = 3$ $\mu$sec, and so $T_1/T_2 = 0.0212$. From the curves we then have, $t_2/T_1 = 220$, $t_1/T_1 = 3{\cdot}9$, and $\eta_2 = 0.92$, while $\eta_1 = 5/6 = 0.835$. Therefore, $\eta = 0.75$, $t_1 = 0.25$ $\mu$sec, and $t_2 = 14$ $\mu$sec.

The curves of Fig. 2 enable the performance at any other time to be determined. Thus, continuing this last example, suppose that it is required to find out how long after the onset of the pulse a time-base will trigger when fed directly from the differentiator if it requires 2 volts to trigger it and the input pulse is of 10 volts amplitude.

As $\eta = 0.75$, the peak output amplitude is 7.5 volts. The curve in Fig. 2 for $T_1/T_2 = 0.0212$ is used. We require 2 volts output, so that the fraction of the maximum is $2/7.5 = 0.266$. The maximum is 0.9 on the $E_0/\eta_1 e$ scale, so the triggering voltage will be obtained at $0.266 \times 0.9 = 0.24$, which corresponds to $t/T_1 = 0.25$, about, or $t = 0.016$ $\mu$sec. For most purposes this delay is negligible.

## Design Data (6) : Differentiating Circuit

A step-wave, Fig. 1 (*b*), of amplitude *e* is passed through an R.C. circuit of the integrating type having a time constant $T_1$, which modifies the wave to the exponential form Fig. 1 (*c*). This wave is $e_{in} = e(1 - \epsilon^{-t/T_1})$ and is applied in its turn to the differentiating circuit Fig. 1 (*a*). The output is

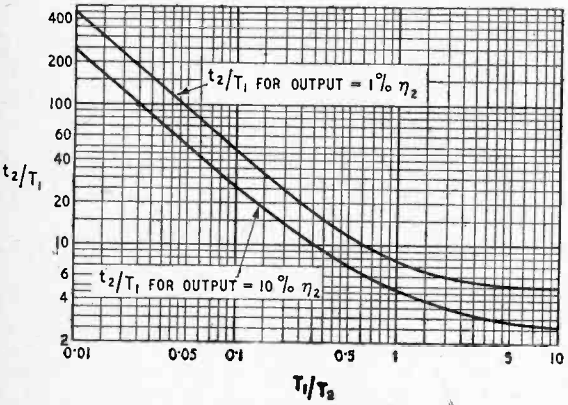



Fig. 3. These curves enable circuit values to be related to the percentage of the voltage remaining at the output at time $t_2$ after the onset of a pulse.

$$E_0 = e\,\frac{C_1}{C_1 + C_2}\cdot\frac{(\epsilon^{-t/T_1} - \epsilon^{-t/R(C_1+C_2)})}{\dfrac{T_1}{R(C_1 + C_2)} - 1} \quad \cdots \quad (1)$$

writing $\eta_1 = \dfrac{C_1}{C_1 + C_2}$

$T_2 = R(C_1 + C_2)$

this reduces to

$$\frac{E_0}{\eta_1 e} = \frac{\epsilon^{-t/T_1} - \epsilon^{-t/T_2}}{T_1/T_2 - 1} \quad \cdots \quad (2)$$

For design purposes this is most conveniently expressed as a family of curves relating $t/T_1$ and

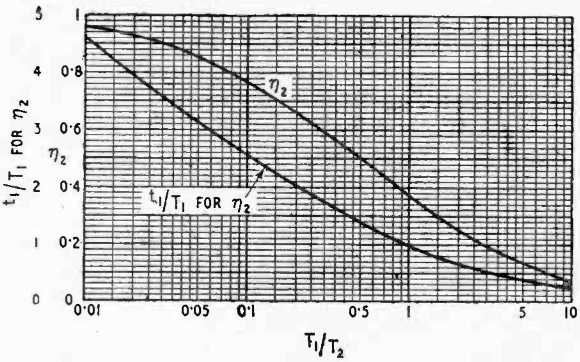



Fig. 4. The maximum values of the output pulses, $\eta_2$, and the time $t_1$ of the output maximum are correlated with circuit values.

$E_0/\eta_1 e$ for a series of values of $T_1/T_2$, and these are given in Fig. 2. The further derived curves of Figs. 3 and 4 enable component values to be determined.

### *Symbols*

$T_1$ = $1/6.28f$ (Mc/s ; $\mu$ sec) where $f$ is the frequency at which the overall response of the circuits preceding the differentiator is $-$ 3 db.

$T_2$ = $R(C_1 + C_2)$ (pF ; M$\Omega$)

$t_1$ = time interval between the onset of the pulse and maximum output ($\mu$sec).

$t_2$ = time interval between the onset of the pulse and the end, the latter being the time when the output has fallen to a negligible quantity ($\mu$sec).

$\eta_1$ = $C_1/(C_1 + C_2)$ = efficiency factor due to $C_2$.

$\eta_2$ = ratio of maximum output to the output with a square input wave, ignoring $C_2$.

$\eta$ = $\eta_1\eta_2$ = ratio of maximum output to input.

### *Procedure*

In general, $T_1$, $t_2$, $C_2$ and R are known and it is required to find $C_1$. Then :—

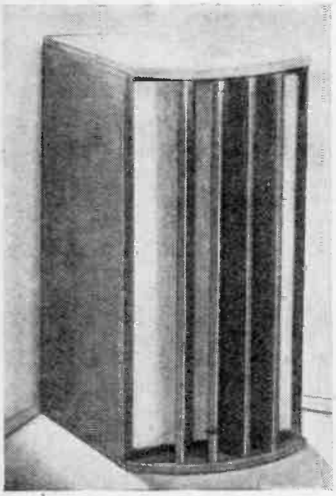
1. Evaluate $t_2/T_1$, and determine $T_1/T_2$ from Fig. 3 for the required maximum permissible output at $t_2$.

2. $C_1 = \dfrac{(T_1/T_2)}{T_1 R} - C_2$.

3. Determine $\eta_2$ from Fig. 4 ; $\eta_1 = C_1/(C_1 + C_2)$ and $\eta = \eta_1\eta_2$.

4. Determine $t_1/T_1$ from Fig. 4 ; $t_1 = T_1\,(t_1/T_1)$.

# Phase Inversion



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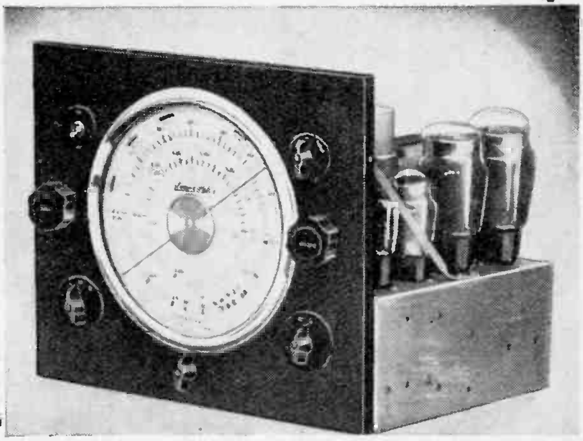

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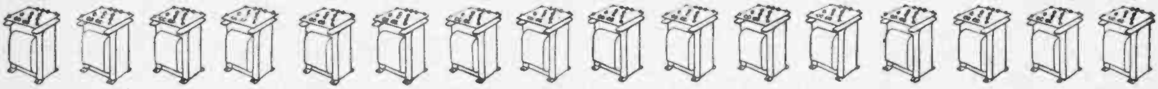

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## TRANSFORMERS & CHOKES

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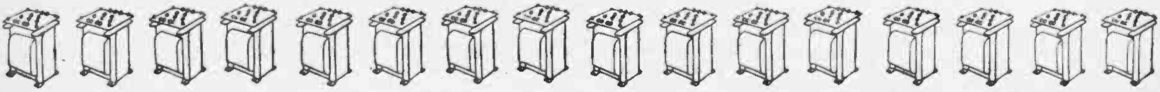


# CONSOL

## Beacon Direction Finding System of High Accuracy

By JOHN E. CLEGG,
M.Sc.Tech., A.M.I.E.E.

CONSOL is the name used in England to describe a radio aid to long-range navigation originally developed by the Germans and first used by them in 1941. The Germans called the system "Sonne" meaning "Sun." This name was presumably used because of the resemblance of the radiation pattern of the beacon to the rays of the sun. So far as the author is aware there is nothing significant in the word Consol.

There were three component parts in the system:

(i) One or more ground transmitting stations (beacons);
(ii) A radio receiver 260 kc/s to 420 kc/s (in the aircraft);
(iii) Maps, charts or tables of bearings (in the aircraft).

The Germans erected beacons extensively to provide overland cover over Europe. They also erected beacons on the western coastline of Europe at places such as Brest, Stavanger and the Lofoten Isles to give navigational assistance in the Atlantic to their long-range aircraft and U-boats. Most of these beacons have been destroyed except the one at Stavanger (319 kc/s) which has been kept in continuous operation. There are also two beacons in Spain, at Seville (311 kc/s), and Lugo (303 kc/s), but their operation is irregular. The U.K. has erected a beacon in Northern Ireland, which is of British manufacture and which incorporates detailed improvements over the German beacons. This beacon is expected to be on the air for testing very shortly on a frequency of 263 kc/s.

**The System.**—Consol has inherited many of its features from pre-war radio navigational aids. For instance, it uses a beam identified by dots and dashes as in Lorenz or S.B.A. It also bears some resemblance to the American Radio Range except that the beams are not fixed but rotating. The word "beam" is here used to describe the equisignal zone produced by the intersection of two overlapping lobes of a radiation pattern as in Fig. 1.

The bearing of an aircraft from the ground station is obtained by making use of the directional properties of a ground station aerial system as in ground station direction finding. However, in the Consol system the transmission is made from this directional aerial

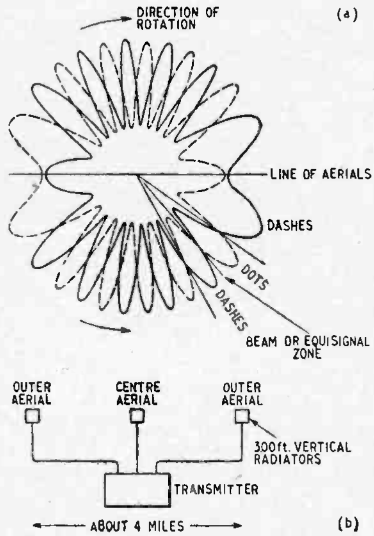



Fig. 1. (a) Polar diagram and (b) plan of Consol aerial system.

to the aircraft and only a receiver is necessary in the aircraft. Consol compares favourably with the best medium-frequency Adcock D.F. in accuracy and additionally has three important advantages. First, it is more convenient and economical to generate on the ground the powerful signals required for long-range working, especially at low frequencies where high aerials are required for good efficiency. Second, the system can serve an unlimited number of aircraft at the same time. Third, only a one-way circuit is required instead of the two-way circuit required for ground D.F. where an operator measures the aircraft's bearing on the ground and transmits it to the aircraft.

**Operating Frequency.**—Consol beacons operate on low frequencies between 260 and 420 kc/s in order to obtain long distance coverage by day and night over land and sea. Except in the tropics, the reliable range of a Consol beacon is 1,000 miles by day when the path lies over the sea. When the path is entirely over land the reliable daylight range is 600 miles. At night the range is greater and not less than 1,500 miles over land and sea. These figures are based on the use of a transmitter delivering an output of 2 kilowatts to aerials 300 feet high. The precise ranges obtained depend also on the nature of the transmitting site, on the goodness of the aircraft receiver, and on the severity of interference.

In the tropics it is expected that the range will be considerably reduced by the high noise levels often experienced in these regions.

**The Beacon.**—This consists of a conventional low-frequency transmitter producing an unmodulated output of 2 kilowatts. This is fed into a phasing unit which is of about the same physical size as the transmitter itself. The aerials consist of three vertical radiators 300ft high which are arranged in line about two miles apart. This represents a spacing of three wavelengths. Four times as much power is fed into the centre aerial as into each of the outer aerials. Initially the phases of the currents in the outer aerials are arranged so that one leads and the other lags on the centre aerial by 90 degrees. This produces a variation in field strength as one moves around the aerial, as

**Consol—**

shown by the solid line of Fig. 1. If now the direction of current in the outer aerials is reversed the diagram will reverse, as shown by the dotted diagram in Fig. 1. The direction of current in the outer aerial is reversed in dot-dash rhythm and this produces 24 equisignal zones or beams along the directions of equal signal strengths from the two diagrams (see Fig. 1.).

There is a resemblance here to the Radio Range except that there are 24 courses instead of four. However, this is as far as the resemblance goes, for a clever artifice is introduced which causes the beams to rotate slowly. In one minute the beams each move steadily through one whole sector during which time the outer aerials are keyed 60 times. During the next minute the centre aerial only is fed and the current is removed from the outer aerials to dummy load resistances and the system returns to its normal state. The process is then repeated. This rotation of the beams is produced by a goniometer which advances the phase of the current in one outer aerial and at the same time retards the phase of the outer aerial.

During the interval in which the system is returning to its original state an identification signal is radiated in morse characters.

**The Airborne Receiver.**—One of the great advantages of this system is that no special equipment is required in the aircraft. The normal receiver which is found on all long-range aircraft will receive the signals satisfactorily. The transmission is unmodulated and a beat oscillator is used to produce the heterodyne beat note as for C.W. morse reception.

Although a normal receiver can be used, improved results and longer range in bad conditions can be obtained by using a receiver with a very narrow bandwidth to improve the signal-to-noise ratio. A bandwidth of 200 c/s is amply wide enough to pass without distortion the keying of the transmitter. The best performance is obtained by limiting the bandwidth before the final detector, but some improvement can be obtained by the use of a simple note filter tuned to 1,000 c/s. The system also lends itself readily to the use of an automatic recorder though this is not yet normal practice. This will enable the navigator to be dispensed with in some circumstances, and will enable higher accuracy to be obtained when fading is causing variations in the counts.

**Maps, Charts and Keys.**—A key is made relating the character counts to bearing at the beacon. This is done from a knowledge of the dimensions of the aerial system and its geographical position. A portion of a typical key is shown in Fig. 2 (b).

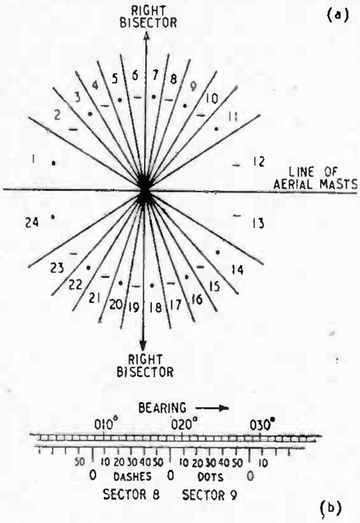



**Fig. 2. (a) Sector diagram for Consol and (b) part of a typical key for use by the navigator.**

Radio waves travel along great circle paths, and the simplest type of chart to use is one on which great circles are straight lines. Gnomonic projection has this property and bearings can be marked on the map or chart directly as straight lines emanating from the beacon. Bearings may also, for all practical purposes, be drawn as straight lines on the international modified polyconic maps. The Germans used Mercator's Charts overprinted with curves of constant bearing, calibrated in dot and dash counts.

For practical purposes, particularly over the longer distances, it is usually more satisfactory to transfer a position line from a special over-printed chart, rather than to plot directly from the station.

**Operating Technique.** — The equisignal or beam swings through a sector of about 10 degrees in one minute, during which time 60 characters are radiated. Signals in odd sectors will start with dots and in even sectors with dashes, as shown in Fig. 2 (a). An operator listening in a dot sector hears a certain number of dots followed by a brief interval of steady tone as the beam sweeps past him and the signal changes slowly and smoothly from dots to dashes. The cycle is completed by the number of dashes required to make up the 60 characters. The operator determines his position in the sector by counting the number of dots (or dashes in a dash sector) which elapse before the beam sweeps past him. He can normally judge this to one character and thus determine his bearing to 1/6th degree.

In the absence of interference the procedure is quite simple. When conditions are difficult the beam or equisignal interval may have a duration of several seconds and then the centre of the beam can be estimated by noting the last recognizable dot (or dash, depending on the sector), and then, keeping to the same rhythm, continuing to count through the beam to the first recognizable dash. The mean of these two counts gives the centre of the beam. For example, 12 clear dots may be heard, followed by, say, four seconds of steady tone, during which time the operator would have continued counting up to the 17th character, which would be recognized as a dash. The centre of the beam would therefore be $14\frac{1}{2}$ dots.

**Ambiguities.**—It will be obvious that there are ambiguities in the system. There are 12-dot sectors and 12-dash sectors, and therefore there are 12 possible bearings corresponding to any one count. By changing the spacing of the aerials (which, for the present case of 24 sectors, is three wavelengths) the number of sectors can be altered. Twenty-four has been chosen as a compromise between accuracy and multiplicity of ambiguities. There should not be difficulty in deciding in which sector one is, when it is considered that the range of the beacon is at least 600 miles. At this range the nearest ambiguous position line will be 20 degrees, or 200 miles away (except in the sectors adjacent to the line of the aerials). It is sometimes recommended that the sector be identified by a loop bearing, but this is seldom necessary.

**Accuracy.**—The sectors lying near to the right bisector of the line of aerials are about 10 degrees wide and these are the most useful sectors. Those lying close to the line of the aerials are wider. The four sectors adjacent to the line of the aerials, numbers 1, 11, 12 and 24 are not normally used because of low accuracy and ambiguities. The beacons will therefore be sited so that the good sectors lie in the direction where good coverage is most important.

During daylight the accuracy of the system is high and in the sectors at right angles to the line of the aerials the accuracy is 0.3 degrees. The accuracy falls to 1 degree in the sectors adjacent to the line of the aerials. At night the situation is complex. Errors are very small in those sectors (5, 6, 17 and 18) adjacent to the right bisector of the line of the aerials, i.e., less than 1 degree. As the angle between the bearing and the right bisector increases the bearing becomes less reliable. It is inadvisable to use sectors 1, 2, 10, 11, 12, 13, 23 and 24 at night at distances beyond 200 miles.

Night errors are, of course, due to sky-wave propagation. This has two distinct effects. A systematic error and a random variation of bearing are produced. The systematic error is always such as to swing the beam towards the right bisector. The sky waves leave the transmitting aerial at an angle inclined to the horizontal so that the path difference between the radiation from the two outer aerials is less than is the case with ground waves which leave horizontally. Thus the waves appear to have left at a smaller angle to the right bisector than they actually have. The effect is zero along the right bisector and hence the performance is good in this direction. The magnitude of this systematic error is also a function of distance from the beacon. Out to 150 miles where the ground wave predominates the error is negligible. As the sky wave begins to overpower the ground ray the error increases rapidly to a maximum value at about 300 miles. Beyond this distance the error decreases slowly because now although the signals are entirely due to sky waves the angle at which the waves have left the beacon decreases. Contour charts showing the error as a function of bearing and distance can be produced and their intelligent use will increase the accuracy of the system at night.

Besides the systematic error there is a random variation of bearing due to interference phenomena between the ground wave and the sky wave and between one sky wave and another. The magnitude of this variation is also a function of bearing and distance as with the systematic error. This error can obviously be reduced by taking a number of readings and finding the mean. Observations made by the author indicate that when, owing to abnormal ionospheric conditions, the variation between counts is high the systematic error is also high and, in fact, is approximately equal to the maximum variation between counts. The systematic error determined in this way can then be subtracted from the main reading to give the true reading.

The introduction of automatic recorders, as mentioned earlier, will do much to improve the accuracy when using sky waves.

**Conclusion.**—The Consol system whilst being far from perfect yet represents a great improvement over pre-war aids such as medium frequency direction finding. During daylight the accuracy and coverage are very good. The accuracy is of the order of 0.5 degree, the range about 1,000 miles and the angular coverage about 300 degrees. At night time the accuracy decreases to 1 to 3 degrees, the range increases to 1,500 miles but the useful angular coverage decreases to about 150 degrees.

# A.C./D.C. VOLTAGE DROPPING

## *Danger of a Common H.T.—L.T. Resistor*

MANY of the smaller A.C./D.C. sets of American origin are designed for 115-volt mains and require modification for use on the 230-volt supplies of this country. This modification usually takes the form of an additional length of "line-cord" or other resistor to drop 115 volts, and is quite satisfactory for direct-current mains.

It is not always realized, however, that this practice is open to serious technical objection in the case of an A.C. supply, and that the performance of the set may be seriously affected. This arises because the rectifier does not draw current continuously, but only on the tips of the positive half-cycles. As a result, the voltage drop in a series resistor is greater for the H.T. than for the heater supply. When the resistor is adjusted to provide the correct heater current, the H.T. voltage is below normal.

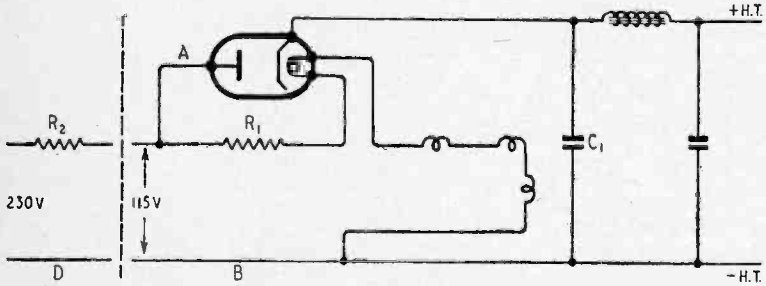



**Fig. 1. The basic circuit of a typical A.C./D.C. set is shown here with a conventional extra voltage-dropper to the left of the dotted line**

The basic circuit of a typical A.C./D.C. set is shown to the right of the dotted line in Fig. 1. The leads A and B together with the resistance $R_1$, are usually in the form of a "line-cord." On the 115-volt supply for which the set is designed, $R_1$ is in the heater circuit only, and its value does not affect the H.T. The value of $R_1$ in ohms is equal to the mains voltage less the total heater voltage, divided by the heater current in amperes.

For a 230-volt supply, the resistance $R_2$ is often added, and in many cases it takes the form of an additional two-way line-cord comprising the lead D and the resistance element $R_2$. This resistance carries the H.T. current as well as the heater current, and this must be taken into account when determining its value.

### D.C. Conditions

For a D.C. supply of 230 volts there must be a drop of 115 volts across $R_2$. The rectifier is conducting all the time on direct current, so that its input current is the same as the H.T. current, perhaps 60 mA. The heater current depends on the valves used, and in many of the newer sets is as low as 150 mA. The total current is merely the sum of the two, or 210 mA, so that

$R_2 = 115/0.21 = 550$ ohms.

There is no difficulty here; but now consider the case of an A.C. supply. The rectifier no longer conducts all the time but only when the instantaneous voltage between A and B is more positive than the voltage across the reservoir capacitance $C_1$. The receiver draws current continuously, and when the rectifier is not conducting it is supplied by $C_1$. The valve has to supply during each short conducting interval a quantity of electricity equal to that delivered to the set during each non-conducting interval plus each conducting interval.

On a 50-c/s supply, the latter period is 0.02 sec; the conducting interval may be no more than one-fifth of this, or 0.004 sec. If the current drawn by the valve were constant throughout this conducting interval, it would be five times as great as the mean output current. In practice it is not constant, and the result is that the peak current in the valve can be ten times the mean H.T. current or even more. If the set draws 60 mA for H.T., the peak rectifier current may be 0.6 A or more.

### Rectifier Current

It is clear that this is going to cause difficulty in voltage dropping. During some four-fifths of the time the rectifier is non-conductive and the heater current is the only current through $R_2$. When the rectifier conducts, however, its current also passes through $R_2$, and its maximum value may be much higher than the heater current. The voltage drop across $R_2$ is thus much greater when the valve is conducting than when it is not.

The set is designed for a peak voltage of $115 \times \sqrt{2}$ between A and B and the correct H.T. voltage will be obtained only when this is secured. The value of $R_2$ needed for this is the peak voltage across $R_2$ ($= 115 \times \sqrt{2}$) divided by the total peak current, which is the peak heater current plus the peak valve current. If the latter is 0.6 A, and the valves take 0.15 A R.M.S., the total peak current is 0.812 A, and

$R_2 = 212/0.812 = 260$ ohms.

Such a value cannot be used, however, because the heater current would be excessive. During the greater part of the time the rectifier is non-conductive and only the heater current flows through $R_2$. The value needed during this time is

$115/0.15 = 765$ ohms.

If $R_2$ is adjusted so that the heater current is correct, as measured by a thermal instrument, its value will be less than 765 ohms but much greater than 260 ohms. The peak input voltage to the rectifier will be below the correct value, and as a result the output voltage and current will be low. The performance of the set will consequently be affected. The H.T. voltage may well drop from a normal 110 volts to 80 volts—a large percentage change. The magnitude of the effect depends on many factors. The most important is the relation of the H.T. current to the heater current, and it decreases as this ratio becomes less. Unfortunately the tendency is for the ratio to increase. The total H.T. current of modern sets is higher than in the older ones, and 0.15-A heater valves are used in place of the older 0.3 A. For this reason a voltage-dropping scheme which was practicable, if not good, with older sets is now becoming useless.

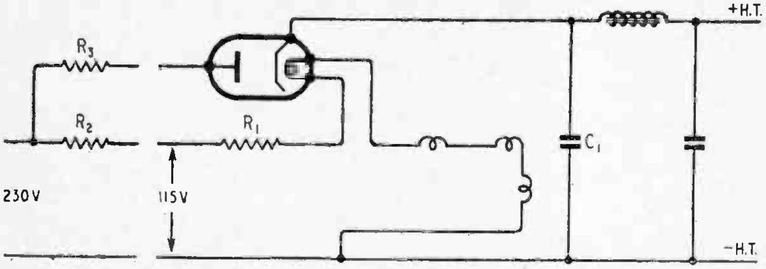


Fig. 2. Separate extra dropping resistors $R_2$ and $R_3$ are needed for the L.T. and H.T circuits if normal operation is to be secured.

The capacitance of $C_1$ also has an effect, and the modern tendency towards the use of very large values is detrimental. The larger the value of $C_1$, the shorter is the conductive period of the valve and the higher the peak current.

## A.C. Operation

On an A.C. supply the effect can be avoided by using a separate dropping resistor for the H.T. supply, as shown in Fig. 2. $R_2$ carries only the heater current, and its value is easily calculated; for 0.15-A valves and the voltages shown it is 765 ohms. $R_3$ carries only the H.T. current, and it is hardly feasible to calculate its value. It should be determined experimentally for the correct output H.T. voltage.

One snag about this arrangement is that the value needed for $R_3$ is in general different for a D.C. supply. It will usually need to be higher on D.C. than on A.C. This could be overcome by adopting the more elaborate arrangement of Fig. 3. Here $R_2$ corresponds to $R_2$ of Fig. 2, but the H.T. resistor is replaced by $R_3$, $R_4$ and C.

The value of $R_3 + R_4$ is chosen to suit a D.C. supply, for then C does nothing. Keeping their sum constant, the individual resistors are varied to suit A.C. conditions with the value selected for C. There are many possible combinations, and the best course is probably to determine in the circuit of Fig. 2 the two values of $R_3$ needed for D.C. and A.C. Then $R_3$ of Fig. 3 should be given the A.C. value, and $R_4$ made equal to the difference between the A.C. and D.C. values. C can then be chosen to have a reactance at 50 c/s, small compared with $R_4$.

Thus, suppose the D.C. value is 1.9 $k\Omega$ and the A.C. value is 0.5 $k\Omega$; then $R_3 = 0.5\ k\Omega$ and $R_4 = 1.4\ k\Omega$. The reactance of C might be made 0.1 $R_4 = 140\Omega$; at 50 c/s, $C = 1/6.28 \times 50 \times 140 = 2.27 \times 10^{-5}F = 22.7\ \mu F$. This is inconveniently large because it must not be an electrolytic capacitor.

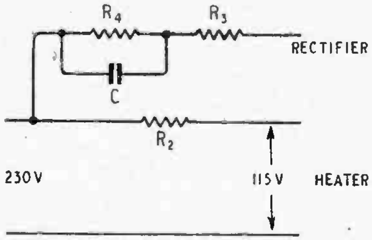


Fig. 3. A method of obtaining equal voltage dropping in the H.T. line on both A.C. and D.C. supplies is shown here.

A smaller capacitance can be used by making $R_3$ smaller and $R_4$ larger, but the values must be determined experimentally.

W. T. C.

# UNBIASED

*By* *FREE GRID*

## $\lambda$ : *0.000,000,000,734 Metre*

SOMETIMES when I read the reports of proceedings in our courts of law I wonder whether I really am living in the 20th century with its much-vaunted scientific progress rather than in the pre-Copernician era when it was believed that it was love rather than gravitational forces which made the world go round.

I am not referring to the apparent naivete of the questions asked by some of our judges, for by long usage and custom—very important things in the eyes of the law—such remarks are expected of them. Even the infamous Judge Jeffreys thought fit to interrupt an important witness at the trial of Alice Lisle to ask "Who *is* Monmouth?" I have in mind cases in which the whole business turns on some simple fact which could be established in five minutes by the use of science, and radio in particular, whereas five days of rhetoric leaves the whole business in a worse state of doubt than before.

Such a case arose the other day when a Judge of the High Court was called upon to decide the precise meaning of the term "Azure" and whether a piece of cloth marked "Exhibit A" was or was not of that colour. Dictionaries galore were produced, many of which contradicted each other and learned counsel spoke at great length and called into the box dress designers of varying degrees of eminence, none of whom seemed to agree with the others even when they gave evidence for the same litigant.

"What *is* Free Grid?"

Eventually an eminent medical authority stated that no two persons were alike in their response to colour sensitivity and what was one shade of blue to one man could appear as a different shade to another man, and there was, therefore, nothing strange in the lack of agreement. The learned judge thereupon decided to pass the buck by giving a decision with the remark that if he were wrong the Lords of Appeal would no doubt set him right.

Surely this is the very field in which radar, which during the war made such a spectacular descent from the metre to the centimetre wavelengths could make a still more spectacular descent in wavelength to the Ångstrom Units in which lie the ultra-short wavelengths of light and colour, such hopelessly unscientific things as blue and red and all their multifarious shades would then give place to wavelengths measured in A.U. and any piece of cloth, the colour of which was in doubt would be submitted to the searching analysis of the Ångstrom Unit radar beam. The precise wavelength which the cloth reflected would then be ascertained and would leave no room for argument.

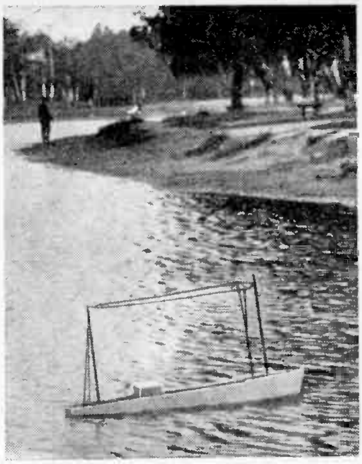
## *Radiarchics and the Food Shortage*

AT first sight there does not appear to be much connection between radio and milk but I have recently been endeavouring to help an unfortunate lactitian who, in his patriotic attempt to carry out the much-advertised wishes of the Ministry of Food, finds his efforts frustrated at every turn by two other departments of the Government octopus.

The lactitian in question, moved by the passionate pleadings of the Minister of Food, both to save and to produce more food, and observing the prodigious quantity of cereals consumed daily by the horse which pulled the van containing his watery wares from house to house, responded by selling the animal to the butcher, thus carrying out Mr. Strachey's requests in one operation.

To take the horse's place he invested in an electrically driven vehicle which he picked up for a song at Great Missenden. Unfortunately he soon found that his delivery time was doubled as he had to climb aboard the vehicle and drive it from house to house instead of merely having to call to it to move along as he had done in the days of the faithful quadruped.

Mrs. Free Grid brought the matter



Radio-ship "Telearch I."

to my attention and I lost no time in telling the milkman that it was but a simple matter to equip his electric vehicle so that it would answer his beck and call like a horse. I need hardly tell you that the project I had in mind was a simple application of the principles of radiarchics, or radio-telearchics as the philological pedants would have me say. These principles were fully discussed in the pages of this journal twenty years ago and in case you doubt my word I reproduce herewith a photograph of the radio-ship "Telearch I" which was designed and built in the *Wireless World* laboratories to exemplify the principles of radio control.

I went even further than the mere offering of advice as I myself constructed the necessary transmitter, receiver and associated apparatus which I need hardly say was an unqualified success. I took particular care to avoid interference to local broadcast receivers by using a horizontally polarized centimetre wave and very low power. In spite of this, Government department No. 1, namely the G.P.O., was soon raising all manner of objections which only a past master in the art of obstructionism could have thought of.

This was not unexpected, but Government department No. 2, in the shape of the motor-vehicle licensing authorities are also trying to cause trouble by pointing out that the law requires every vehicle to be in charge of a qualified driver. I have freely conceded this point but have challenged the authorities to tell me of any regulation which compels the driver to be actually seated in the vehicle. If any of you legally minded people can help me out in this I shall be greatly obliged as I feel confident that I have the law as well as right on my side.

# Towards VALVE STANDARDIZATION

## "Significant Progress Has Been Made"

SPEAKING before the Radio Industries Club on Tuesday, May 28th, J. W. Ridgeway, O.B.E., dealt with a matter of the utmost importance to all branches of radio: his principal topic was the vexed question of valve standardization. This subject is one which has been debated in technical circles, including the columns of this journal, almost since radio began and Mr. Ridgeway's address was therefore bound to arouse the greatest interest. He is a director of Edison Swan, and also chairman of the British Radio Valve Manufacturers' Association.

The talk stressed one point which should be generally accepted but which is too frequently overlooked: namely, that the standardization of so complicated an engineering product as a radio valve is a task of almost overwhelming difficulty. It is not sufficient that a group of engineers should sit round a table to work out an ideal standard valve; if that were all the problem would have disappeared years ago. In practice one has to take into account the different manufacturing techniques in the factories of different manufacturers and the different needs and practices of all the countless valve users. Also there is the extremely complex situation resulting from differing commercial policies and differing commercial needs consequent upon the marketing, or the desire to market, radio valves in all the different countries of the world. This list of obstacles would be formidable enough by itself, but it has to be seen against a background of the disorganization of the war years.

Despite all this, Mr. Ridgeway was able to report that the valve manufacturers who constitute the membership of the British Radio Valve Manufacturers' Association had undertaken a serious study of the whole problem of valve standardization. This start had been made at a time when the demands of war had been at their peak but, nevertheless, very marked progress had already been made. The valve manufacturers had set themselves the task of developing a range of valves "capable of manufacture by each of the member manufacturers using his own technique and methods of construction, but the working characteristics of which would be such that valves of any one type were freely interchangeable in the appropriate socket in domestic apparatus without significant change in the performance of the apparatus concerned." That was the ultimate goal before the manufacturers, and when reached it would provide all the advantages which were so frequently claimed for a true standard range of valves. In addition, however, it would provide something more, since this policy laid down that the various valve types would be capable of manufacture by the various manufacturers using their own techniques and method of construction. In this way the most serious risk of standardization would be avoided, that risk being the danger of stagnation by the elimination of the skill and individuality of competing manufacturers.

In working towards this target it had been seen that the first step was to adopt a base, or bases, acceptable to all the valve manufacturers concerned. This had been done, and the valve manufacturers had been determined that the bases adopted should incorporate the most recent advances in the art so that the range of valves to follow could be as efficient as possible. It had been found desirable to adopt two standard bases: one which offered the maximum possible saving in space (consistent with technical performance) and was satisfactory for valves of smaller dissipations, and the other for those larger valves such as certain rectifiers and power output types where

**Towards Valve Standardization—**

more dissipation was required. On the score of size as well as of technical considerations, it had been considered necessary that both designs should embody what is commonly known as the "all-glass technique." These bases had been agreed.

In addition to this major step Mr. Ridgeway disclosed that the valve manufacturers had also practically completed a scheme of standardized pin connections for use on the two standard bases. The next step was to agree upon the valve types which were to be included within the standard range and to work out common specifications which the B.V.A. members could all accept and which would enable them to produce standard interchangeable valves.

Mr. Ridgeway's address was the first public intimation of the programme which the B.V.A. manufacturers had set themselves. Those directly concerned, such as the set-making side of the Radio Industry and, of course, the Service establishments, have known of this programme for some time, but it has never been overlooked that the wider technical public is vitally interested, too.

Vast numbers of users of valves have been concerned at the wide diversity of types and consequent difficulty in replacement which have grown up over the years of radio's rapid advancement, while those whose business it is to sell radio valves have despaired of the difficulty of maintaining full and representative stocks of so widely diverse a product. All these people will be cheered to know that this crying need has not been overlooked by the B.V.A. manufacturers, and that they have set themselves the task of working towards a true standard range of British valves and that they have already made very significant progress towards this end. What is perhaps more important is the attempt to achieve that objective without sacrificing the individuality of the separate manufacturers. The co-existence of different valve designs and production techniques is an essential element in the technical advancement of radio as a whole, and that could not be maintained if standardization were effected by a slavish copying of some one range produced elsewhere or by a standardization which was so rigid that diversity of technique and the progress which follows in its train were eliminated.

"RADIOPHARE."

## DESIGN DATA: CORRECTION

In Design Data No. 2 the selectivity figure in the example should be $-5.2$ db instead of $-5.54$ db, and $f_r$ on p. 91 should be 44.93 Mc/s instead of 45.017 Mc/s.

In Design Data No. 3, a misprint occurred in equation (2), which should read

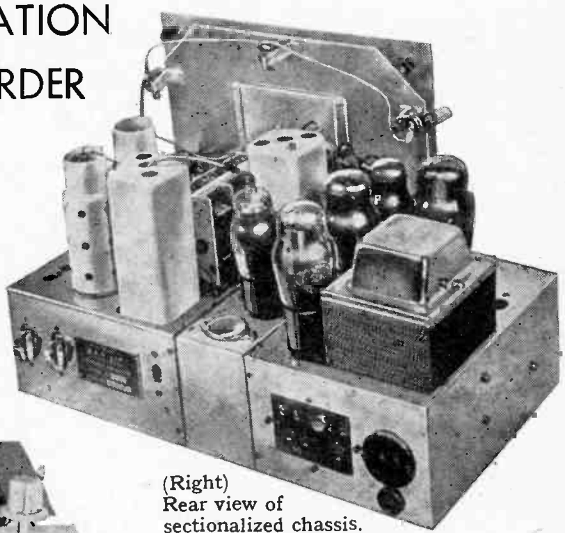
$$n\text{CR} = \frac{225}{k} \cdot {}^4\sqrt{(\text{S}_n{}^2 - 1)}.$$

The curve based on the equation is correct. In the example given, the value of $k$ calculated was shown as 0.908 instead of 0.98, this has affected some subsequent values by a few per cent.

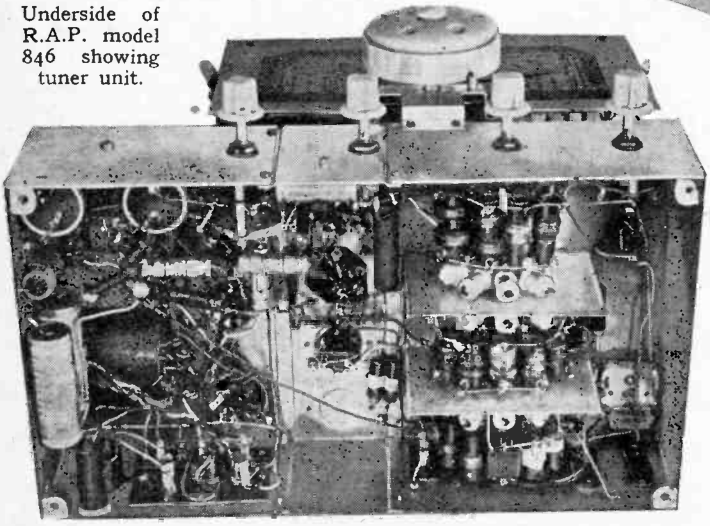
# SPECIFICATION TO ORDER

UNIT construction has been adopted in the chassis of post-war R.A.P. receivers and no fewer than nine circuit combinations can be supplied with various combinations of R.F., I.F. and output power units. The chassis illustrated is the Model 846, in which the single I.F. stage in the centre section is placed between an R.F. unit comprising a signal-frequency amplifier and frequency converter, and an output unit containing the second detector, a phase invertor, push-pull output pentodes and a power rectifier.

Other noteworthy features of these chassis produced by Manufacturing R.A.P., 15, Browns Road, Surbiton, Surrey, include a neat grouping of tuning coils round the wave-range switch and a vernier tuning scale.



(Right) Rear view of sectionalized chassis.



Underside of R.A.P. model 846 showing tuner unit.

## Letters to the Editor

# Ex-Government Components • Miniature Earpieces • Listeners' Tastes

### *Surplus Components*

YOUR Editorial on the disposal of Government surplus components appears plausible at first sight, but it contains no facts to support the pessimistic picture which it suggests, and there are strong general arguments which are quite contrary to your case.

The disposal of surpluses has been the subject of lengthy negotiations between the Government and the Radio Industry, so any recent action of the Government, so long delayed, cannot be called reckless; if the method of disposal eventually adopted by the Government is considered too drastic (you give no details of the method) it is likely that the reluctance of the components industry to reach a compromise may have contributed to the situation. So far as I am aware, delivery of components to receiver manufacturers is still commonly measured in weeks and scores of weeks, rather than in days; and so far from there being a glut of components, it is said by some that production for both the home and the export markets is threatened by shortage of components.

There is at present an abnormal accumulation of civilian orders for the radio industry as a whole, representing arrears of replacements in the home market, reconstruction in devastated countries, and demands based on sterling balances held by the Dominions and certain foreign countries which represent part of Britain's war debts. The Government's policy is that the Radio Industry should be encouraged to settle down to the sort of size which can be maintained over a long period, and should not be encouraged to maintain an inflated volume of production for the next year or two, with subsequent collapse. I do not know how far this consideration affects the components section of the industry, but it would appear reasonable to use up the Government surplus in filling the immediate accumulated orders for receivers, and maintain component production on a more modest level. In particular, the ex-Government components will all be of "tropical" quality, and therefore particularly suitable for export receivers. Early delivery of the goods is essential to building up an export trade in radio receivers, and in the national interest we cannot allow exports to be imperilled so that component manufacturers who cannot deliver now may have more work to do in a year's time. The Industry is entitled to be jealous of the home market, but it had no appreciable pre-war export market and cannot claim as of right that a foreign market created solely by war circumstances should be preserved against war surpluses. The Industry should be prepared for the present to sacrifice to Government surpluses a demand which it cannot fill immediately, in order to build up a permanent overseas trade.

D. A. BELL.
London, N.21.

### *Hearing-Aid 'Phones*

I WAS very interested to see the description by C. M. R. Balbi of the new miniature shell-type earpiece in your June issue.

While it embodies many desirable mechanical features which manufacturers have, for some years, endeavoured to incorporate in their miniature earpieces, these have always had to be jettisoned in favour of more efficient but less mechanically attractive designs.

From Mr. Balbi's description this earpiece is designed on the principle of a bone conductor, but applied as an air conductor, and I cannot help feeling therefore that it falls between two stools.

The bone conductor, to be efficient, requires the maximum movement of a comparatively heavy electro-magnetic structure vibrating against the mastoid bone. This earpiece does not seem to fulfil this requirement, inasmuch as there is insufficient

**Letters to the Editor**—

mass to vibrate against the bone, nor is the crystal capable of sufficient amplitude.

As an air-conductor, on the other hand, it is difficult to see how it can compete satisfactorily with a miniature electro-magnetic earpiece, where far more amplitude can be imparted to the diaphragm than to the "shell" of the new instrument, and where the sound waves are directed through a channel in the anatomical ear-tip into the outer ear, as against a completely random vibration of the whole shell.

Finally, with anatomical ear fittings, there are five sizes for both the left and right ears, making a total of ten different sizes. The hearing-aid manufacturer who stocks anatomical ear tips for use with his miniature earpieces must have all these sizes available if he is to provide a self-supporting earpiece, and more important still, to avoid acoustic feedback between microphone and earpiece.

Clearly, therefore, he would have to carry a very considerable stock of these earpieces in order to satisfy the requirements of each individual client.

A. P. R. MACKIE,
Allen and Hanburys (Acoustic Aids), Ltd., London, W.1.

### *Why Listeners Hate "Top"*

IN answer to "Diallist's" question (your May issue) the main reason why the man who *listens* to his programmes chooses deliberately to distort the sound is, in one word, distortion. By this is meant anything which was not present in the original. The term includes interference of all kinds, resonance effects, high frequency beaming (mentioned by your contributor), "pentode distortion," harmonic distortion produced by overloading on crescendo passages, distortion due to mis-tuning or mis-alignment of pre-set circuits, record scratch, etcetera. All these produce their maximum effect in the higher audio-frequency range, and it is a fact that distorted top is physically more uncomfortable and unpleasant to hear than any other form of distortion. The only ready remedy for this is to apply deliberate distortion of another kind, less unpleasant; i.e., by cutting the false top. The choice in this case is that of the lesser of two evils.

The remedy is known (to some at least), but is not easy to obtain. It consists essentially of three requirements. The first is a really good loudspeaker to be used in a room possessing reasonable acoustics; next, a high-class amplifier with ample power reserve; and finally, a faultless input to the amplifier. The last is the most difficult of all to secure, although we hope that ultimately it will be in normal supply. The usual remark of the average listener on hearing the results from an equipment which has endeavoured to include the above requirements, and which has a full and *natural* high frequency response, is "what a lovely tone," and as this is the same as he makes when he hears an ordinary set running with minimum top (and therefore minimum high frequency distortion), I take it he means (if he means anything at all!) "how pleasant and comfortable to listen to."

G. F. REDGRAVE,
London, S.E.26.

# RANDOM RADIATIONS

*By "DIALLIST"*

### What Is Interference?

THE findings of the Committee on interference with radio reception are not known at the time of writing, but at a recent I.E.E. discussion the general opinion was that they would define interference as radiation from commercial, domestic or other electrical apparatus with a field strength sufficient to override a one-millivolt signal in neighbouring receiving sets. I suppose we must regard such a standard as satisfactory; it is at any rate better than the lack of any standard at all and it does give the B.B.C. something definite to work on. If it is recommended they will know that "service area" means the region round a station in which the field strength of its signals is not below one millivolt. So long as it is backed up by adequate penalties for those who infringe it the adoption of this definition would go a long way towards putting some sort of order into the present chaotic state of affairs. To be of real value it will have to apply to all the frequencies on which broadcasting is done, and these include the 42 Mc/s television band. What are we going to do about the owners of commercial internal combustion vehicles and private motor cars? Probably the great majority of those now in use, with the exception of Army and other service vehicles, which are effectively "suppressed," do cause strong interference on both the sound and vision channels of television. Though it probably costs less than a sovereign to buy a set of suppressors and to have them fitted to the ignition system, I sadly fear that there will not be an order that they must be installed within a short time if heavy penalties are to be avoided. Our national make-up renders it far more likely that we shall try moral suasion, with the usual patchy results. Let us hope that this will not be so and that, whatever recommendations the Committee makes, they are adopted and enforced with an iron hand.

□ □ □

### Wireless Sports Models

ALMOST all of the new wireless sets seem to be of what I call the "family bus" type: four (or in a few cases five) valves plus rectifier, with only one short-wave band and not very delicate tuning arrangements. I've heard of only one firm up to now that is catering for the long-distance enthusiast, who yearns for a "sports model" in the shape of a communication receiver, or at any rate something built on the same lines but less elaborate and less expensive. There used before the war to be a good market for sets of this kind and I am sure that there would be now if they were available. In case any manufacturer is tickled by the idea, but does not quite know what kind of receiver I have in mind, here is the sort of thing which I believe would be snapped up as fast as they could be turned out. One or perhaps two R.F. stages, separate really stable oscillator used with frequency changer, two I.F. stages, D.D.T. for detector and A.V.C., and output stage. A B.F.O. is an advantage, though not absolutely essential. Tuning range: 10-550 metres in five or six wavebands. Adequate image suppression, electrical bandspreading between 10 and about 80 metres, tuning drive reasonably free from backlash. Controls: tuning, volume (manual), A.V.C. on-off, bandwidth (say, 3kc/s, 6kc/s and 10kc/s) B.F.O. on-off, wavechange. Cabinet: metal with crackle finish; no built-in loudspeaker. Readers who are interested may have other suggestions to make.

□ □ □

## An Ingenious Tool

FROM the Bio Electric people I have just had a very neat little soldering iron, whose heating arrangements are ingenious and, I believe, of an entirely novel kind. Intended for fine radio and instrument work, the Stylus, as it is called, measures 10in overall and weighs under 4 oz. The bit, made of $\frac{3}{16}$in round copper rod, is tapered at its business end to a shape rather resembling that of a pen nib. The bit is fixed into an aluminium body which itself fits into an aluminium tube some $2\frac{1}{2}$in in length running to the well-shaped wooden handle. To return to the body of the iron, the part lying within the tube is $\frac{3}{8}$in in diameter and has a B.S.F. screw thread cut in it. In the grooves of this thread lie the turns of heater wire. The body is anodized and the thin layer of aluminium oxide covering it forms the sole insulation for the 12-volt heater element. When I first saw the inside of the iron I confess I had my doubts about the reliability of such a thin film of insulation. The firm tells me that before the iron was put on to the market heaters were subjected to the strenuous test of six months (4,408 hours) of *continuous* running, at the end of which time the megger showed an infinity reading.

The heater wire is made of a special alloy with a high temperature/resistance factor. As the wire is in such close contact with the body there is almost no temperature gradient: the temperature of the body is as near that of the heater as makes no difference. Temperature control is first-rate: I have left the iron idle on the bench for a couple of hours and then found the temperature still exactly right. The loading is 25 watts at 12 volts and the iron can be heated either from a mains transformer or a secondary battery. It reaches its working temperature, by the way, in about four minutes after switching on.

# RECENT INVENTIONS

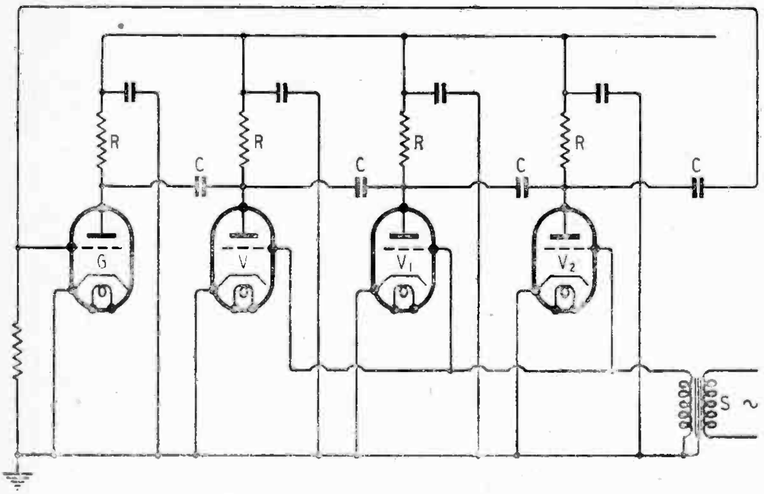
## *A Selection of the More Interesting Radio Developments*

### FREQUENCY MODULATION

A VALVE G is back-coupled, in known manner, through a series of resistance-capacity sections marked R, C, so as to generate oscillations at a frequency which is determined by the time-constant of the network.

According to the invention, the resistances are shunted by non-linear devices, such as the triodes V, $V_1$, $V_2$, with their grids connected in parallel to a source S of signals. The resulting changes in the impedance of the network give rise to frequency variations, which automatically adjust themselves to keep the phase difference across the network at the 180 degrees required to maintain the generator G in constant oscillation. By using pentodes instead of triodes the modulating voltage can be applied to the anodes; the grids are then biased to control the slope of each valve and therefore the mean frequency of the carrier.

*Standard Telephones and Cables, Ltd. (communicated by International Standard Electric Corp.). Application date February 11th, 1944. No. 571840.*




Circuit for frequency modulation.

### LIGHT MASKS

THE viewing screen of a cathode ray tube is shielded by two sets of louvres, which are set at right angles to each other, so as to exclude any extraneous light that has an angle of incidence greater than 45°, whilst allowing a clear view of the televised picture, or other indication, within the solid angle so defined.

Each of the spaced louvre strips is cut from laminated sheet plastic about one-sixteenth of an inch thick. The material consists of comparatively wide sections of transparent cellulose acetate, separated by thin transverse layers of an opaque cement or binder. The crossed louvres give protection against external light coming from all directions, and at the same time offer less obstruction to an observer than the usual projecting hood.

*Philco Radio and Television Corp. (assignees of G. Zindell, jun.). Convention date (U.S.A.), September 10th, 1942. No. 572338.*

### WAVE GUIDES

THE power passing through a wave guide can be measured by the rise in temperature of an insulated wire wound around a given section of the guide, but the operation is a slow one.

According to the invention, two aligned openings are made in the opposite narrow sides of a rectangular wave guide. They are then enlarged, by the addition of a suitable framework, to enclose a quarter-wave "grid," which is made by winding a wire to and fro at right angles to the axis of the guide. Assuming the waves passing through the guide to be of the $H_{10}$ type, currents will flow in the two narrow sides at right angles to the main axis, and the grid will accept them as an open-circuited quarter-wave section. As viewed from inside the guide, the grid wires appear to be short-circuited to the narrow walls, and therefore present little impedance to the passage of the main current. The local current in the grid will, however, cause its temperature to rise, and so give a rapid and continual indication of the power being transmitted.

*J. Collard. Application date September 14th, 1943. No. 572881.*

### CRYSTAL RECTIFIERS

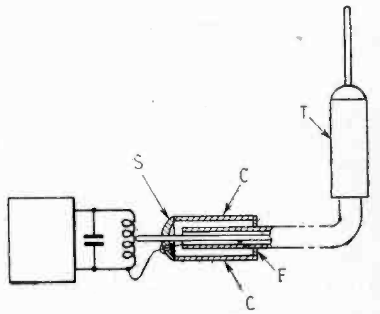
A POINT-CONTACT for rectifying ultra-high frequencies is made between a rod of synthetic silicon carbide, ground to a knife-edge, and a knife-edged wire, the two edges being set at right-angles to reduce the shunt capacity. The crystal-rod is soldered to a resilient hair-pin support, and the combination is enclosed in a casing filled with paraffin-wax.

*The British Thomson-Houston Co., Ltd., and T. H. Kinman. Application date, March 6th, 1942. No. 572138.*

### COAXIAL FEEDERS

BOTH ends of a coaxial feed line are terminated by a device which (a) keeps the inner and outer conductors in fixed relation; (b) prevents the ingress of moisture; (c) allows the line, when required, to be filled with gas under pressure, and (d) throws no appreciable shunt capacity across the line or its associated circuits.

As shown, a quarter-wave metal cylinder C is firmly fixed at one end by a flange F to the outer conductor of the line, and is sealed at its other end by insulation S, which holds the inner conductor firmly in place. Any capacity shunt across the insulator S is now in series with the very high impedance of the closed quarter-wave section formed by the outer conductor and the cylinder C, and is therefore negligible at the working frequency. For a television aerial, the cylinder should be made resonant to the middle frequency of the waveband to be passed. A similar termination T is fitted to the aerial end of the line.




Coaxial cable termination.

*The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), March 16th, 1943. No. 572085.*

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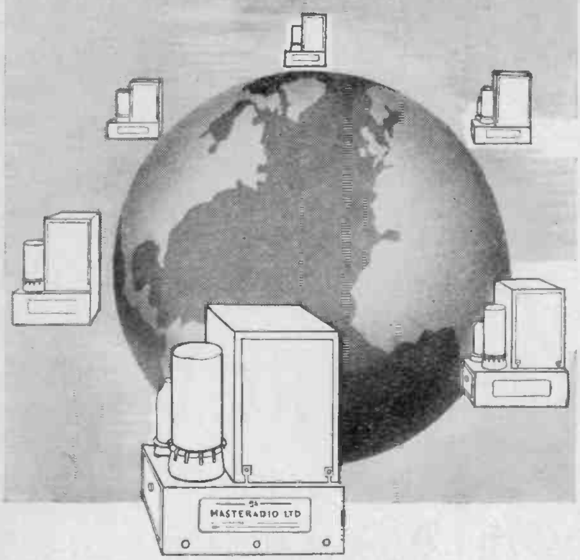
# EARTH FREE
## *& Silent as the Stars*

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## WARNING

*Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturer's guarantee. Many of these components will have been designed for special purposes, making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.*

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H.P. RADIO SERVICES, Ltd., 55, County Rd., Walton, Liverpool, 4. Tel. Aintree 1445. Estab. 1935. [5590

DOUBLE DECCA, new 1946 model, vastly improved, 100-250 volts, ac/dc/battery (all dry), 3 wavebands, portable, £18/4/6, including tax, rotational deliveries have commenced, order yours now.—Snell, Arcade, Swansea. Est. 1900. Tel. 3784. [5364

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THE V55R Communication receiver is now available for immediate delivery, 9 tubes, 5 wavebands, 3½ watts output, a.v.c., b.f.o., 200/250 a.c. mains.—Write, enclosing 2½d. stamp for V55R illustrated brochure, Voice & Vision Co., 58-60, Rutland St., Leicester [5402

COIL packs, 3 waveband with switching aligned on standard receiver, £1/16/6; 465 k/c I.F.s. suitable for above available; insist on Weymouth Radio products, available from your dealer.—Weymouth Radio Mnfg. Co., Ltd., Crescent St., Weymouth.

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Material supplies are more difficult now than at any time during the war, with the result that the delivery position is not improving. This is probably a natural symptom of the transition and all industries are encountering similar difficulty. We in Radio will do our best to overcome it.
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ASTOUNDING new 1946 console radio, obtains full marks on all counts from expert Sunday Pictorial Test Panel. Dynatron, the supreme reproducer, 11 valves, all wave, ac. 88 guineas, plus 22/6/7 tax, rotational deliveries now commencing, full details sent with pleasure, autoradiogram available soon.—Snell, Arcade, Swansea. Tel. 3784. [5376

4V TRF, AC/DC, complete kit, including valves and speakers, £5/10; larger model kit, with polished cabinet and 6in speaker and valves, £7/10; car radio, 4v superhet, kit and vibrator; line cord, 1/4 per yd, £6 100yds; vibrator unit, 6v in, 250v out, £1/10; details on request.—Cook, "Enham," Old Barn Rd., Christchurch, Hants. [5486

KITS, kits, kits, 2 waveband, all mains 4-valve, tube line-up, 6K7, 6J7, 25Z6, 25L6, polished aluminium chassis, really first grade components, station named dial, delivered complete to last nut, full wiring instructions; price £7/8, c.w.o. or c.o.d.—Isherwoods, 81, Plungington Rd., Preston, Lancs. Tel. 3348 Preston. Radio repairs est. 1936.

ENTIRELY new 1946 R.G.D. all-wave autoradiogram, magnificent model, finest ever made, new lightweight pick-up, permanent sapphire point, very limited production, rotational deliveries now commencing, £179/14/4, including reduced tax, post orders welcomed, safe delivery guaranteed, early booking respectfully advised, a pleasure to send full details.—Snell Arcade, Swansea. Est. 1900. Tel. 3784. [5366

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HALLICRAFTERS SX24, 4 wavebands, 540kc to 43.5mc, recently ser.—Box 821.

HALLICRAFTER S.X.24, in absolutely new cond.; £55, or nearest offer. Box 68. [5503

R.C.A. AR88 communications receiver, as brand new, 14 valves, 550kcs to 43mcs, £55.—Box 8215. [5385

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SPARTON 831-X, med. and short-wave, 8 valve chassis (1942), complete, set new spare valves; offers.—Box 31. [5496

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TELEVISION; Marconiphone 709 Console all-wave radio & television; what offers?—Yorath, 60, Bishops Rd., Whitchurch, Cardiff.

RADIOGRAM, ac, all mains, all wave, H.M.V. model 661, upright walnut cabinet, perfect order, overhauled; £55.—Tel. Reliance 2821. [5286

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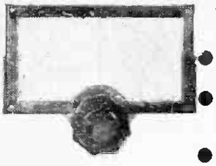

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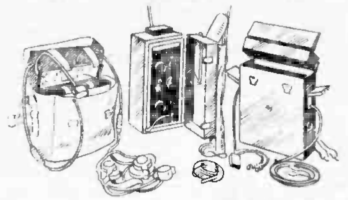

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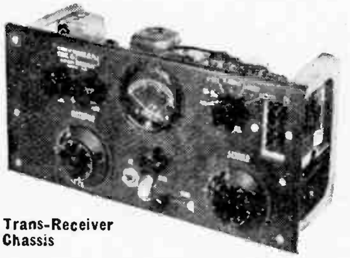

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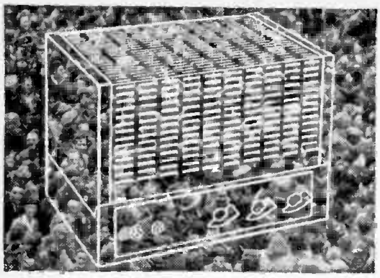

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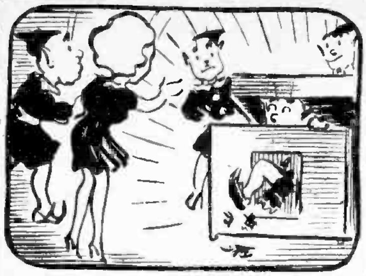

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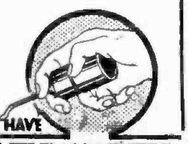

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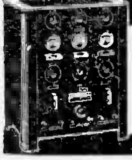

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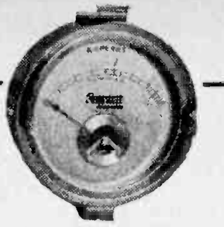

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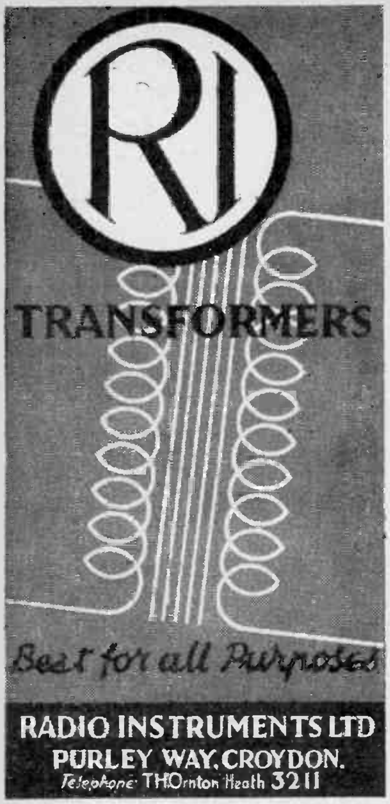




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### PATENTS

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AGENCIES required for electrical and wireless goods, components and light tools, etc., by ex-Serviceman calling on radio retail and hardware stores in the counties of Dorset, Hampshire and Sussex.—Write in confidence in the first instance to Box 8338. [5434

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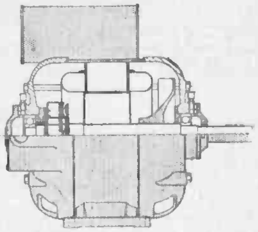

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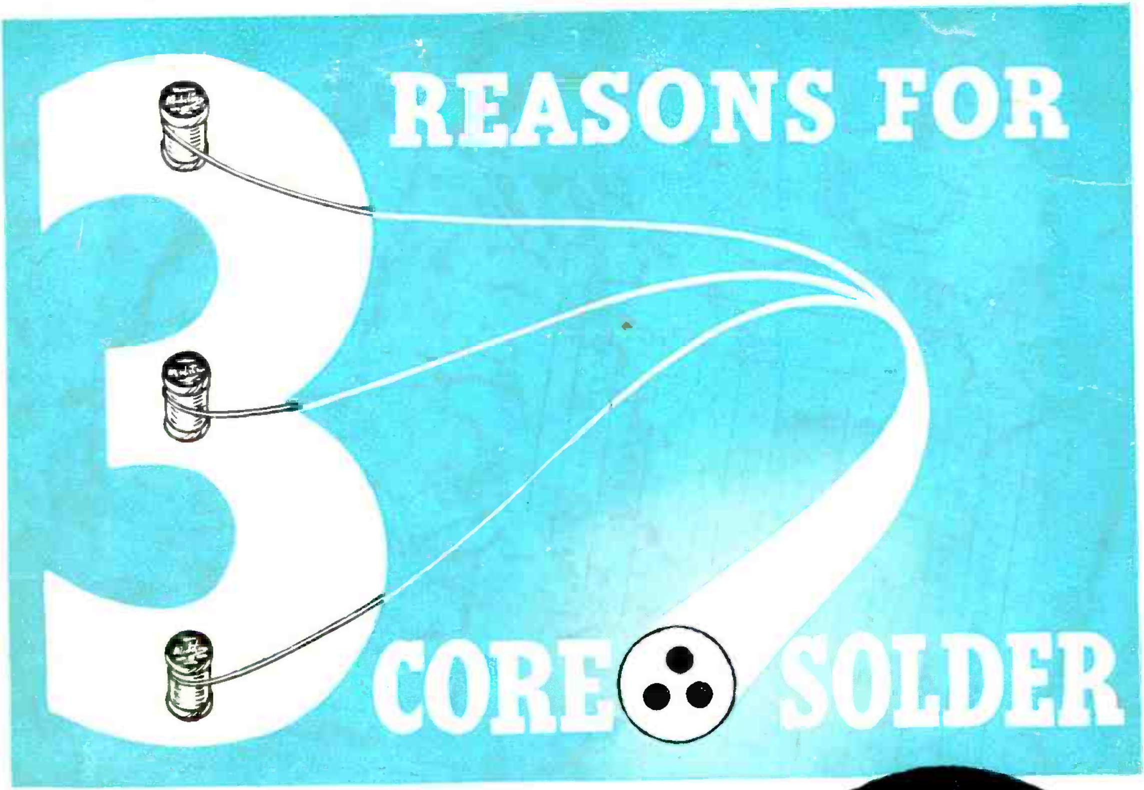


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