Wireless World

RADIO AND ELECTRONICS

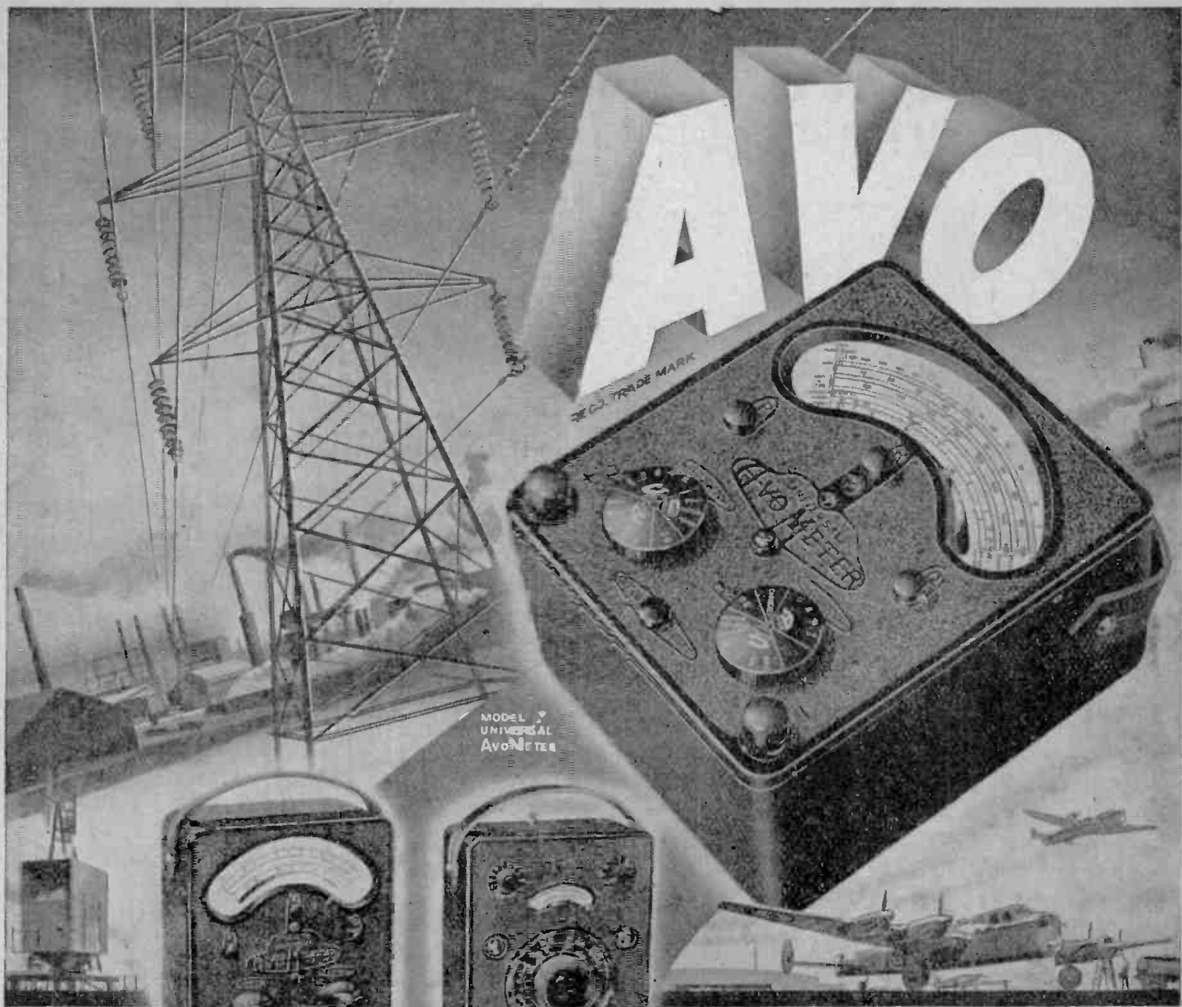
NOV. 1946

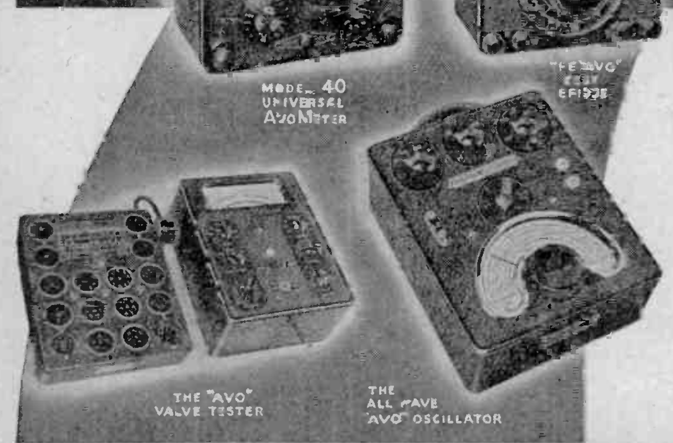
1/6

Vol. LII. No. 11

IN THIS ISSUE: RADIO AIDS TO CIVIL AVIATION : A Survey


RADIO INDUSTRY
prefers
B.I. Callender's
PRODUCTS
Our products for the Radio Industry range from the tallest steel radio towers to 0.001 μF capacitors. If you're not interested in monsters or midgets we make a lot of other things besides, including every type of cable and wire used in radio work. You get the benefit of 60 odd years research and manufacturing experience when you specify B.I. Callender's.
BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON W.C.2

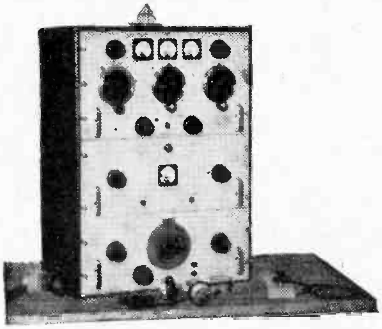




THE world-wide use of "AVO" Electrical Testing Instruments is striking testimony to their outstanding versatility, precision, and reliability. In every sphere of electrical test work they are maintaining the "AVO" reputation for dependable accuracy, which is often used as a standard by which other instruments are judged.

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
WINDER HOUSE · DOUGLAS STREET · LONDON · S.W.1 *TELEPHONE: VICTORIA 3404/7*

REDIFON G.32
TRANSMITTER/RECEIVER



This compact, transportable, 50 watt Transmitter/Receiver is used by Colonial and other authorities for medium range communications over land, sea, and to aircraft by telephony and C.W., or M.C.W., telegraphy.

The transmitting unit in the Redifon G32 covers from 4 to 16 m/cs (75 to 18.75 metres) in two bands. An electron-coupled oscillator is used, operating as an oscillator frequency doubler. The very sensitive receiver covers from 150 k/cs to 20 m/cs (15 to 2,000 metres) and incorporates a crystal gate, three I.F. band-widths, beat frequency oscillator and other features.

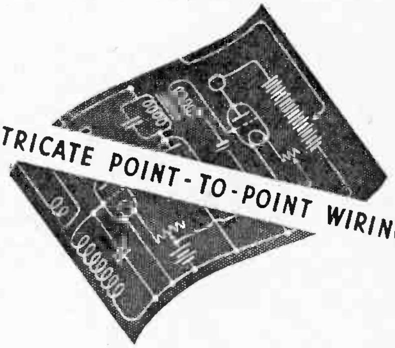
The entire transmitter/receiver is contained in a single robust steel housing, finished to service tropical specifications, 28 inches high by 21 inches wide and 12 inches deep. The net weight of this unit is 130 lbs. Power can be taken from 24 volt accumulator batteries or 180-250v. 50-cycle, single phase A.C. mains, through alternative power units.

This transmitter/receiver is available for *early delivery*. Further particulars can be supplied on request to Communications Sales Division.

REDIFFUSION Ltd.

Designers and Manufacturers of Radio Communication and Industrial Electronic Equipment

BROOMHILL ROAD, LONDON, S.W.18



FOR INTRICATE POINT-TO-POINT WIRING JOBS

Available in solid and stranded tinned copper conductors with rubber insulation, HAMOFIL wires are specially designed for efficient, economical wiring of electrical, radio and electronic apparatus.

A popular inexpensive grade known as HAMOFIL "Push Back" permits the cotton braiding to be slid back along the wire to facilitate joining or soldering.

Seven colours—Plain and striped.

Hamofil
CONNECTING WIRES
STRANDED SINGLE

De La Rue Insulation Limited

IMPERIAL HOUSE · REGENT STREET · LONDON W.1 · ENGLAND
Tel.: REGent 2901 Cables: Delinsul, Piccy, London

DA9B(46)

POINTERS FOR DESIGNERS

THE CMG8

The CMG 8 is a typical example of the OSRAM range of emission-type photocells which constitute the essential means of converting light changes into electric current. Widely used in sound projectors and industrial apparatus they are non-microphonic and of convenient size. Outstanding features include:—

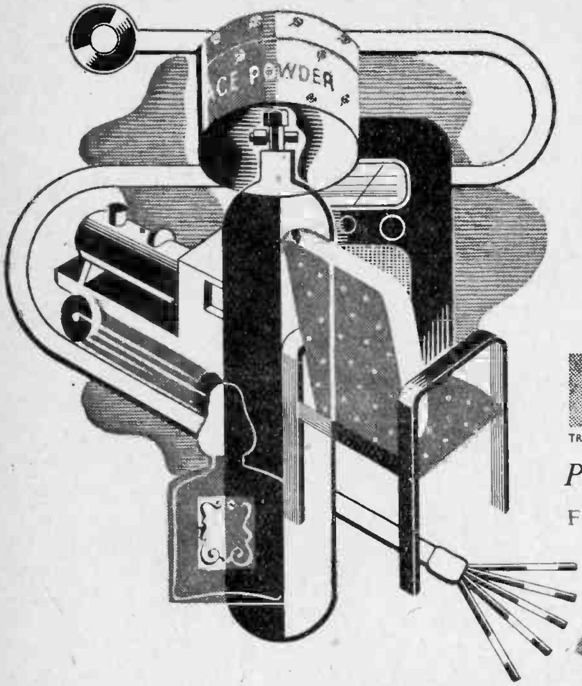
- Linear response for sound reproduction giving undistorted output.
- High sensitivity to artificial light.

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.

WHAT HAVE THEY in common?



They all have name-tabs of Lasso Tape, which adheres without moistening to any surface, flat or moulded; of metal, wood, glass, plastic, textile or rubber. Simply press on firmly with the fingers. No tools are required.

Lasso Tapes name-tabs are obtainable in 10 yd. lengths in various widths, or as separate labels measuring up to 6″ x 6″. In a wide range of colours, they are printed with your own inscriptions at suitable intervals and the wording cannot be erased. The ideal method of attaching name-tabs, numbers and similar information to furniture, carpets, plastics, toys, tools, electrical equipment, motor car fittings, bottles and cartons. Guaranteed resistant to water, oil and solvents. An informative booklet is free on request.

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TRADE MARK

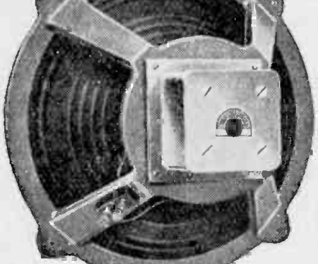
Pressure Sensitive Tapes

FOR LABELLING, SEALING AND IDENTIFICATION

LASSOLASTIC · LASSOBAND · LASSOTHYL · LASSOPHANE

Herts Pharmaceuticals Ltd., Welwyn Garden City, Herts. Tel.: Welwyn Garden 3333 (6 lines) (5)

Wharfedale



15-inch SPEAKER W.15

An entirely new model, having the following main characteristics:—
Flux density 13,500 lines. Total flux 180,000 lines. Speech coil 12/15 ohms, 2″ diameter. Peak input 20 watts. Bass resonance about 60 c.p.s. Dust-proof assembly. Weight 16½lb. Response almost level between 50 and 5,000 cycles. Price 250/-.

Made and Guaranteed by

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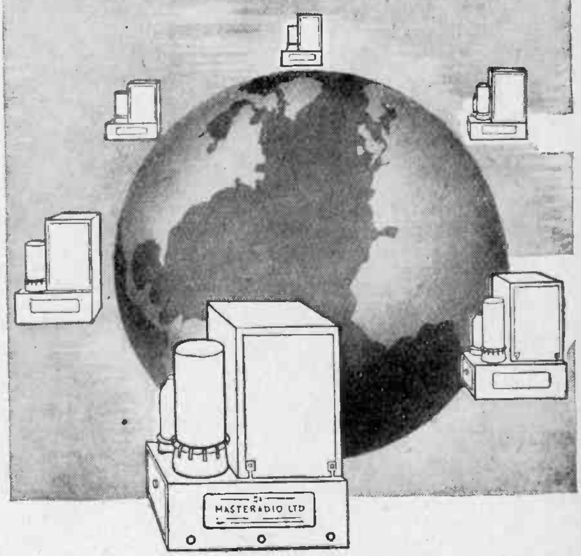
BRADFORD RD., IDLE, BRADFORD

'Phone: Idle 461. 'Grams: Wharfdel, Idle, Bradford

EARTH FREE
& Silent as the Stars



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CLEAR AS THE BELL OF BIG BEN WHEN YOU'RE USING

Exide

L.T. ACCUMULATORS

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H.T. BATTERIES

The perfect pair for battery Radio sets

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

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R&A

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Reproducers and Amplifiers Ltd.,
WOLVERHAMPTON,
ENGLAND.

M.R. SUPPLIES Ltd.

continue to offer only material of the utmost dependability, all goods being new and perfect. Immediate despatch. Prices nett.

ROTHERMEL PIEZO-CRYSTAL MICRCPHONES (exclusive offer). The well-known D.104 specially housed with knuckle-joint for angle adjustment, with ¼in. (26) threaded boss. Response 50/7,500 c/s. Output level minus 60 DB. With 5ft. screened lead, **75/-**. Also same make P.C. deaf-aid type inserts, 1¾in. dia., **29/6**.

MOVING COIL MICROPHONES. Grampian MCR, spring-suspended in square frame. Fine performance and value, **£4 4s.** The new Resio VMC, only 2¾in. dia., with local on-off switch, imp. 12 ohms, recommended for its really excellent response, **£5 10s.** **FLOOR STANDS,** to suit all above microphones, collapsible, ext. to 5ft. 6in., **49/6** (all chromium).

GRAMOPHONE PICKUPS. Rothermel replacement heads for Garrard and Collaro arms, providing easy change-over from magnetic type—giving far better performance. Either **46/11** (please state which required). Also new ball-bearing Senior, complete model, with black streamlined bakelite arm, **57/6**. Also from stock, the new Lexington Moving Coil pickups, with needle charger and ejector, sapphire needle and input transformer (mu-metal housed), **£8 10s. 3d.** (Please note that in most cases a one-valve preliminary amplifier is necessary for M/coil pickups). Instructions sent with each. **SAPPHIRE NEEDLES** (Rothermel), **12/6**.

STROBOSCOPES (50-cycle), showing 78, 79 and 80 r.p.m.—cardboard only. **1/-**.

OUTPUT TRANSFORMERS. Our improved "W.W." model is still supreme. Level 30/9,000 c/s, handling 25-watts AC. Provides 11 ratios from 12/1 to 75/1 with C.T. for P.P. Tapped prim. and sec., generous core section, weight 9¼ lbs., **59/6** (despatch 1/6).

MICRO-AMMETERS, new ex-Govt., well-known maker deflection 0/500 micro-amps. 2in. flush panel mtg. Int. res. marked on each (mostly 500 ohms). Very special offer, **37/6**. **B.P.L. COMBINED MEASURING INSTRUMENTS** (new model). 17 ranges: AC and DC volts, 10, 50, 100, 500 and 1,000. **DC Milliamps:** 1, 10, 100, and 500. Ohms: 0/1,000 and 0/100,000. Also output volts. In fine polished black plastic case 5½in. × 4in. × 3in. with range switching, terminals and carrying handle. 1,000 ohms/volt, **£8 15s.**

SMALL MOTORS (ex-Govt.), 12/24v. D.C. Housing, 2¾in. by 2in. sq. Double-ended shaft with pulleys each end. Excellent torque. Suitable for cine, laboratory use, boat motors, etc., only **15/-**. **ROTARY TRANSFORMERS,** input 12v. DC., output 480v. 40 ma. (cont.) or 400v. 80 ma. (4-hr. periods), new, ex-Govt., **22/6**. **MALLORY VIBRATORS,** type 650. 6-volt, 4-pin. For 250v. 60 m.a. delivery (in conjunction with appropriate transf. and rect.), **12/6**.

METAL (Selenium) **RECTIFIERS** by S.T.C. (A) up to 12v. 1.5 amp., **12/6**. (B) 12v. 6 amps., **39/6**. (C) 12v. 10 amps. **49/6** (letters refer to appropriate mains transformers, below).

STEP-DOWN MAINS TRANSFORMERS (all 24-hour rated). Primaries all tapped 200/220/240 v. Sec.: 7, 11 and 15v. at 2 amps. (A), **21/-**. Sec. 5, 12 and 17v. at 6 amps. (B), **49/6**. Sec.: 7, 8 and 15v. at 10 amps. (C), **75/-**. (Desp. 2/6). Also Sec.: 2, 4, 6, 8, 10 and 12v. at 3.3 amps., **37/6**. Sec.: 22v. 2 amps., **19/6**. Sec.: 30v. 4 amps., **45/-**.

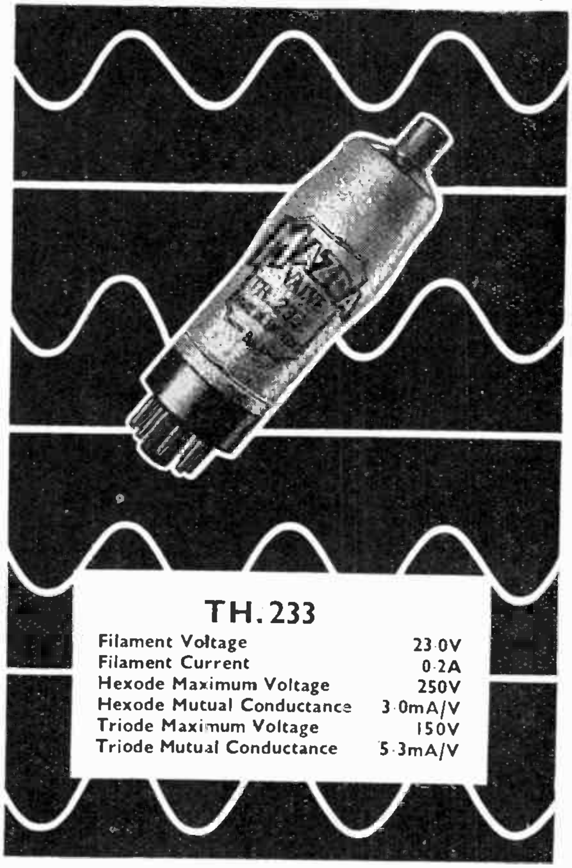
SLIDING RESISTANCES, open tubular type, 1 ohm 12 amps, **17/6**. 14 ohms graded 1 to 4 amps, **19/6**. **STAGE LIGHTING DIMMERS,** with screw motion and hand-wheel, controlling stated load from full-bright to blackout at 220/240 v Now supplied from stock held here. 500-watt, **£3 18s. 6d.** (despatch 2/6). 1,500-watt, **£8 8s.** (desp. 4/6). 2,500-watt, **£9 13s. 6d.** (desp. 6/-). Large range of Sliding Resistances always in stock.

Please include sufficient for packing and despatch.

M.R. SUPPLIES Ltd., 68, New Oxford Street, London, W.C.1.

Telephone: MUSeum 2958

TH. 41	
Filament Voltage	4·0V
Filament Current	1·3A
Hexode Maximum Voltage	250V
Hexode Mutual Conductance	3.1mA/V
Triode Maximum Voltage	150V
Triode Mutual Conductance	5·3mA/V



TH. 233	
Filament Voltage	23·0V
Filament Current	0·2A
Hexode Maximum Voltage	250V
Hexode Mutual Conductance	3·0mA/V
Triode Maximum Voltage	150V
Triode Mutual Conductance	5·3mA/V

The TH.41 designed for use in A.C. Mains Receivers and the TH.233 in AC/DC Receivers, are Triode-Hexode Frequency Changers.

They have been specially designed to meet the requirements of All-Wave Receivers and the inter-action between the input and oscillator circuits has been reduced to a minimum.

A high Conversion Conductance is provided with a large initial grid bias, thus ensuring that no grid current is taken on the Short Wave bands.

The characteristics have been so designed as to provide large signal handling capacity with low cross modulation and low harmonic content.

MAZDA

RADIO VALVES AND CATHODE RAY TUBES

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

Difficult Problems?

Made in Three Principal Materials

FREQUELEX
An insulating material of Low Di-electric Loss, for Coil Formers, Aerial Insulators, Valve Holders, etc.

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

TEMPLEX
A Condenser material of medium permittivity. For the construction of Condensers having a constant capacity at all temperatures.

Bullers

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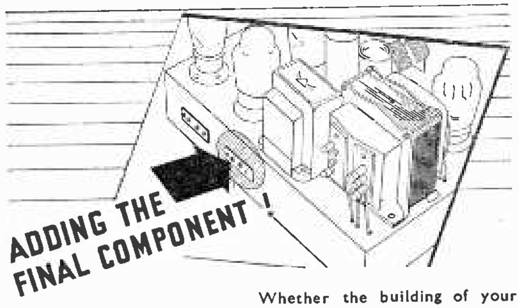
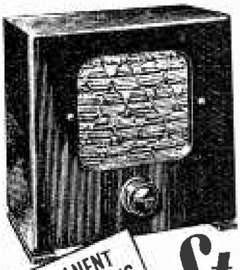
Telephone: Mansion House 9971 (3 lines) Telegrams: "Bullers, Cannon, London"





Whether the building of your receiver is a hobby or to provide entertainment in the home, selection of the final component demands the same attention as other details of the circuits. Stentorian Speakers are designed to match any desired impedance. They give such a faithful reproduction that you will at once appreciate the difference.

Stentorian

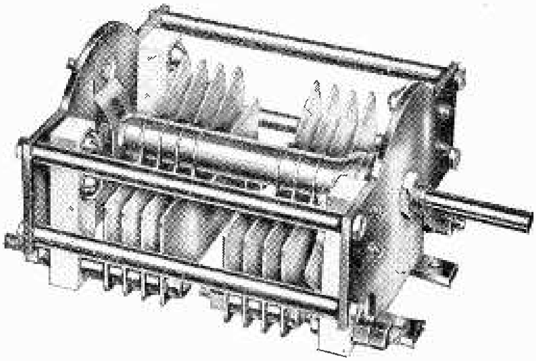
PRICES

Minor Type MX (for Low Impedance Extention) 29/6.
Minor Type MC (with Universal Transformer) 35 6.
Baby Type BX (for Low Impedance Extention) 43/6.
Baby Type BC (with Universal Transformer) 49/6.

WHITELEY ELECTRICAL RADIO CO. LTD., Mansfield, Notts.

"Cyldon"

Transmitting Capacitors



TYPE TRMSS

Max. Capacity	*List Price*
30 + 30 pF	£1 : 7 : 6 each
60 + 60 ,,	£1 : 10 : 0 ,,
80 + 80 ,,	£1 : 12 : 0 ,,
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Air Gap ·082"

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The Gramophone enthusiast should study the important NEW TREND in PICK-UP RESEARCH . . . . . .

The moving coil design shows a great advance in frequency response, attack and general clarity. Assuming a good amplifier and loudspeaker these pick-ups do really show to advantage the recent improvements in recording technique. Bass is "clean" and the "top" discriminates between orchestral instruments instead of the conglomerative shrillness we have too often accepted. We show two makes of these new pick-ups :—

1. THE WILKINS & WRIGHT MOVING-COIL PICK-UP TYPE "N." Uses easily changed commercial hard-steel needles, playing approximately 20 records. Needle pressure adjustable from ½ oz. to 1 oz. Complete with coupling transformer and equalizer in screened case, arm rest, instructions and fixing screws.

PRICE (including Purchase Tax) **£7 0 7**

WILKINS & WRIGHT "SCRATCH" FILTER—not merely a "top" tone control, but a low-pass filter cutting above 8.5 Kc/s. (Frequency of cut-off is adjustable.)
PRICE (including Purchase Tax) **£2 11 4**

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2. THE LEXINGTON MOVING-COIL PICK-UPS.
"De Luxe" Model, automatic insertion and rejection of sapphire needles. Needle pressure approximately ½oz.

PRICE (including Purchase Tax) **£6 5 0**

"Junior" Model. Similar construction to the "De Luxe," but without mounting base and automatic needle device. Uses commercial steel needles, easily replaced. PRICE **£3 18 9**

LEXINGTON ACCESSORIES :—Sapphires, **15/3.** Input transformer, **16/-.** Mu-metal screening box for transformer, **14/2.** (We also stock a special two-stage pre-amplifier and equalizer either complete or in parts).

NOTE : MOVING COIL PICK-UPS give a small output usually necessitating one or two additional amplifier stages. For larger output we recommend :—
Rothermel "Senior" Crystal .... **£2 16 3** (Including Tax)
B.T.H. Magnetic .... **£1 11 9** (Including Tax)

WEBB'S AMPLIFIER CASES
Well constructed portable type, removable top cover with ventilating louvres and carrying handles. Removable bottom plate on chassis completes total shielding. Overall size 16 x 8 x 9½ins. high, finished black crackle ; chassis punched for seven valve-holders and transformer.
PRICE **£2 12 6**
(Carriage 2/- extra).

WEBB'S "HI-FI" OUTPUT TRANSFORMERS
Secondary tapped 2½, 7½ and 15 ohms ; 20 watts—in four push-pull types for anode to anode loads of :—
PPHF4—4,000 ohms. PPHF8—8 000 ohms.
PPHF6—6,000 ohms. PPHF10—10,000 ohms.
PRICE .... (each type) **£1 7 6**

GOODMAN'S 12in. PERMANENT MAGNET LOUD SPEAKER.
A heavy duty reproducer capable of excellent quality, speech-coil 15 ohms.
PRICE **£6 15 0**

MATCHED VALVES.
Another Webb's Service. We supply matched pairs of valves for push-pull working without additional charge.

PX 4's	**£1 3 2**	per pair
PX 25's	**£2 8 8**	per pair
KT66's or 6L6G's	**£1 16 6**	per pair
6V6G's..........................	**£1 5 8**	per pair

(Owing to fluctuating deliveries we reserve right to supply direct equivalent valves in other recognised British makes).

MATCHED RESISTORS
Welwyn high-stability, carbon resistors, 1-watt rating, tolerance 1 per cent., 2/6 each.
Erie 1-watt resistors in pairs matched to 2 per cent. Absolute values plus-minus 20 per cent., 2/- per pair.
Stock values of matched pairs, 20,000, 25,000, 33,000, 50,000 ohms.

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Telephone : GERRARD 2089. Write, phone or call.
Shop hours : 9 a.m. to 5.30 p.m. (Sats. 9 a.m. to 1 p.m.)

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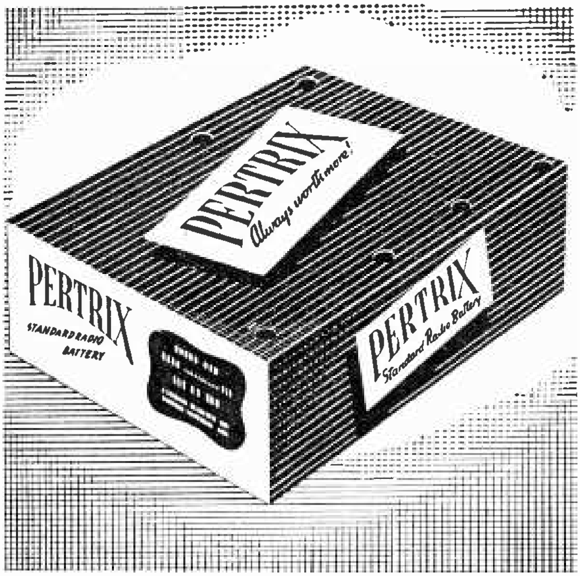

PERTRIX BATTERIES have emerged from the testing ground of war as more reliable, more efficient than ever before. You will soon see them in the smart new post-war pack shown above. It denotes the finest battery for radio use yet made.

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CONTINUOUSLY VARIABLE WIRE WOUND POTENTIOMETERS

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PRESET RESISTORS

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FIXED ATTENUATORS

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from the **HOUSE** *of*

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The Problem of Insulating delicate instrument panels from vibration and shock by means of Flexilant Mountings

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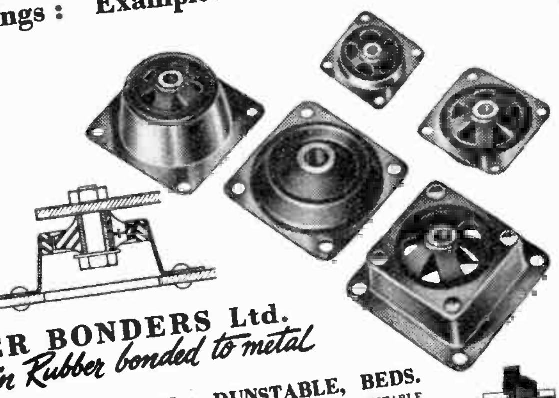
The "Flexilant" Mounting of which several varieties are illustrated here is so accurately made that its displacement under load can be calculated to within .010" of requirements. The series is designed to carry loads of from 1 to 45 lbs, per mounting and these may be arranged with bolt axis at 90° to 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.

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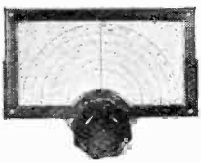
"Q-MAX" PRODUCTS

"Q-MAX" CHASSIS CUTTER

Ends all your tiresome scraping and drilling. Cuts holes easily, cleanly, and quickly.
For octal holes (1⅛").
10/6 (Pstg. 9d.)



"Q-MAX" MEASURING INSTRUMENTS

0-1mA M.C.	£2	19	6
0-5mA M.C.	£2	9	6
0-50mA M.C.	£2	9	6
0-250mA M.C.	£2	9	6
0.100mA M.C.	£5	5	0
0-1A Thermo C	£3	17	6
0-1A Hot wire	£1	19	6
0-5A Hot wire	£2	2	0
0-250mA—M. Iron	£2	2	0
0-10v A—M. Iron	£2	2	0
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"Q-MAX" SLOW MOTION DIAL for individual calibration. Comprises an 8-1 slow motion drive, dial (6¼" × 3½") engraved 5 blank scales and one 0-180 scales escutcheon glass and fluted knob. **15/6** (Pstg. 9d.)

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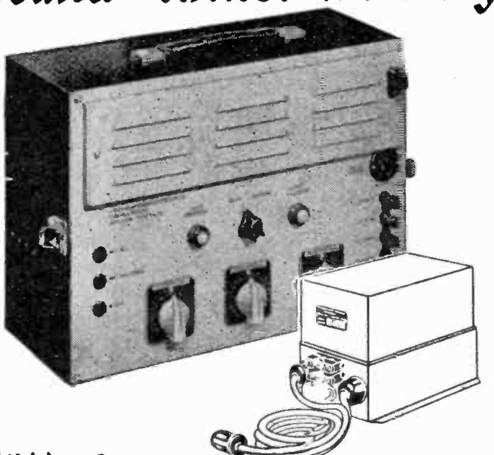
(Opposite Chancery Lane.) Tel.: HOLborn 6231

Sound Understanding



Precision Built for Perfect Reproduction

A Portable Amplifier capable of providing an undistorted output of 20 watts. Separate volume control for microphone and pickup. AC Mains or from 12 volt accumulator, used with the B.S.R. Vibrator Power Unit VP 60.A.

BSR

BIRMINGHAM SOUND REPRODUCERS LTD.
CLAREMONT WORKS
OLD HILL STAFFS.

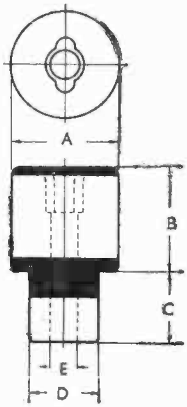
M-W.58

METALLISED CERAMICS

Two additions to the S.P. range of FREQUENTITE bushes

R.50650 R.50764 ★R.50844 ★R.50855

TYPE	A mms.	B mms.	C mms.	D mms.	E mms.
R.50650	9·5	9·5	6·4	6·25	2·75
R.50764	9·5	16·7	6·4	6·25	2·75
★R.50844	9·5	12·7	9·5	6·25	2·75
★R.50855	12·7	22·2	12·7	9·5	3·9



★ Recent additions to the range

For full information and prices please write to:

STEATITE & PORCELAIN PRODUCTS LTD.

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S.P.43

Comfort and Concentration!

There is nothing more conducive to getting full pleasure from your radio than wearing a pair of lightweight yet highly sensitive headphones.

When you are searching the short-wave bands, or for that matter enjoying any broadcast programme without disturbing others in the room, you will appreciate using a pair of the world-famous S. G. Brown type "F"

FEATHERWEIGHT HEADPHONES

Light in weigh, highly sensitive and inexpensive. They will give you years of service and are most comfortable to wear.

Price **23/-** per pair.

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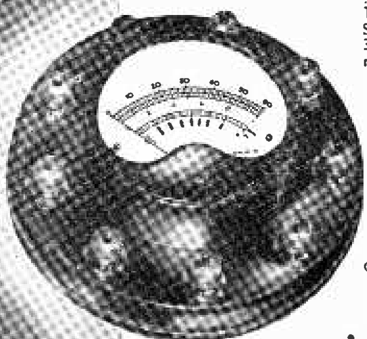

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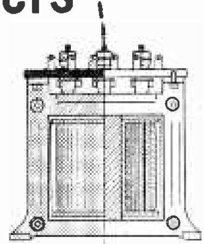

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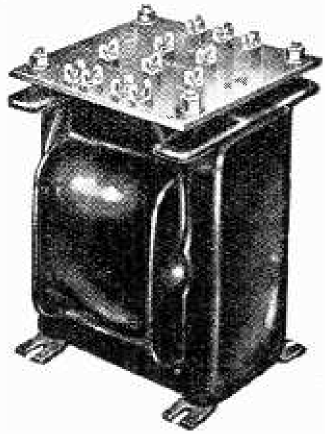

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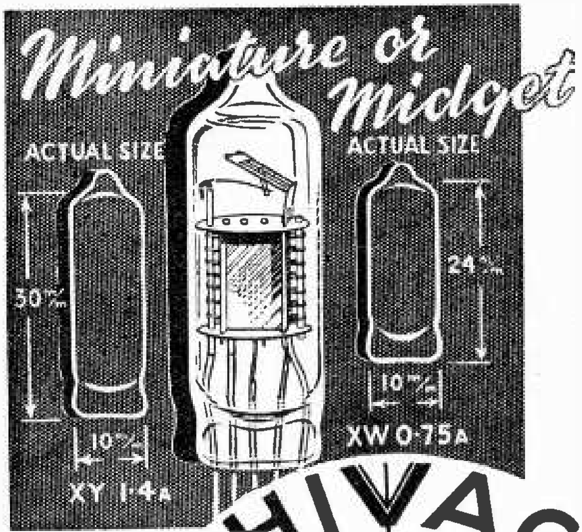

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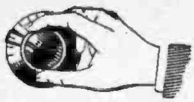

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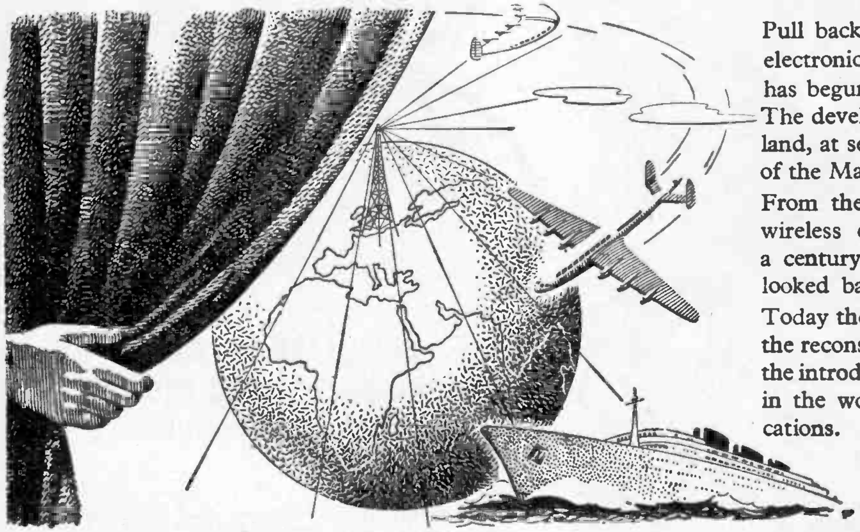

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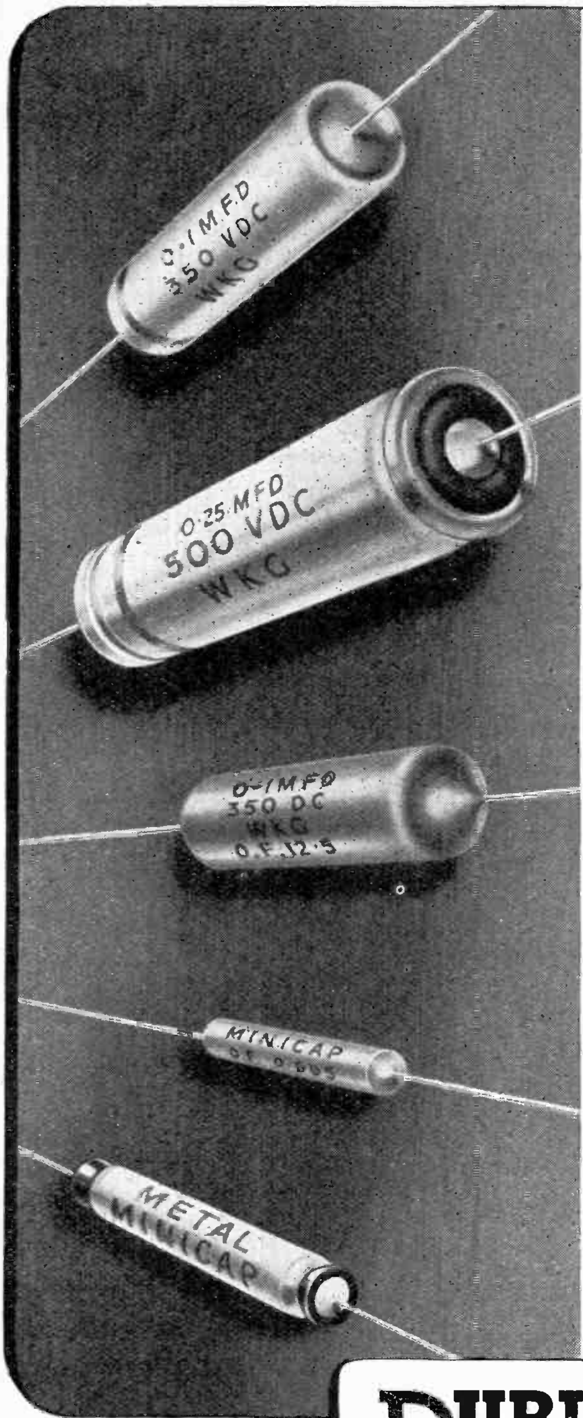

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Wireless World

Radio and Electronics

36th YEAR OF PUBLICATION

NOVEMBER 1946

Proprietors:
ILIFFE & SONS LTD.

Managing Editor:
HUGH S. POCOCK,
M.I.E.E.

Editor:
H. F. SMITH

Editorial, Advertising and Publishing Offices:
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

Telephone:
Waterloo 3333 (50 lines).
Telegrams:
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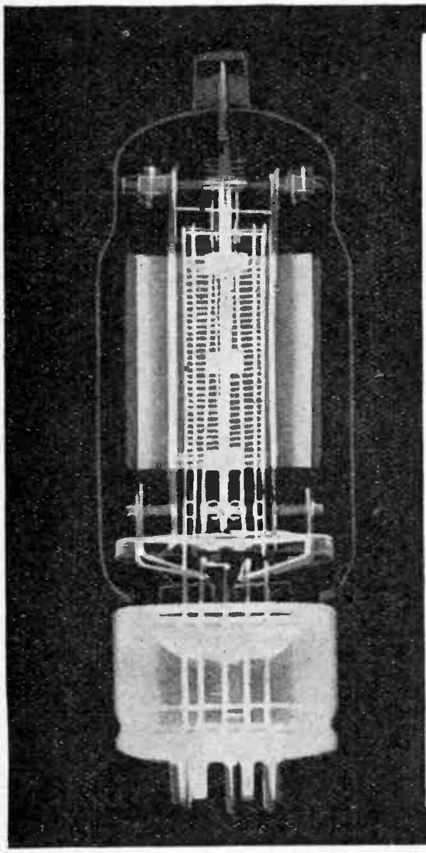

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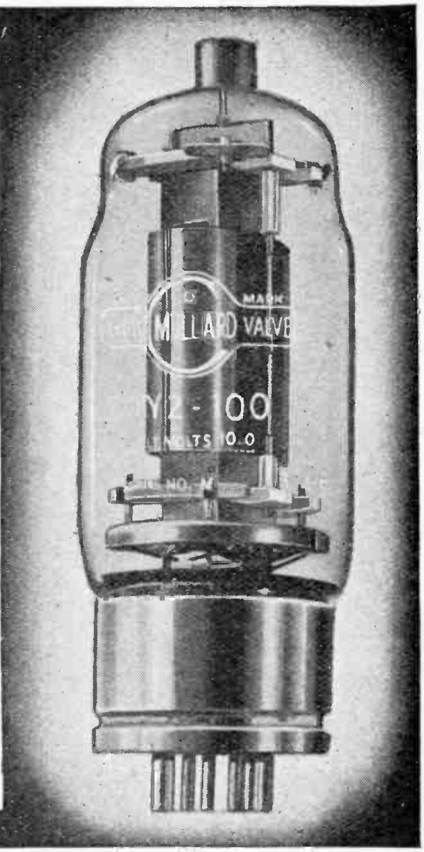

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Wireless World

Radio and Electronics

Vol. LII. No. 11 NOVEMBER, 1946 Price 1s. 6d.

Monthly Commentary

Restrictive Licences

ALMOST autocratic control of all forms of radio communication is conferred on the Postmaster-General by the Wireless Telegraphy Act. Fortunately, these sweeping powers have almost always been wielded competently and wisely, and it is seldom that this journal has found occasion to complain of restrictive Post Office practices. But an exception exists in the conditions laid down in the broadcast receiving licence, which we were impelled to criticize in last month's issue. We now think our criticism was too mild.

Put quite simply, the licence means precisely what it says. It does not confer authority to receive "CQ" telegraphy or "pirate" broadcast telephony. In reply to our question, posed last month, as to what form of licence is needed for the reception of broadcast telegraphy, we are informed that a new form of licence, intended evidently for newspapers, news agencies, and the like, is now under consideration. It will permit the reception of both telegraphic and telephonic broadcast and multi-destination wireless press messages, but seems to be of little use to private individuals.

In the interests of secrecy, some case can be made out for discouraging indiscriminate listening to telegraphy, but we have no sympathy with the restriction of listening to "authorized" telephonic broadcast stations. When a Post Office spokesman volunteers the statement that the licence does not permit listening to the "Voice of Israel" station, we must admit that the lay Press has some excuse for describing the P.O. attitude as totalitarian. What is the difference, one is tempted to ask, between the regimented German citizen who, during the war, listened to the broadcasts of his country's enemies and the citizen of this country who listens to-day to the Jewish rebels in revolt against the British mandate in Palestine? It is difficult to see any difference except in the penalties to which they render themselves liable; the Wireless Telegraphy Act provides much milder penalties than decapitation of offenders by the headsman's axe! And it is equally difficult to avoid reaching the conclusion that the Post Office has assumed the right to censor our listening and guard us from dangerous thoughts; surely, the idea of conferring such powers was never in the minds of those who framed the 1904 Act.

The most charitable explanation is that the Post Office, in drafting the licence, was animated by a spirit of over-cautiousness and showed excess of zeal in guarding its monopoly in radio communications. We are in no way concerned in the political issues in the background, but we are very much concerned with the fact that the unnecessarily restrictive provisions of the licence may hinder the free development of wireless. It is small consolation to have the assurance of the Post Office that individual applications for "dispensations" will have sympathetic consideration.

Television Receiver Construction

RECENTLY we have had many requests for information on the construction of television receiving equipment, and so we feel that a large number of readers may wish to know our plans. It may be said at once that it is intended to describe fully a complete television receiver, and a design is now being developed for publication in *Wireless World*. Some details are set out elsewhere in this issue.

It should be made clear that sufficiently detailed information will be given to enable anyone experienced in wireless construction and adjustment to build the apparatus. But it is not intended to encourage the inexperienced to construct the set by providing practical wiring plans. This does not imply any intention to divide our readers into professional and amateur camps; the design is to be presented in a form that, it is hoped, will appeal to all readers who have sufficient experience to enable them to gain a practical first-hand knowledge of all that is involved in television reception.

AIR NAVIGATION: *Survey of Radio Aids*

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

SINCE the possibility of direct observation can seldom be counted on for long, radio is the only adequate basis for aircraft navigation. During the war, development of the art was greatly intensified; and it branched out along so many new lines that today there is an abundance of systems not yet fully developed—or else suited primarily to military needs—whilst comparatively few civil flying aids suitable for present and near-future conditions are at present available.

There is, in fact, almost an embarrassment of riches as regards techniques, and it is mainly a matter of embodying them in appropriate and fully-engineered equipment. Systems that have reached at least an experimental stage are already more numerous than is necessary, since many perform similar or overlapping functions; and if such development went on more or less unco-ordinated all over the world, the result would soon be a situation in which an aircraft fitted to use the ground services wherever it went would have little room for anything but radio gear. As it is, B.O.A.C. aircraft are decorated with some 17 different aerials!

The need for world-wide standardization and co-ordination being so obvious and urgent, the appropriate authority (at present the Provisional International Civil Aviation Organization) recently met in London, and has reassembled in the U.S.A. prior to a meeting in Canada, to study the state of the art and to try to decide which systems should be chosen for international standard use.

This field of radio is already so vast, and most of the equipment so new, that there may be some use in attempting to render the outlines of the wood discernible rather than the innumerable trees. Some of the latter have already been described in these pages; and concise details of fifty of them (if related communications and auxiliaries are included) are contained in an excellently produced Stationery Office publication.[1] Many of these details are only tentative, and some of them have already been superseded.

First of all, what are air navigational aids required to do? They should enable the pilot to keep closely on the desired track, and to know his position at any time en route and should warn him of obstructions. They should also enable him to make the correct approach to a clear runway at the destination and (if necessary) land "blind." In between these two phases there is another, which

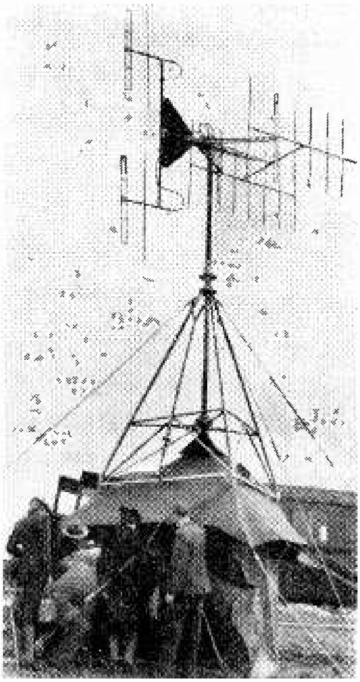

Fig. 1. V.H.F. Rotating Beacon, which can quickly be set up on a site. The Yagi aerial (right) transmits sharply beamed speech, and the cardioid aerial a continuous tuning note in all directions outside the beam.

may begin fifty miles or more from the destination, during which it may be necessary for the aircraft to be "stood off" until its turn to land is due. During this phase, if confusion and risk of collision are to be avoided, pilot and ground controller must work in complete harmony and with precise positional knowledge of one another. During the other two phases, while it is desirable for the aircraft to be self-sufficient, it should be able in the event of failure of equipment to fall back on accurate information from the ground.

Although cathode-ray tube displays were largely used in the air during the war, it is now generally accepted that nothing other than easily interpreted meter presentation direct to the pilot will do. In achieving this operational simplicity, however, it is difficult to avoid making the "works" more complicated, which tends to add also to bulk and weight. But great advances have been made in "miniaturization," and equipment that before the war would have been thought fantastically complex for use in the air proved quite practical even in battle. And while it is obviously a bad thing to be obliged to carry a large number of different sets of equipment, the opposite extreme of using a single set to do everything entails the risk that if it fails one has "had it." The best compromise, perhaps, is a few sets (maybe only two), each of which can, to some extent, substitute for the other in an emergency.

Considering now the basic sorts of information provided by navigational aids, these are comparatively few. There is the *bearing*, with respect to North, of a known point from the aircraft. This information is sufficient to locate the aircraft on a *position line*. Two intersecting position lines give a *fix*. This is the basis of ordinary D.F., as known before the war. Alternatively, a fix may be derived from one bearing plus distance or *range*. This is the facility that radar introduced. A class of information closely related to bearing is course or *heading*; i.e., an indication when the aircraft's nose is pointing in a certain direction. It is even more useful than bearing if it happens to be the direction in which one wants to go, but not otherwise.

o Civil Aviation

Lastly, there is the relative distance from two fixed points, which is the foundation of the *hyperbolic* systems—so-called because lines of constant difference in distance are hyperbolæ. Readings from two pairs of points give a fix—if one possesses a map on which the relevant hyperbolæ are drawn.

The present tendency is to convert these basic sorts of information, by means of some type of automatic computor, into what the pilot actually wants to know, e.g., his closeness to a prescribed track, and his distance along it from his destination.

Still another basis for classification is the type of radio transmission employed, such as unmodulated C.W. (Decca system), keyed or amplitude-modulated C.W., or pulses (not necessarily radar). The wavebands occupied generally increase in that order. One system to be referred to later (A.S.M.I.), with a pulse duration of one-eighth microsecond, requires a band of about 16 Mc/s.

An important subdivision distinguishes primary radar, which works on the echo principle, from secondary radar, in which the outgoing pulse triggers a responder into replying with pulses, usually on a different frequency. The range for a given power is thereby greatly increased, and the responder can be coded for purposes of identification.

Before the war direction-finding by loop aerial was the main navigational aid. D.F. facilities can easily be incorporated with the communication radio; and there are plenty of transmitters on which to take bearings, besides the radio beacons set up for the purpose. But its accuracy is somewhat variable, depending on sites and aspects of aerials, time of day and operational skill; and it is not continuously direct-reading or instantaneously-fixing. Recent D.F. developments include the radio compass, in which the loop aerial automatically orientates itself and gives continuous readings of bearing; and cathode-ray direction-finders (C.R.D.F.), in which a radial trace on the tube screen shows directly the bearing of the transmitter tuned in. C.R.D.F. is being given a rôle in airport ground control systems to supplement radar locating and identifying apparatus; while the radio compass and even earlier forms of

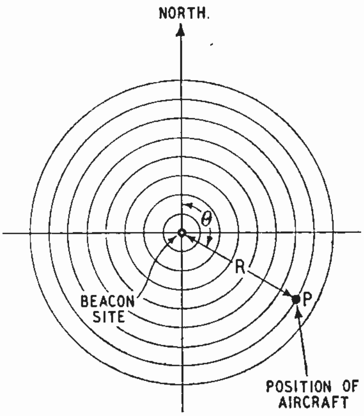

Fig. 2. In the "spider's web" system of navigation, the position, P, of an aircraft is determined by polar co-ordinates, R and θ, with reference to a central origin, which is the site of two beacons, one for measuring R and one for θ.

D.F. are likely to be widely used for some time.

As long ago as 1929 a beacon with a rotating directional transmitting aerial came into service at Orfordness. The Morse signals transmitted are related to the aerial's orientation, so that one's bearing can be obtained by merely listening to it. The same idea in modern form, shown in Fig. 1, with a recorded voice calling out its bearings on the V.H.F. band, appeals to pilots—because they have only to switch to the appropriate channel on their V.H.F. receiver, and to the authorities—because the ground gear is automatic and cheap.

A further elaboration is Consol,[2] with a range of 1,000-1,500 miles and much greater accuracy, provided that one possesses a special map and a rough idea of one's bearing from the beacon.

Since no apparatus is needed in the air beyond the ordinary receiver, there seems no reason why beacons in this class should not continue to be used, at least as auxiliary aids for the benefit of aircraft in which equipment for more refined systems is either absent or unserviceable. They are sometimes called Radio Ranges (presumably because they have nothing to do with range!).

All-round direction-giving beacons of more refined types are being developed as the "θ" parts of the polar-co-ordinate or "spider's web" systems of navigation (Fig. 2). The "R," or distance-measuring, parts employ secondary radar. Between them they fix positions relative to the site of the ground beacons.

One type of experimental θ beacon ("John Gilpin") has a U.H.F. pulse transmitter which at intervals of about 30 pulses is switched from one aerial to either of two others about 500ft away. A special airborne receiving equipment notes the phase discontinuities between these groups of pulses, and from them computes the bearing of the beacon and displays it on a meter. The system is something like Gee with the transmitting aerials so close together that the hyperbolæ are radial straight lines.

Another line of development (Omni-directional Radio Beacon, O.R.B.) uses C.W. in the V.H.F. band. The phase difference, in degrees, between two 60-c/s signals on the beacon carrier wave is equal to the bearing, in degrees, of the beacon. This is because one of the 60-c/s signals is generated by the rotation at 60 r.p.s. of the aerial, which radiates asymmetrically in azimuth. The other, a constant reference signal, is borne by the same carrier wave, but is separable in the receiver because it takes the form of a 60-c/s frequency modulation of a 10-kc/s amplitude modulation of the carrier. The two signals can therefore be compared in a phase discriminator and made to actuate a direct-reading bearing indicator.

P.O.P.I. (Post Office Position Indicator) is not, as one might suppose from the name, a facility for the general public on the ground, but yet another beacon—designed by the P.O. Engineering Dept.—from which a receiver gives direct readings of bearing. Its technique is intermediate between the last two, but as it works in the M.F. band its range is much greater, probably 1,000-1,500 miles in daytime, like Con-

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sol and Decca, and, like them, not dependent on flying height. It is not part of a spider's web scheme; positions are determined by the bearings of *two* stations.

The other polar co-ordinate needed to give a spider's web fix; i.e., distance, and also identification of the origin, are supplied by a secondary radar beacon "Eureka."[3] The airborne equipment "Rebecca"[3] interrogates the beacon, which responds as already described. Wartime Rebecca displayed the information on a calibrated C.R.T.; but other wartime techniques, using the time displacement between the outgoing pulse and the responding pulse from a selected source to control a meter-deflecting current, are being applied to make Rebecca direct-reading.

Even this is not enough, because a pilot who wants to fly somewhere other than to the site of the R and θ beacons would be left with a nasty geometrical problem; viz., origin-shifting of polar co-ordinates (Fig. 3*a*). Great strides are being made with electro-mechanical computors, and an experimental unit has already been made up for continuously indicating the R and θ of any desired point, provided that the track to that point lies wholly within the service area of the R and θ beacons, and that the R and θ of the beacon site have been pre-set on the unit (Fig. 3*b*).

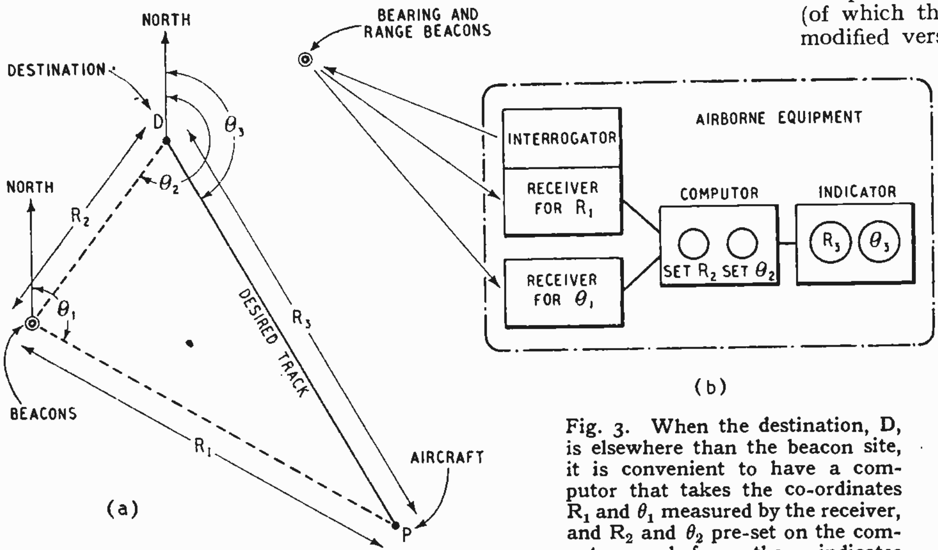

Fig. 3. When the destination, D, is elsewhere than the beacon site, it is convenient to have a computor that takes the co-ordinates R_1 and θ_1 measured by the receiver, and R_2 and θ_2 pre-set on the computor, and from them indicates the range and bearing, R_3 and θ_3, of the destination.

An advantage of having Rebecca in an aircraft is its versatility. Besides giving distance from Eureka beacons, and their identity, its semi-directional aerials enable homing indication to be provided. This applies not only to the all-round Eureka beacons but also to the sharply beamed short-range beacons "Babs," giving left/right and distance indications for helping pilots to approach the runway in bad visibility. There are other facilities, too, such as interrogation of I.F.F.,[3] giving identity of other aircraft, ships, etc.

A gadget that is being fitted to Rebecca in R.A.F. aircraft has a switch that can be set to any desired radius from 3 to 12 miles, whereupon a left/right indicator shows the departure from an orbit of that radius. It is even possible to feed this meter current into an automatic pilot so that the aircraft flies round and round until further notice without any human effort. The main object of orbiting is to kill time until permission can be given to land.

Although radar beam approach systems such as Babs have the advantage over C.W. systems of giving continuous readings of distance from destination, this is not so very helpful, at least for actual landing, without accurate simultaneous information on height above ground. Better still is information on whether the aircraft is at all times at the correct height for landing; in other words, is in the glide path. The pre-war Lorenz system, using a single C.W. approach beam and two vertical distance-marker beacons, was one of the first instrument-landing schemes. The present-day American SCS-51 (of which the Pye "Abas" is a modified version), by using independent beams to mark the horizontal and vertical approach planes, defines the landing path more precisely, and indicates it to the pilot by cross-pointer meters (Fig. 4).

But blind *landing* is still the most acute problem, and one that cannot yet be said to be completely solved. It is one thing to demonstrate satisfactory blind landings, and quite another to guarantee them under all working conditions.

If all pilots had instruments enabling them to keep to the prescribed tracks at the correct heights, and if the ground staff organized all flights to schedule, and had equipment to show the positions of all aircraft, especially

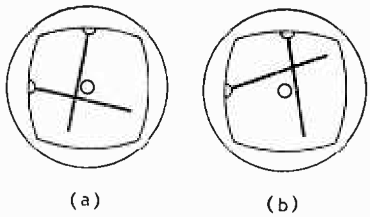

Fig. 4. The centre of the SCS-51 instrument-landing dial represents the position of the aircraft relative to the radio beams marking vertical and horizontal approach planes. With an indication such as *a* before him, the pilot should turn left and lose height; with *b*, *vice versa*. Flashing lights indicate when he is passing over distance marker beacons.

near airfields, risk of collisions in the air or on the ground would in theory be excluded. To help fill the gap between this ideal and the reality, especially on long-distance flights, and where tropical clouds may be encountered, airborne primary radar giving warning of high ground, storm clouds, and other aircraft is an obvious extension of wartime practice. A light X-band (3 cm.) set is now being tested in S.E. Asia.

On the ground there are several forms of primary radar. Size and complexity do not matter so much there. Ability to cope quickly with a large amount of information is the chief requisite. The American G.C.A. (Ground Control of Approach), Fig. 5, successful during the war, uses two radar sets. One enables Traffic Directors to locate all aircraft within about 25 miles, and marshal them by spoken instructions on a V.H.F. channel. As each one in turn reaches the beginning of the approach, it is handed over to an approach controlled who, by the use of separate precision radar equipment, can follow the aircraft exactly enough to bring the pilot down over the runway by his instructions. The only airborne equipment needed, therefore is V.H.F. communication, which at a pinch need not

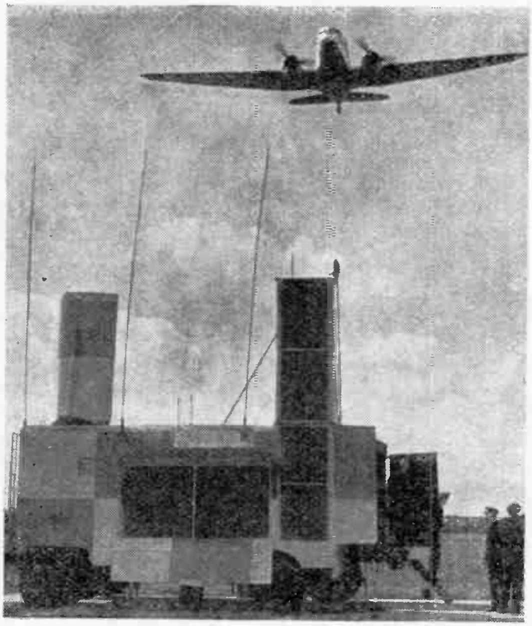

Fig. 5. The G.C.A. dual radar installation for "talking down" aircraft, though elaborate, is completely mobile.

even be two-way, as replies from the aircraft are not essential.

For general airfield control, several types of A.C.R. (Airfield Control Radar) have reached the experimental stages (Fig. 6). They include primary search radar with P.P.I. displays for locating aircraft, and C.R.D.F. and/or secondary radar for identifying them. The C.R.D.F. display can be superimposed on the P.P.I. and points out which of the echoes corresponds to the aircraft that is talking by V.H.F. Secondary radar necessitates the aircraft to be fitted with a responder, the equivalent of wartime I.F.F.

Before a controller can confidently authorize a landing, he must know that the runway is clear. A.S.M.I. (Airfield Surface Movement Indicator) enables him to do so when direct vision fails. As one would expect, it is a high-resolution, very-low-angle short-range radar installation. It is now in the experimental stages.

The Standard Telephones and Cables, Ltd. "Condar" system, although it gives a P.P.I. display of range and bearing on a C.R.T., is not radar. It is a special type of C.R.D.F. in which the radial C.R.T. trace, due to the V.H.F. signal from the aircraft, is used also as a time base, on which a bright spot marks the range. The position of this spot along the range scale is controlled by the phase difference between a 809-c/s signal taken direct from an oscillator in the ground apparatus and a similar signal derived by demodulating the aircraft's carrier wave, which has been modulated by the ground oscillator signal received on a separate radio channel.

Hyperbolic systems are now more or less well known. Gee[4] and Loran both use pulses, and differ chiefly in their radio frequencies: 20-85 Mc/s for Gee,

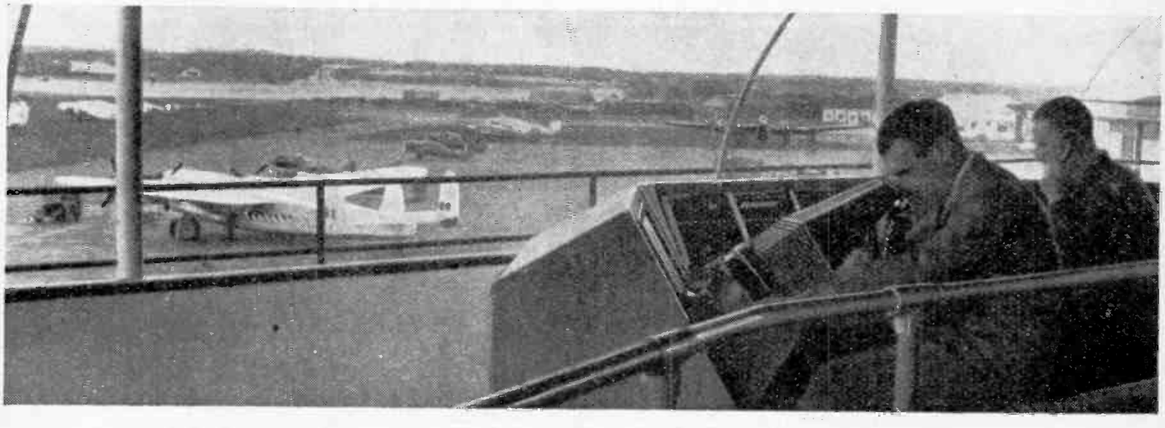

Fig. 6. Experimental flying control tower at R.A.E., Farnborough, showing radar (A.C.R.).

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and 1.75-1.95 Mc/s for ordinary Loran. So Loran gives a longer range and rather less precision. It is possible to produce a combination receiver for working on either. At present both display their results on a C.R.T. in a form that is not directly interpretable by the pilot, and a certain amount of operation is needed to obtain them. To overcome this objection, it is intended to put in hand a programme of development whereby Gee, by the addition of ingenious equipment, is to be made direct-reading, and ultimately to give continuous readings without operation, as does Decca. The accuracy and range are somewhat less than with Decca, however, especially at low altitudes, and the waveband occupied is, of course, vastly greater.

Owing to the scale on which Gee was produced during the war, it has the advantage of being available in quantity at the present time.

The Decca system,[5] using unmodulated C.W. on frequencies of the order of 0.1 Mc/s, is now in regular 24-hour service in England, giving a useful radius of about 300 miles at night and over 1,000 miles by day. It is equally applicable at sea and even on land, as the effect of terrain screening is relatively slight. A disadvantage is that if one flies into the service area not knowing the position within a few miles, the lane and zone number indicators cannot be set, so the pointer readings are ambiguous. The same may happen if for any reason functioning is interrupted for a while. Methods of zone and lane identification now undergoing trial should overcome this difficulty.

The system has from its start provided automatic direct continuous readings. These readings refer to special co-ordinates on a map, enabling a navigator to determine his position with great accuracy, but not directly useful to the pilot unless he homes on predetermined lattice lines. An auxiliary device is already being tried, however, which among other things gives the pilot direct readings of his displacement from a track of *any* desired shape, or selected approach orbit, and indicates miles to destination, actual ground speed, and time ahead of or behind schedule (Fig. 7). It is also believed possible, by using still lower radiated frequencies (10-14 kc/s), to obtain a working day and night range of at least 1,500 miles.

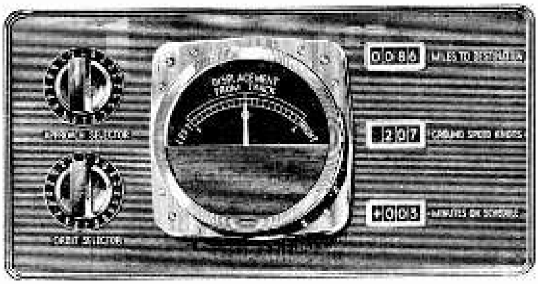

Fig. 7. Decca Track Control Unit indicator.

Radio communication between air and ground is an essential part of some navigational systems, and an invaluable stand-by when all else fails. The outstanding advance during the war was the general introduction by the R.A.F. of V.H.F. speech for short- and medium-range communication. This is now accepted on its merits as standard practice. A recent model (TR 1407) gives automatic selection of 336 crystal-referenced channels, with either A.M. or F.M.

Diversity of language is a difficulty in some areas, however, and to meet it automatic telephone technique has been applied to radio for communicating by visually displaying figures and obvious pictorial symbols. Transmission of messages and acknowledgments is automatic, by button-pushing; and many other facilities are ingeniously provided.

It remains to be seen how aircraft radio installations will develop as integrated systems. A major choice lies between V.H.F. systems, which have a very restricted range at low altitudes, and those working at lower frequencies, which are generally subject to night errors at certain ranges.

An example of the former, especially suitable for the shorter routes, is a combined V.H.F. equipment giving speech communication with the ground, "spider's web" location, and glide path landing. The ground controller, using information received from the aircraft and from his own radar and other aids, could from time to time instruct the pilot what co-ordinates to set on his computor in order to make a route that would avoid obstructions and, if necessary, delay him sufficiently to clear preceding arrivals.

Alternatively a similar procedure can be applied on hyperbolic systems. Decca, especially if lane identification and track control prove successful, has much in its favour, because it combines a good range at low altitudes with remarkable accuracy, and is very flexible.

Private owners are reluctant to fit additional radio for navigation only, and are naturally much attracted by devices such as the V.H.F. rotating beacon, and ground D.F. and G.C.A. systems. These navigational facilities are "thrown in" with the essential air-to-ground speech communication provided by a set such as the STR9* (Standard Telephones) which, weighing only 22lb, operates on four crystal-controlled channels in the 115-145 Mc/s band.

[* Illustrated in our review of the S.B.A.C. exhibition on page 367.—ED.]

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2 *Wireless World*, July 1946, pp. 223–5.

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4 *Wireless World*, Jan. 1946, pp. 23–6.

5 *Wireless World*, March 1946, pp. 93–5 and Aug. 1946, pp. 260–2.

WIRELESS WORLD DIARY

COPIES of the 1947 Diary are expected to be ready by the end of November, when they will be distributed through booksellers and stationers. Price is 3s 4½d, inc. purchase tax.

R.M.S. *Queen Elizabeth*

Radio and Radar Installations on the Grand Scale

THE maiden voyage of the Cunard White Star Liner *Queen Elizabeth* as a passenger vessel after her years of war service affords an opportunity of reviewing the ship's radio and radar installations. It is not possible, however, to give a detailed description of the equipment; we will, therefore, confine ourselves to a brief outline of the main features of the installation, for the operation of which the vessel carries ten radio officers.

In order to permit simultaneous transmission and reception of messages, handling of radiotelephone calls, and observation of safety-of-life requirements, the radio station is divided in two. The main office, situated approximately amidships on the sun deck, is the centralized control point for the whole station and contains all the receivers, telephone equipment, and transmitter control gear. The four main transmitters, covering the H.F., M.F. and L.F. bands, are housed in a separate room on the same deck just forward of the mainmast and about 250 feet from the main control room. This also houses a complete emergency station which can be put into operation instantaneously in the event of any failure in the ship's power supply or main equipment.

In a third room, adjacent to the ship's engine-room, are two 3-phase motor alternators for converting the ship's D.C. supply to A.C. at 220 V, 50 c/s, from which all the main radio equipment is designed to operate.

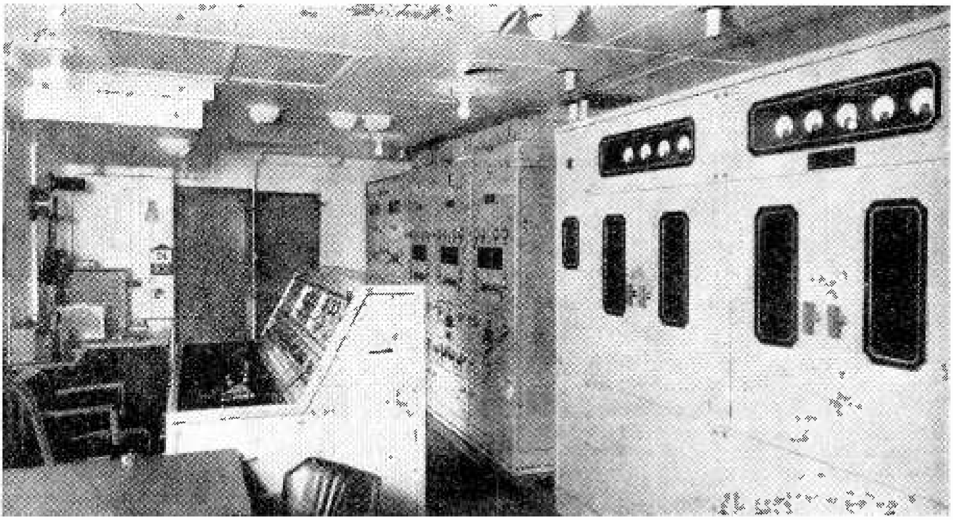
The main control office has an area of approximately 600 sq ft, and is provided with four main operating positions; two radiotelegraph and two radiotelephone, all of which may be used simultaneously without mutual interference. During peak traffic periods the number of operating points can be extended considerably by a system of inter-position control. All points in operation can be checked by the supervisor at a central control unit.

An automatic dialling system is employed, both at the engineer's control position and in the operating room, whereby the transmitters are switched on, the service (C.W. or M.C.W.) selected and the frequency changed. Ten channels are provided by the 3-kW M.W. and L.W. transmitters and six by each of the three 1-kW S.W. transmitters which operate in the 3-18-Mc/s band.

An outstanding feature of the whole installation, which was provided by the International Marine Radio Company, is the elaborate radiotelephone system, whereby passengers may pick up their bedside telephone and call any country whose telephone service is connected to an international exchange. They may also converse with passengers on other ships fitted with radiotelephones. In addition to room telephones similar calls may be made from the booths in various parts of the vessel. A special telephone booth adjacent to the main control office is fitted with a loudspeaker—a useful feature in the case of family groups wishing to hear a distant caller.

The radiotelephone equipment embodies such devices as compressor and expander units, permitting calls to be handled under the most difficult of atmospheric conditions. Two telephone calls may be handled simultaneously; thus one passenger may be speaking to America whilst another is speaking to Europe.

The future probability of a passenger radiotelephone and radiotelegraph service between commercial aircraft and ships is also envisaged, and provision for such service has been made in the ex-



A view of the main transmitting room in the *Queen Elizabeth* showing, in the centre, the engineer's control desk. Mounted against the right-hand bulkhead are, left to right, three high-frequency W/T and R/T transmitters and the M.F./L.F. telegraphy transmitter. The small emergency station is located in the left-hand corner. Her call-sign is GBSS.

R.M.S. "Queen Elizabeth"—

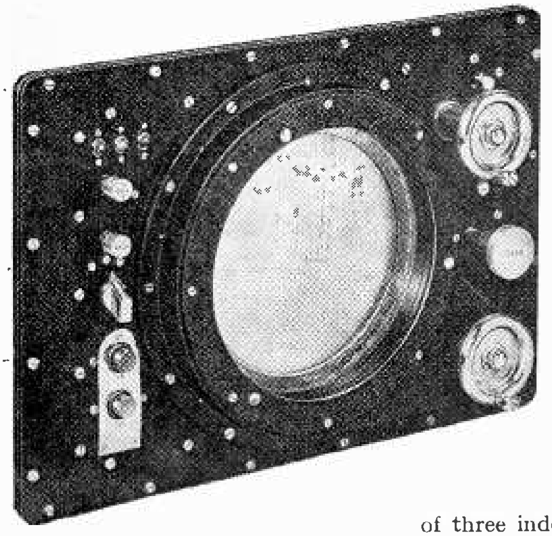
tensive bands covered by both transmitters and receivers.

In order to maintain the graceful lines of the vessel the number of aerials has been reduced to a minimum. Above the main control office there is only one dipole to which all receivers are connected through a special coupling system in the lead-in trunk. The number of transmitting aerials has been reduced by the simultaneous operation of one H.F. transmitter and the L.F. transmitter into one aerial. The two aerials used for the radiotelephone service are of the inverted "V" type mounted in a fore-and-aft line, thus giving east-west directivity when the vessel is on the Atlantic.

Two motor-lifeboats are fitted with complete radiotelegraph and radiotelephone equipment operating in the International distress frequency bands. In addition the vessel carries two of the well-known hand-operated portable transmitters designed by I.M.R.C. to the Ministry of War Transport specification, of which some 6,000 were supplied during the war years. Supplementary to these transmitters is the I.M.R.C. rocket kite aerial system.

Docking operations are greatly facilitated by the installation of a low-power radiotelephone equipment on the bridge, enabling the captain, navigation officers or pilot to talk directly to tugs, dock master, or officials awaiting the vessel's arrival.

The public-address equipment comprises a complete system for the origination and diffusion of programmes throughout the ship. Four 30-watt amplifiers are installed and can be grouped or used individually for the relaying of three independent programmes originating on board and a broadcast programme. Supplementary to this equipment is a separate emergency announcement system controlled from the bridge.



Control panel of the Cossor P.P.I. The top handwheel rotates the display in relation to the ship's heading line and that below rotates the cursor on the Perspex screen. To check that the apparatus is operating when on the open sea and no reflections are shown, a test button is provided. The control unit measures only 19 in wide × 27 in high × 12½ in deep

In addition to the standard I.M.R.C. direction finders operating in the M.F. band, the *Queen Elizabeth* has been fitted with Gee and Loran equipment and Admiralty Type 268 and Cossor radar gear.

The Cossor equipment comprises four units: the indicator, or P.P.I., which is housed in a special radar room in the wheelhouse; the main transmitter and receiver rack contained in a hermetically sealed tank 30in × 25in × 25in; the scanner, erected above the wheelhouse; and the alternator with an A.C. output of 180 volts at 500 c/s.

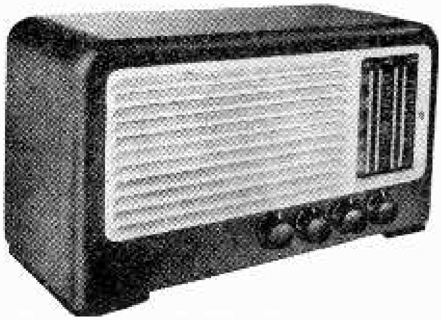
The 30-kW radar transmitter, working in the 9.425—9.525-Mc/s band, has a pulse recurrence of 1,000 on the 12-mile range and 2,000 on the 3- and 1.2-mile ranges. Its minimum range is given as 50 yds with an accuracy of ±5 per cent of the maximum range of the scale in use. This is defined as making it possible to separately distinguish two small objects with a range difference of only 70 yards.

Calibration rings of 0.2 nautical mile separation are provided for the 1.2-mile range and 0.5- and 1-mile rings, respectively, for the 3- and 12-mile ranges.

This prototype of a compact standard equipment conforms in all essentials to the recommendations laid down by the Ministry of Transport.

Our Cover

SCANNERS for the "Queen Elizabeth's" two radar sets are illustrated on the front cover of this issue. On the left is that for the Cossor gear, alongside which is the Admiralty 268 scanner enclosed in Perspex. A thermostatically controlled de-icing heater is incorporated in the Cossor scanner, which is constructed to maintain its scanning rate of 30-40 r.p.m. in wind speeds up to 80 knots.



FERRANTI Model 146

A three-waveband superhet circuit (4 valves + rectifier) is employed in this new receiver which is rated for an output of 4 watts undistorted. It is for A.C. mains and costs £18 18s, plus £4 os. 10d. tax.

SHORT-WAVE CONDITIONS

Expectations for November

By T. W. BENNINGTON

(Engineering Division, B.B.C.)

DURING the undisturbed part of September there was a very considerable increase in the daytime maximum usable frequencies for this latitude, while the night-time M.U.F.s decreased appreciably as compared with August. These variations were such as would be expected, having regard to the seasonal effect in the Northern Hemisphere.

The increase in daytime M.U.F.s was, however, enhanced by the high solar activity, and long-distance communication on exceptionally high frequencies was more frequent than of late, though, towards the latter half of the month, it was often prevented by ionosphere disturbances. Sporadic E, though it was often prevalent, was less so than during the past few months.

A large amount of ionosphere storminess occurred, though during the first half of the month only the 7th-8th and 10th were disturbed, and then not seriously. On the 16th, however, a disturbed period set in; on most of the remaining days of the month conditions were subnormal, particularly during darkness. The ionosphere storms took place as follows:—16th-21st (severe 17th), 21st-25th (very severe 22nd and 23rd) and 27th-30th (very disturbed 28th). "Dellinger" fade-outs were reported on 13th, 19th and 23rd.

During these ionosphere storms the Aurora Borealis was seen at several points in England, and Cable and Wireless states that on 22nd earth currents interfered considerably with cable traffic, though the cables were working normally on 23rd. Some delay to the company's direct radio traffic occurred on the circuits from this country to Montreal and New York due to the disturbance, but it was possible to maintain communication with Australia *via* the relay station at Colombo and with Canada and Australia *via* the Barbados relay station. Direct communication to Cairo and Capetown was not interrupted, these circuits passing through ionospheric regions remote from the zone of disturbance, which is centred on the North Magnetic Pole.

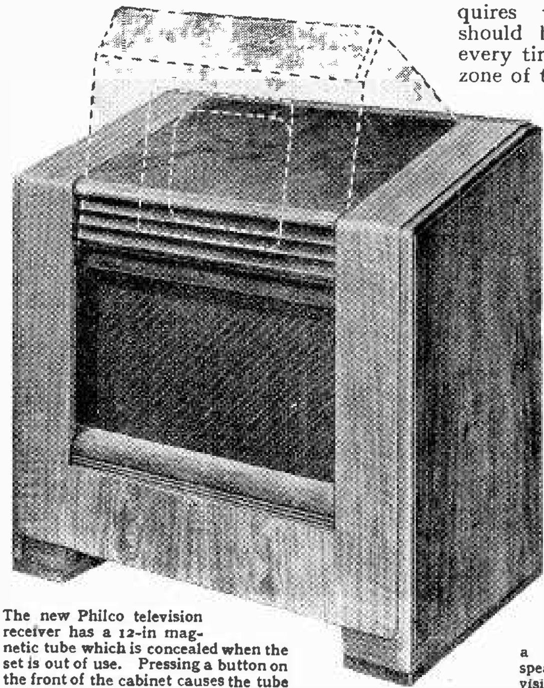
Forecast.—Daytime M.U.F.s during November should be even higher than during October over many paths, and communication on exceptionally high frequencies by way of the regular layers will be possible for long periods. On the other hand, the night-time M.U.F.s will generally be considerably lower than during October, so that the change-over from day to night frequencies and *vice versa* will be large in degree and relatively rapid in time. Night-time frequencies below 9 Mc/s will in many cases be required, though it is not expected that those below 7 Mc/s will often be really necessary.

The effects of any ionosphere storms which occur during November are likely to be particularly noticeable during darkness, for then the ionisation is, in any case, rather low and any further abnormal decrease may well interrupt communications. Although one cannot be at all certain, it would appear that such disturbances are more likely to occur within the periods 9th-12th, 14th-16th, and 21st-23rd than on the other days of the month.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during November for four long-distance circuits running in different directions from this country. In addition, a figure in brackets is given, which indicates 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	9 Mc/s		(14 Mc/s)
	0400	7 ,,		(12 ,,)
	0900	11 ,,	or 15 Mc/s	(16 ,,)
	1100	17 ,,		(24 ,,)
	1200	21 ,,		(30 ,,)
	1300	26 ,,		(36 ,,)
	1800	21 ,,	or 17 Mc/s	(28 ,,)
	2000	15 ,,		(22 ,,)
	2100	11 ,,		(16 ,,)
Buenos Aires:	0000	11 ,,		(16 ,,)
	0300	9 ,,		(15 ,,)
	0600	11 ,,		(16 ,,)
	0800	17 ,,	or 21 Mc/s	(24 ,,)
	1000	26 ,,		(36 ,,)
	1800	21 ,,	or 17 Mc/s	(28 ,,)
	2000	15 ,,		(20 ,,)
	2100	11 ,,		(17 ,,)
Cape Town:	0000	9 ,,		(15 ,,)
	0500	11 ,,	or 15 Mc/s	(17 ,,)
	0700	21 ,,		(30 ,,)
	0800	26 ,,		(37 ,,)
	1600	21 ,,	or 17 Mc/s	(32 ,,)
	1800	15 ,,		(22 ,,)
	1900	11 ,,		(17 ,,)
Chungking:	0000	7 ,,		(11 ,,)
	0400	9 ,,	or 11 Mc/s	(13 ,,)
	0600	17 ,,	or 21 Mc/s	(23 ,,)
	0800	26 ,,		(35 ,)
	1100	21 ,,	or 17 Mc/s	(28 ,,)
	1300	15 ,,		(20 ,,)
	1400	11 ,,		(17 ,,)
	1600	9 ,,		(15 ,,
	2000	7 ,,		(12 ,,)

Footnote.—The forecasting of disturbed ionospheric periods is based on the fact that as the sun rotates in an average period of 27.3 days any area upon it which gives rise to terrestrial phenomena will be in a similar position at time intervals of that duration. Thus there is the well-known recurrence tendency for magnetic storms to occur. But it is well to point out the limitations of this method. It requires that the solar area should be in an active state every time it enters the central zone of the sun's disc, and also does not take immediate account of new active areas which may come into being. At the present time the sunspot activity is increasing rapidly, so, when the forecasts are made for so long a period as two months ahead, the data is particularly liable to error at present.



The new Philco television receiver has a 12-in magnetic tube which is concealed when the set is out of use. Pressing a button on the front of the cabinet causes the tube to rise into view and at the same time switches on. The "user" controls—sound volume and tone and picture controls—are mounted alongside the tube while the pre-set controls are behind a removable panel under the speaker grille. Both sound and vision receivers are of the straight type.

DEFLECTOR COIL COUPLING

Correcting Distortion by the Valve Characteristics

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

IT was shown in a recent article that it is almost impracticable to obtain a linear saw-tooth current at frame frequency in a deflector coil by the "ideal" method of making each small group of elements linear in itself. This is because the requirements are so stringent that the design becomes uneconomical. In practice, therefore, it is necessary to balance inverse distortions in different elements so that they cancel and provide an overall result which is undistorted.

When a positive-going saw-tooth voltage is applied to the grid of a valve, the curvature of the valve characteristics makes the anode current tend to change more rapidly with time than a linear function. When a linear saw-tooth current wave is applied to the deflector coil through a coupling containing inductive or capacitive elements, the coil current tends to change more slowly with time than a linear function. It is, therefore, theoretically possible so to proportion the elements that the property of the circuit of reducing the rate of current change offsets the property of the valve of increasing the current rate of change.

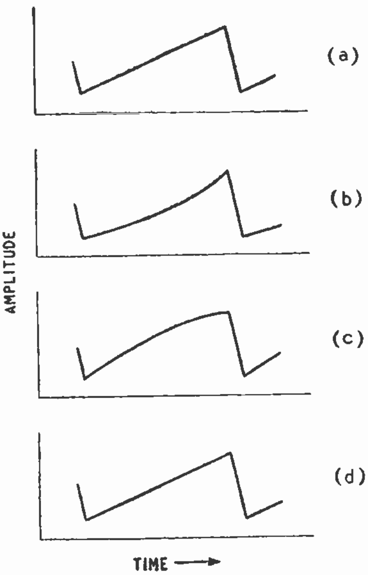


Fig. 1. A perfect saw-tooth grid voltage wave is shown at (a) and the anode current wave at (b). The latter rises too quickly because of valve curvature. If the valve were linear the anode current wave would be the same as (a) and the coupling to the deflector coil would distort the coil current to (c). With a non-linear valve distortion (b) corrects for distortion (c) and a linear coil current (d) is obtained.

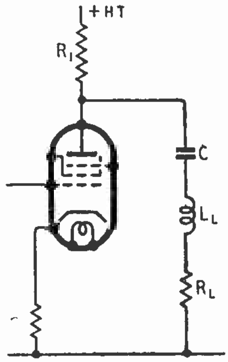


Fig. 2. Circuit of resistance-capacitance fed deflector coil.

This is shown in Fig. 1 where (a) represents a linear saw-tooth wave applied to the output valve. The resulting anode current has the form (b) because of the valve curvature. If the current were still linear like (a), the coil current would be distorted to the form (c) by the capacitive or inductive elements in the coupling. The distorted wave (b), however, is inversely distorted by the coupling and the resulting coil current is linear (d).

In practice, of course, perfect compensation is not to be expected, but a considerable improvement is easily obtained. Unfortunately, exact calculation of the output current resulting from the application of a linear saw-tooth wave to a non-linear valve with an inductive or capacitive output coupling is exceedingly difficult. In fact, it is practicable only when the valve characteristic can be expressed by a fairly simple equation.

It is possible, however, to solve the inverse problem fairly simply by semi-graphical means. If a perfect output current is assumed it is not difficult, but may be a little laborious, to calculate the grid voltage wave necessary to produce it. Arrangements can then be made to provide this grid voltage or, if it should prove to be one which is too troublesome to generate, by a process of trial and error the conditions demanding an easily generated grid voltage can be found.

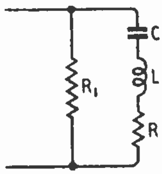


Fig. 3. Equivalent of Fig. 2 apart from the valve.

The first step is to calculate the changing current which the valve must provide and the back e.m.f. on its anode. This is easily done. For a capacitive coupling, Fig. 2, the equivalent circuit has the form of Fig. 3; in the former R_L and L_L represent the resistance and inductance of the deflector coil assembly. In Fig. 3, R and L equal R_L and L_L of Fig. 2. The current through the deflector coil is assumed to be $\Delta it/T_1$ where Δi is the total change of current required, T_1 is the period of the scan (19 msec for the frame, 84.5 μsec for the line) and t varies from 0 to T_1.

The transformer-coupled circuit is shown in Fig. 4 and has the equivalent of Fig. 5 in which L_p is the primary inductance, r_p and r_s are the primary and secondary winding resistances, n is the ratio of primary/secondary turns and $k = M/\sqrt{L_pL_s}$ is the coupling coefficient. Only the case of a unity ratio transformer for which $n = 1$ will be considered; any other ratio can be brought to this by multiplying the secondary impedances by n^2 and dividing the secondary current by n.

The equations relating the input current I and the back e.m.f. E across the input terminals to the coil current are given in the Appendix and it will be seen that the expressions are of identical form for both methods of coupling. This means that if the circuit values are such that the coefficients are the same the performance of the circuits is identical.

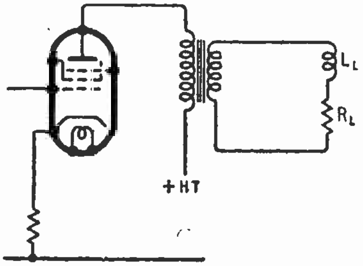


Fig. 4. Circuit of transformer-fed deflector coil.

However, in practice, it is not usually possible so to choose the circuit values that the coefficients are the same, and the two circuits thus do behave somewhat differently.

The procedure for determining the grid voltage needed by the output valve to produce a linear coil current is quite straightforward, but rather tedious. From the known circuit values, A, B, D, *a*, *b* and *d* (see Appendix) are enumerated and equations (1) and (2) are evaluated for a series of values of *t*. As Δi, the total amplitude of saw-tooth current required in the coil, is known this gives the values of input current I and back e.m.f. E at a number of intervals of time during the scan.

The voltage and current are related through time, but as during the interval considered they are uniquely related, time can be dropped and voltage and current considered as being directly related. Their ratio has the form of an impedance which is a function of time.

The current is not the anode current of the valve, nor is the voltage the anode voltage. However, they become these when certain constants, at present unknown and dependent on the valve operating conditions, are added to them. The simplest way of determining these unknowns is graphically, and is best explained by means of an example. For this the circuit of Fig. 2 will be

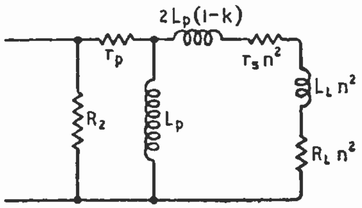


Fig. 5. Equivalent circuit of transformer-coupled deflector coil.

taken with $R_1 = 5$ kΩ; C = 16 μF; L = 0.6 H; $R_L = 1.25$ kΩ; $\Delta i = 50$ mA; and $T_1 = 19$ msec., corresponding to the period of the frame scan. Then the values of the coefficients in equations (1) and (2) are: A = 31.6; B = 1,250: D = 593; $a = 0.00634$; $b = 1.25$; and $d = 0.119$. Taking a series of values of t between 0 and 19 msec., Table I is prepared in which columns (3) and (4) are calculated from equations (1) and (2). The values selected for t are purely arbitrary and it is convenient to choose them to give round figures to t/T_1 since this simplifies the arithmetic.

A set of anode-volts/anode-current characteristics of the valve which it is proposed to use is required and these are shown in Fig. 6 for the 6V6. Now plot the figures of columns (3) and (4) of Table I on a piece of tracing paper *to the same scale as the valve curves.* This is shown in Fig. 7 labelled "load line."

This curve can now be superimposed on the valve curves where it forms the load line. Its current and voltage scales must always be parallel with those of the valve curves, but its position otherwise depends only on the operating conditions of the valve.

It is important that the valve rating is not exceeded and therefore the mean current should be marked on Fig. 7. The time at which this occurs is given by equation (3) in the appendix and in the example is at $t/T_1 = 0.51$, or $t = 9.7$ msec. Equation (1) then gives 33.77 mA for the mean current.

The D.C. load line for R_1 can now be drawn through this current. With $R_1 = 5$ kΩ the voltage drop across it is $33.77 \times 5 = 168.85$ volts. The mean current corresponds to a back e.m.f. of $-$ 40.73 volts; therefore, the load line is drawn through the points I =

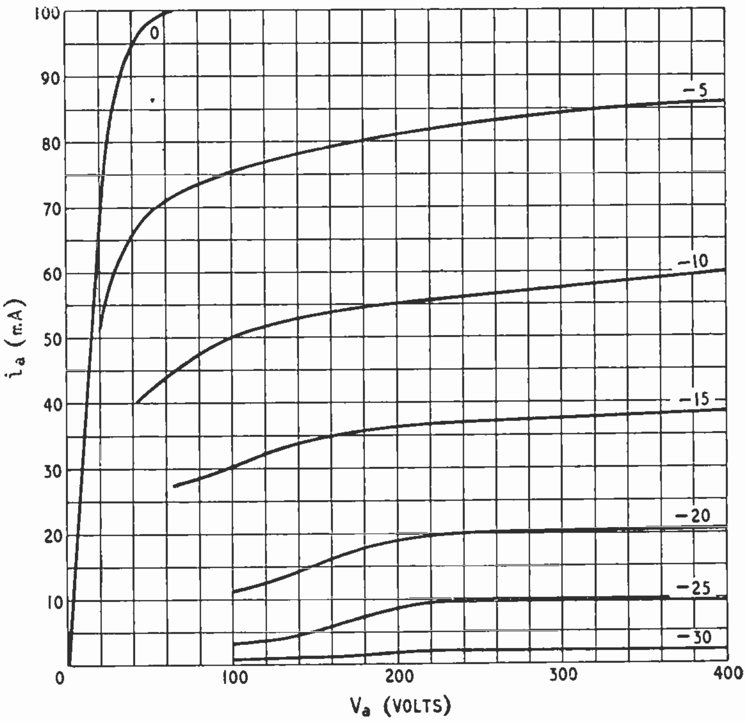


Fig. 6. Characteristics of 6V6 output valve.

Deflector Coil Coupling—

33.77 mA, E = −40.73 volts and I = 0, E = 168.85 − 40.73 = + 128.12 volts.

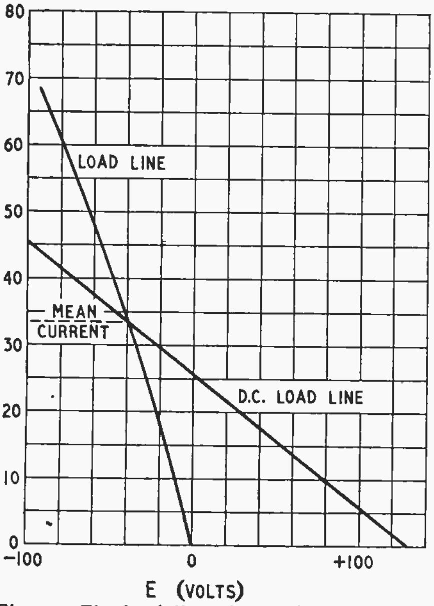


Fig. 7. The load line shows the relation between the saw-tooth current and the back voltage across the circuit.

The position of Fig. 7 on Fig. 6 is now limited by these points. It must be so placed that the mean current ordinate on Fig. 7 does not lie above the maximum rated anode current on Fig. 6, and so that the extension of the D.C. load line of Fig. 7 does not cut the zero anode current ordinate to the right of the maximum H.T. voltage available. The permissible positions for the load curve are considerably restricted by this, and it will often suffice to place it so that it lies on these limits.

This is shown in Fig. 8, which consists of the valve curves of Fig. 6 with the load lines of Fig. 7 superimposed so that the mean current of Fig. 7, 33.77 mA, lies on the maximum rated anode current of 45 mA for the 6V6 and so that the extension of the D.C. load line cuts the zero anode current ordinate at 340 volts, which is here assumed to be the maximum H.T. voltage. The scales of Figs. 6 and 7 are both shown in Fig. 8, so that this represents exactly the superposition of the two graphs.

Now reading from the " Fig. 7 " scale, list the currents and grid voltages corresponding to the intersections of the load line with the valve curves. Plot them as a curve, Fig. 9, and from this read off the grid voltages corresponding to the currents of column (3) in the Table. This intermediate stage of plotting Fig. 9 is necessary only because it is difficult to interpolate between the valve curves. These grid voltages are listed in column (5) and can now be plotted as a curve against time, column (1) as shown in Fig. 10.

This is the input grid voltage waveform needed to produce a linear coil current taking into account valve curvature. It will be seen that the curve is quite reasonably straight for a first attempt. The general shape is of a grid input voltage rising with time rather less rapidly than linearly, so that the valve is actually over-correcting slightly.

The use of negative current feedback by a variable resistance in the cathode circuit of the valve enables the linearity of the valve to be varied at will and so gives a practical control of the linearity. It is, however, still better to feedback from the coil current. By

TABLE I

(1) t (msec)	(2) t/T_1	(3) I (mA.)	(4) −E (V.)	(5) Vg (V.)
0	0	0.317	1.58	−21.4
1.9	0.1	6.626	8.126	−19.6
3.8	0.2	13.05	15.27	−17.3
5.7	0.3	19.6	23.0	−15.4
7.6	0.4	26.27	31.3	−13.5
9.5	0.5	33.05	40.23	−11.6
11.4	0.6	39.96	49.73	− 9.8
13.3	0.7	46.98	59.8	− 8.2
15.2	0.8	54.17	70.5	− 6.6
17.1	0.9	61.39	81.8	− 5
19.0	1.0	68.77	93.7	− 3.4
9.7	0.51	33.77	40.73	− 11.4

making the valve correct as nearly as possible for the effect of the coupling capacitance or inductance and then using negative feedback from the coil current almost any desired degree of linearity can be achieved.

Now in the case of transformer coupling the same general considerations apply. It is not possible to apply the example above

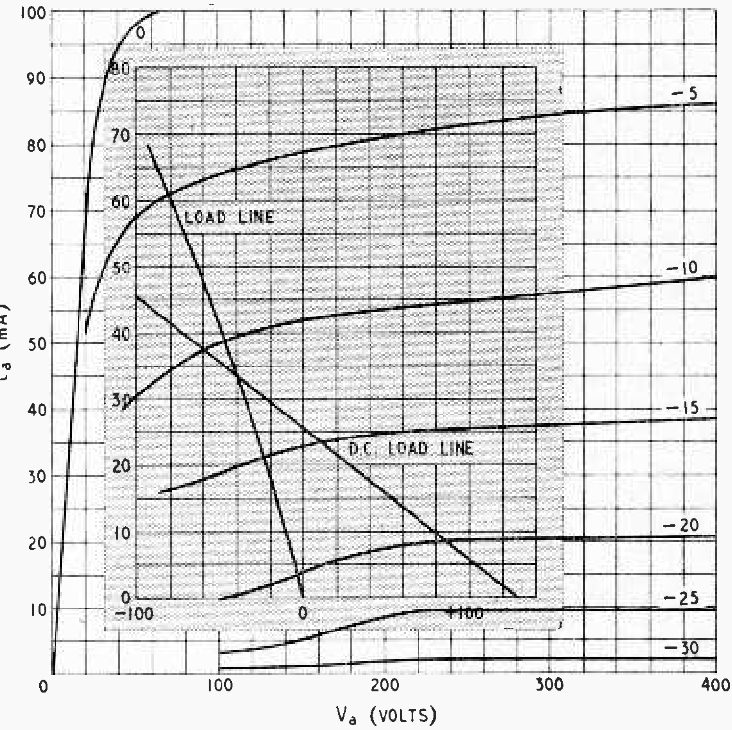


Fig. 8. The load lines of Fig. 7 are here shown superimposed on the valve curves of Fig. 6.

exactly to this case, however, for no constants in the transformer circuit will give coefficients in the equations equal to those adopted in the example. However, the results obtainable are very similar and in a calculation for transformer coupling carried out in the same manner as for a resistance - capacitance feed very similar results were secured. The values assumed for the transformer were $L_p = 100$ H; $k = 0.99$; $r_p = r_s = 750\ \Omega$; $R_2 = 50$ kΩ; $L_L = 0.6$ H; $R_L = 1.25$ kΩ; $n = 1$; T = 19 msec;

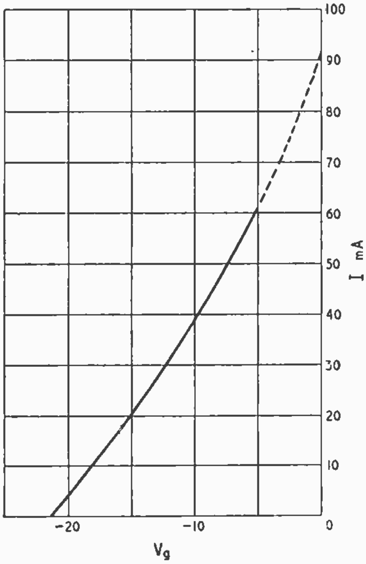


Fig. 9. The dynamic grid-volts—deflector-coil current curve produced by plotting the intersections of the load line of Fig. 8 with the valve curves.

$\Delta i = 50$ mA; and $E_{HT} = 250$ V. A lower H.T. voltage is permissible with transformer coupling because there is less voltage drop in the 750 Ω of the primary winding resistance than in the 5-kΩ coupling resistor of the resistance-capacitance feed. The same valve—a 6V6—was assumed with the same mean anode current of 45 mA.

In practice one would not use a 1–1 ratio transformer. This does not affect the calculation, however, for any ratio is easily reduced to the equivalent of a 1–1 ratio. Thus, if L_L were 3 mH then the ratio would be $n = \sqrt{0.6/0.003} = \sqrt{200} = 14.14$. The coil resistance and secondary resistance should then be 1,250/200 = 6.25 Ω and 750/200 = 3.75 Ω respectively, and the current would be 0.05 × 14.14 = 0.707 A.

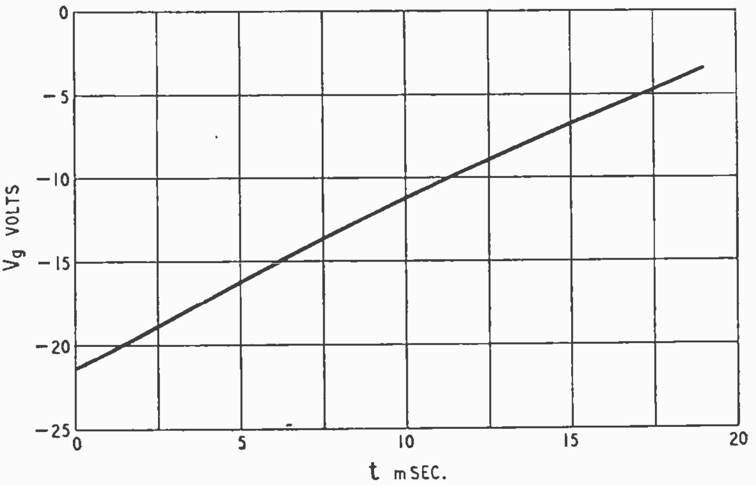


Fig. 10. The curve of input grid voltage against time is nearly a straight line showing that the valve and circuit distortions nearly compensate each other.

It will thus be seen that whichever form of coupling be adopted it is possible to reduce the inductance and capacitance to practicable values by allowing the curvature of the valve characteristic compensate for the distortion of the coupling. It is usually desirable, however, to utilize fairly heavy negative feedback in order to increase the linearity and to make the design non-critical.

APPENDIX

In the circuits of Figs. 3 and 5, the input current and the back e.m.f. across the input terminals are

$$I = \Delta i[a + bt/T_1 + dt^2/T_1^2] \quad \text{.. (1)}$$
$$E = -\Delta i[A + Bt/T_1 + Dt^2/T_1^2] \quad (2)$$

when the coil current is $\Delta it/T_1$.

In the above, for resistance-capacitance coupling (Fig. 3)

$A = L/T_1$; $a = L/R_1T_1$;
$B = R$; $b = 1 + R/R_1$;
$D = T_1/2C$; $d = T_1/2CR_1$;

while for transformer coupling (Fig. 5)

$A = L/T_1$;
$B = R + r_p(1 + L/L_p)$;
$D = T_1 r_p R/2L_p$;
$a = L/R_2T_1$;
$b = (1 + L/L_p)(1 + r_p/R_2) + R/R_2$;
$d = (1 + r_p/R_2)\,T_1R/2L_p$;

where $R = n^2(R_L + r_s)$ and $L = n^2L_L + 2L_p(1 - k)$.

The mean anode current occurs when

$$\frac{t}{T_1} = -\frac{b}{2d} + \sqrt{\left[\frac{b^2}{4d^2} + \frac{b}{2d} + \frac{1}{3}\right]} \quad (3)$$

The units are volts, amperes, ohms, henrys, farads and seconds.

Useful Test Meter

A NEW version of the Pifco "All-in-One Radiometer" is now available and supplies are being distributed through the trade. The moving-iron movement is suitable for A.C. or D.C. supplies and three ranges are available: 0-30 mA, 0-6 V and 0-240 V. In addition, an internal battery is provided for continuity tests, and a socket on the front of the bakelite case enables the filaments of 4- and 5-pin valves to be tested. The price is 25s.

Twelve-watt Amplifier

The TYPE 12 amplifiers made by R.S. Amplifiers, Reynolds Road, Acton Lane, London, W.4, have been redesigned and are housed in an all-metal cabinet with carrying handles. The amplifiers, which are suitable for use with the R.S. Type R.L.1 ribbon microphone, have two input channels and are available for A.C. only, or universal mains operation. The price in each case is £21.

μ IS OVERWORKED

Some Examples of the Confusing Jargon of Radio

By "CATHODE RAY"

ONE might very well suppose that there had been overwhelming feline influence at the back of radio, judging from the prevalence of μ in its language. This conclusion is supported by the fact that some of the μ's exhale an odour of red herring.

The first μ, which I think antedated radio, was *permeability*. That meaning may be considered to have a good title and right to the use of the symbol. And it is entirely appropriate that a concern manufacturing an alloy having a particularly high permeability should give it the distinctive trade name "*Mu*metal."

Amplification factor and *micro-* seem to have almost tied for second place in the race to claim μ. If anything, "micro-" led. It was chiefly in radio that very small fractions of electrical units were of practical importance, and people soon tired of writing strings of noughts after the decimal point, or, alternatively, "micro-" and even "micro-micro-." "μ" was an unlucky choice of abbreviation, however, because one of the fundamental formulæ in magnetism is:—

$$B=\mu H$$

and when "μH" also means "microhenry," which is a unit of inductance, well . . . !

μ for Magnification

Whoever applied μ to denote the newly discovered amplification factor of a valve may have thought the subject-matter was far enough from inductance to be safe. The choice presumably arose from the idea of *magnification*; μ being the Greek "m." (What a mercy some benefactor thought of "Q" before μ got roped in to mean resonant-circuit magnification! It must have been touch and go!)

In America, where you can more or less buy over the counter a 100,000-watt broadcasting station (why not 100,000,000,000-microwatt, I wonder?), they are very fond of reckoning the mutual conductance of valves in micromhos. It only wants somebody to abbreviate this "micro-" to "μ" to increase the confusion.

Actually, a vastly sillier and more confusing thing *was* done, when the name "variable-mu" was coined. Of the three things about a valve, μ, r_a and g_m, the least variable of them in a variable-mu valve is μ. The whole point of a variable-mu valve is that its *mutual conductance* can easily be varied over a wide range. So presumably "variable-mu" is an abbreviation for "variable-mutual-conductance." Admittedly an abbreviation is just what was wanted; but the abbreviator cannot be credited with much sense for failing to realize that as "mu" is the way "μ" is pronounced, it wouldn't be long before misguided people started writing "variable-μ." Which is exactly what they did! (A rather similar indiscretion was the name "transitron," derived, I believe, from the American term "transconductance," but inevitably suggesting that the device in question is based on the transit-time effect in a valve.)

But even that isn't the worst. It certainly is rather a nuisance to have to warn every new generation of students about "variable-mu." If some of them are not warned, however, the consequences are not likely to be very serious. Quite otherwise is the way people use μ (as if it didn't stand for enough things already) to mean *amplification*, particularly the voltage amplification of a stage.

Their doing so says, in effect, that the internal resistance of a valve is always zero. Which is absurd, especially with pentodes. You will, no doubt, suppose that the people who do this lived long ago, before it was agreed that the meaning of μ in connection with valves should be *amplification factor*. Or that they are ignorant persons who only need a little patient instruction to put them right. Or that it was a mere slip on some casual occasion. Or that they are independent spirits who exclaim, "To the devil with all you who slavishly adhere to a hide-bound custom; *I* am going to write "μ" to mean what *you* understand by $\frac{\mu R_1}{R_1+r_a}$. Not at all. Believe it or not, they include doctors of science, solemnly contributing their considered learning to journals of the highest standing. Examples could be quoted in which a distinguished leader in the radio art and science has, as recently as this Year of Our Lord, 1946, used μ indiscriminately to signify amplification factor *or* stage amplification, not just in the same paper, but on the same page and in the same paragraph thereof.

Pity the Plodders!

The unquestionable standing and qualifications of such persons greatly aggravates the offence, because thousands of earnest plodders like ourselves are forced to spend a lot of time trying to make sense of the thing on the pardonable assumption that such an authority couldn't possibly be wrong, or perhaps build a considerable superstructure of error and confusion on this apparently secure foundation before suspecting the flaw.

For example, it is of considerable importance in everything concerned with negative feedback—and what branches of telecommunications are not so concerned nowadays?—to distinguish between the factor by which the use of feedback divides *amplification*, viz. $(1+AB)$, and that by which it apparently divides the internal resistance of the stage $(1+\mu B)$. (A stands for stage amplification, and B for the fraction fed back.) Typical values for a pentode are $A=100$ and $\mu=3{,}000$. So to make μ sometimes mean μ

μ is Overworked—
and sometimes A is not really very excusable.

The Miller effect is another notoriously sticky patch for students. Can you wonder, when the whole essence of the thing is obscured by misuse of the overworked μ?

What can be done about it? Short of trying at this late date to reverse generally accepted usages, the following can and ought to be done:—

(1) Use the abbreviation "μ" for "micro-" with discretion, especially where magnetic formulæ are concerned.

(2) Scrap "$\mu\mu$" altogether and substitute "*p*" (= "pico-." It is much easier and more euphonious to adopt the habit of talking about using "50 puffs" rather than "50 mu-mu-eff" or—worse still—"point 4-oze 5.")

(3) If, as I fear, it is too late to change "variable-mu," at least refrain from "variable-μ."

(4) Agree internationally that any person convicted of misusing μ to mean stage gain shall be banished for life to an island inhabited exclusively by cats and be compelled to talk no other language than theirs.

MANUFACTURERS' LITERATURE

THE Mullard Valve and Service Guide (published for use by the trade only) gives base connections, characteristics and equivalents of Mullard receiving valves and a table of replacements for obsolete types, with notes on circuit changes where necessary.

Illustrated catalogues of the "Philharmonic" range of sound equipment (amplifiers, microphones, loudspeakers, etc.) and of "Intercom" loudspeaker call systems have been issued by Ardente Acoustic Laboratories, Guildford, Surrey.

Technical details of silvered mica capacitors are given in an illustrated brochure received from Stability Radio Components, 14, Norman's Building, Central Street, London, E.C.1.

The Type DS10 short-wave 5 kW transmitter (2.5 to 22 Mc/s) for air and sea communications is described in an illustrated booklet issued by Standard Telephones and Cables (Radio Division), Oakleigh Road, New Southgate, London, N.11.

New price lists giving specifications and sizes of "Somerford" power transformers and smoothing chokes have been issued by Gardners Radio, Somerford, Christchurch, Hants.

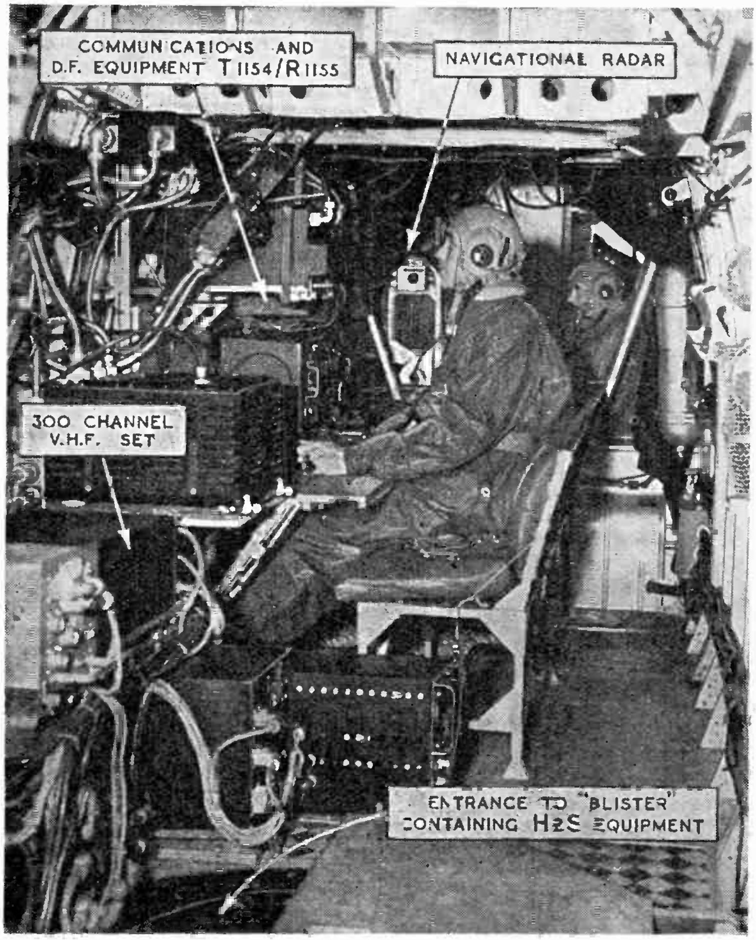
EMPIRE RADIO SCHOOL

Unified Methods of Training

THE latest training establishment formed under the joint auspices of the Air Ministry and the Dominion Governments is an Empire Radio School. Located at Debden, Essex, it has as its principal objects the unifying of radio training methods throughout the British Commonwealth and the training of signals and radar officers in all types of Service equipment, including the most up-to-date types.

Commonwealth Air Forces are eligible for these courses and its facilities are also available to members of civil aviation signal services and of foreign air forces.

The Liaison Branch was recently responsible for organizing a mission, consisting of the Commandant of the school and a team of R.A.F. signal specialists, to tour the Antipodes with brief visits *en route* to R.A.F. headquarters in Palestine, Iraq,



Interior of the converted Halifax bomber showing the location of the principal items of radio equipment.

In addition to ground instruction, the operation of equipments is studied in special radio equipped flying classrooms.

Personnel of any of the British Burma and South-East Asia. A converted Halifax bomber was specially fitted for the flight with all the latest radar and radio equipments in Service use.

AVIATION RADIO EQUIPMENT

Review of the S.B.A.C. Exhibition

AIRBORNE and ground radio installations were included in the aircraft equipment shown at the exhibition held in September by the Society of British Aircraft Constructors. This equipment comprised three main types: general-purpose communication sets, V.H.F. apparatus and radio aids to navigation.

Airborne communication sets are designed, as a rule, in the form of separate units, the number of units in an installation depending on the actual service required; this in turn is governed largely by the size of the aircraft and the space available.

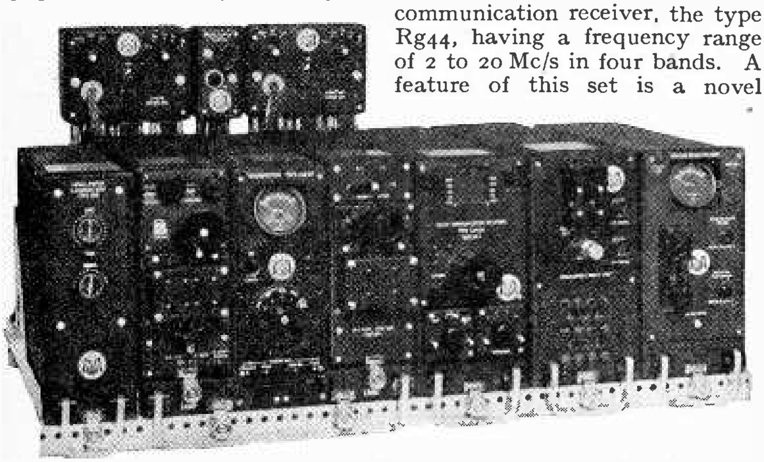
The transmitters and receivers are capable of operation over a wide range of frequencies, although in the case of airborne transmitters operation on a number of pre-selected spot frequencies is the customary procedure. The accompanying receivers, however, give continuous coverage throughout the recognized aircraft wavebands and often beyond. Many of the receivers embody D.F. and homing facilities.

On the other hand the V.H.F. equipment is mostly of single-unit construction and operates on a limited number of spot frequencies, both as regards transmitters and receivers, so that continuous tuning is not included. Operation is by remote control, the change from one frequency to another being relay-operated. Thus the main items of the installation can be accommodated in any convenient part of the aircraft, with only the remote control unit accessible to the pilot or radio operator.

Navigational aids shown consisted mainly of ground D.F. installations and beacon transmitters, but there were some examples of blind approach airborne equipment and simplified systems for taking radio bearings in the air.

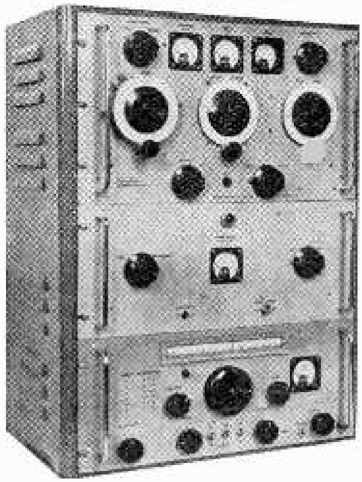
Marconi's Wireless Telegraph Company showed a new design of aircraft racking, having extreme adaptability. It consists largely of perforated channel-section members which can be cut to the required size and bolted together to form a complete installation. Into this slide the various items of equipment and each unit carries plugs, which engage with sockets on the racking, thereby making all inter-unit electrical connections.

Marconi's showed also a new communication receiver, the type Rg44, having a frequency range of 2 to 20 Mc/s in four bands. A feature of this set is a novel tuning system which embodies a drum scale having the entire tuning range engraved on it in spiral form. As the drum rotates pointers move transversely across the drum and follow the spirally engraved scales. There are four separate scales, each with its own pointer, and their combined lengths amount to about 30 feet.



Marconi lightweight radio installation for a medium size civil air liner. It comprises transmitter, receiver and D.F. equipment. Overall length is only 24in.

Included in the Marconi exhibit was a compact V.H.F. transmitter-receiver covering 78 to 100 Mc/s for mobile use for aerodrome control, ground and airborne equipment for blind approach and other navigational radio aids.



Rediffusion G32 transmitter-receiver for ground control stations. The carrier output is 50 watts.

Standard Telephones and Cables showed a general-purpose aircraft installation, Type STR11/13. Designed for fitting into medium size aircraft, where space is at a premium, wide use is made of miniature components in order to reduce the overall size of the individual units, in addition to which the design is such that the main items can be stowed in any convenient part of the aircraft and only the control units need be accessible.

On transmission the frequency range is 2 to 9.1 Mc/s and 320 to 520 kc/s, with provision for the selection of 12 spot frequencies in these bands. Continuous tuning is provided in the receiver, where the coverage is 2 to 11 Mc/s and 150 to 1,500 kc/s. Operation on C.W., M.C.W. or R.T. is possible, whilst D.F. facilities can also be included if required.

Other S.T.C. equipment comprised ground station direction-finding apparatus and two V.H.F. transmitter-receivers. One, the STR9, provides for R.T. operation on four spot frequencies in the band 115 to 145 Mc/s with full electrical remote control. It gives 4 watts R.F. output, weighs 22lb and consumes 180 watts at 26 volts D.C. It embodies a sensitive superheterodyne receiver.

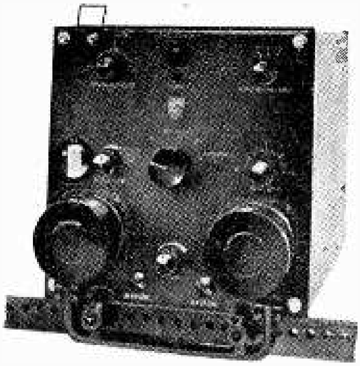
The other V.H.F. set is the STR12, also remote controlled, but with the choice of 12 spot frequencies in the range 122 to 132 Mc/s. Facilities are included for M.C.W. as well as for R.T. operation. Both these sets are crystal stabilized on transmission and on reception.

High power transmitters for medium- and short-wave operation and for installation in ground control stations on airfields, were shown by Rediffusion. The Model G40 is a recent development and this gives an R.F. output of 800 watts on C.W. or 500 watts when modulated.

This transmitter can be assembled for single channel operation over a wide band of frequencies, with or without a modulator, or as a two-channel set with both channels operating independently on different frequencies. In this form the output is 500 watts on C.W. from each channel.

Rediffusion were showing a new communication receiver, the R44, having a frequency coverage of 150 kc/s to 20 Mc/s in six bands. Three degrees of I.F. selectivity are provided, these being 9 kc/s, 3 kc/s and 400 c/s respectively, the last-mentioned being with the aid of a crystal filter in the I.F. amplifier.

There was also a specimen layout of the Rediffusion R.A.F. aircrew radio D.F. trainer and some radio heating apparatus for use in the manufacture of airframe parts.

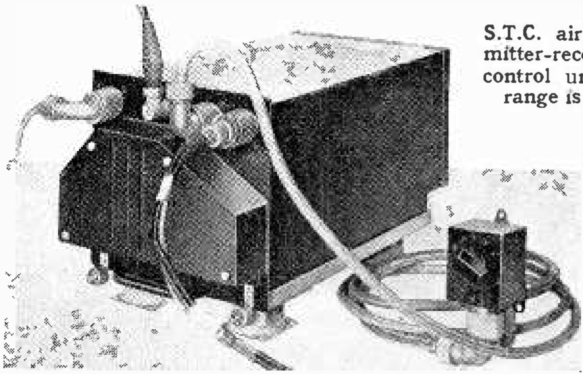


Philips aircraft direction finding receiver, Type SVP101.

The G.E.C. radio exhibit included a Glide Path Receiver for landing aircraft in conditions of poor visibility on aerodromes equipped with appropriate transmitting apparatus. There was also a Range and Localizer Receiver, which is a companion unit to the glide path set for use in directing the aircraft to the aerodrome from a distance.

Both these sets are remotely controlled and visual indications of height and approach path are provided. The G.E.C. "Asac" system of frequency selection, using a variable oscillator and one crystal controlled master oscillator, is employed in the Range and Localizer Receiver. Fifty channels having crystal stability are available.

There was also included in the G.E.C. exhibit a lightweight V.H.F. receiver with remote control by push-buttons for operation on any one of four pre-set crystal controlled frequencies in the bands 100 to 124 Mc/s or 118 to 132 Mc/s.



S.T.C. aircraft V.H.F. transmitter-receiver with remote control unit. The frequency range is 115 to 145 Mc/s.

Two airborne sets were shown by Philips, one is a transmitter, the type SVZ142, giving 100 watts output on C.W. and 40 watts when suppressor grid modulated. Designed for remote control operation, selection can be made of any one of 12 spot frequencies within the range 2.8 to 18.1 Mc/s. Provision is made to shift the operating frequency by about 1 per cent in the event of interference, so that in effect this gives 24 operating frequencies, all of which are crystal controlled.

The other Philips product consists of an airborne direction finder, the type SVP101. This uses a pair of crossed loops, a goniometer, and covers the frequency range 150 to 1,750 kc/s. Provision is made for remote or direct control and for omni-directional reception, aural or visual indication of bearing, or automatic direction finding, using visual indication and motor drive for the goniometer.

There was demonstrated on the Philips stand a new development for control of radio frequencies which is described as Philips "Igo" system. A single quartz crystal is used to stabilize the output from a variable frequency oscillator on spot frequencies over a very wide band. This gives an almost unlimited choice of stabilized frequencies, without the necessity to control each with a separate crystal.

Airborne radio apparatus is in the main operated from the 12- or 24-volt accumulator battery which supplies the power for the electrical equipment in the aircraft. A wide range of rotary transformers giving both H.T. and L.T. were shown by Newton Bros., which firm also included many examples of the carbon-pile regulator which is used with these

Aviation Radio Equipment—

machines. This regulator maintains the output of the rotary generator practically constant over a wide range of load conditions, or with a fluctuating input voltage. It operates on the principle of varying pressure on a stack of thin carbon discs, the varying pressure being applied by an electro-magnetic control in the input leads.

Rotary transformers for radio power supplies were shown also by B.T.H., Delco-Remy and English Electric.

The appearance at the exhibition of engine-driven alternators, giving 115 and 200 volts A.C. at 400 c/s to replace the existing 12- and 24-volt D.C. machines foreshadows a change in the design of future power supply units for airborne radio equipments. They were shown for single- and three-phase supplies by B.T.H. and English Electric.

The application of electronic equipment in the production of aircraft components was seen on the stand of Reid and Siegrist. Here a cathode-ray oscilloscope was used, in conjunction with two beams of light and photo-electric cells, to balance dynamically the high-speed rotors of gyroscopes. Speedy results with a constant standard of accuracy is obtained and its operation demands no special skill.

Another example of electronics in industry was the Supersonic Flaw Detector developed by Henry Hughes & Son. An operating frequency of about 2 Mc/s is used and minute cracks and flaws deep in a solid metal bar can be located by measuring the depth of penetration, before reflection, of the supersonic oscillations. Flaws can be detected from a depth of a fraction of an inch down to 20 feet or more in materials having a reasonably flat surface.

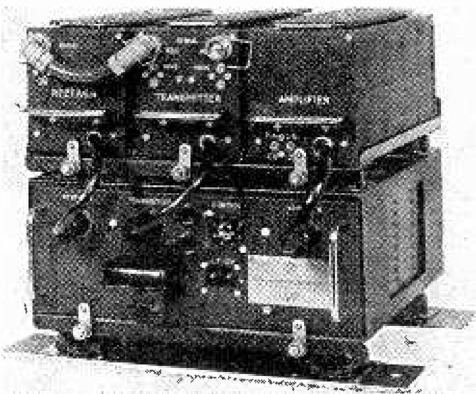
Mobile V.H.F. Gear

New Pye Communication Equipment

DESIGNED by Pye to Home Office specification, the apparatus illustrated here is intended for the use of police, fire and other services requiring a mobile radio telephone for installation in motor cars, small craft, etc. Amplitude modulation is employed. It operates in the V.H.F. band on a fixed frequency between 27 and 100 Mc/s and both transmitter and receiver are crystal controlled.

The mobile installation comprises a 6-valve transmitter giving 12 watts R.F. output, an 11-valve superheterodyne receiver, a modulating amplifier, a power supply unit, microphone, loudspeaker and a quarter-wave vertical aerial.

The first four items, which comprise the bulky units, are designed for assembly on a framework fitted with shock absorbers and intended for stowage in any convenient part of the vehicle, such as the luggage boot of a motor car. Only the remote control unit, measuring 4in × 3½in × 2¾in, and the microphone need be accessible to the crew.



Four main items of Pye mobile radio telephone assembled on shock absorbing mountings.

Each of the four items of the composite unit can be quickly removed for servicing, as plug-and-socket connections are employed throughout. Incidentally, the overall size of this unit is only 12in × 11in × 11in, which is made possible by the use of miniature components wherever practicable. All components are made to a tropical specification.

The receiver, which has a sensitivity of better than 1µV, has one R.F. stage, a 3-valve frequency changer consisting of a mixer, crystal oscillator - tripler and another tripler, 3 I.F. stages, double diode detector and A.V.C., another double diode for noise limiting, and A.F. and output stages. The audio output is 3 watts into a P.M. moving-coil loudspeaker.

In order to allow for frequency tolerances in the crystals and also to permit multi-channel operation, as described in *Wireless World* for February last, the band-width of the I.F. amplifier is set to approximately 60 kc/s.

The switching system allows the modulating amplifier to be used separately if required as a P.A. system, or as a loud hailer in a boat. The audio output is between 10 and 12 watts. Operating power is obtained from a 12- or 14-volt accumulator, the H.T. being supplied by rotary transformers, one for the transmitter and receiver alternately, as most systems are worked simplex, the other supplies the modulation amplifier.

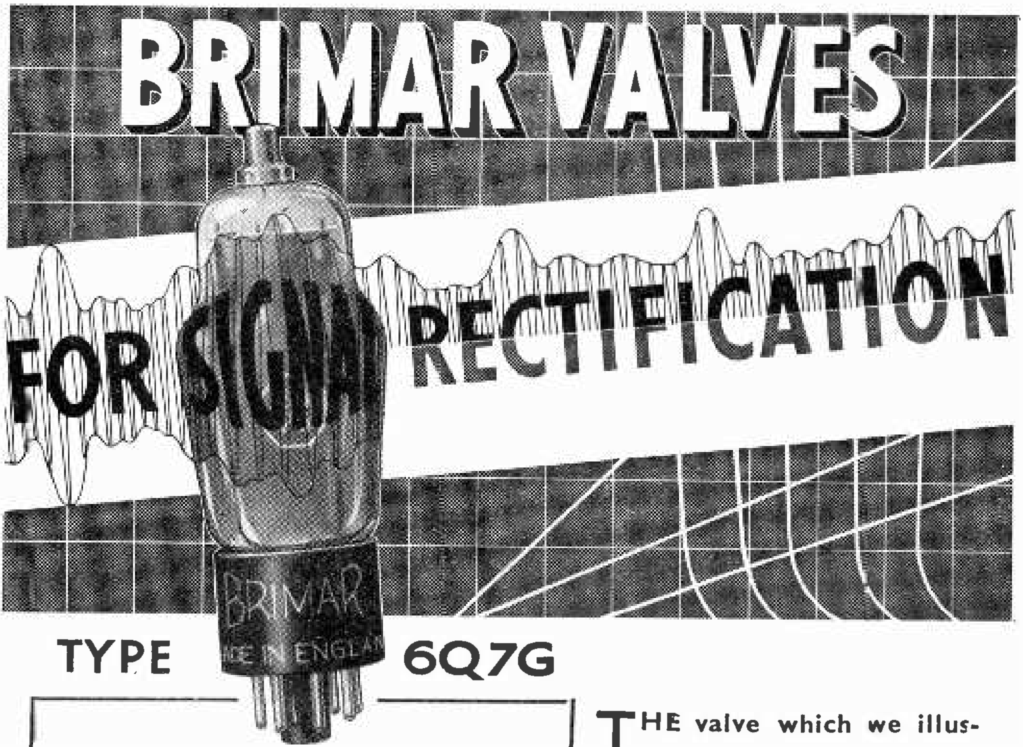
Modified versions of the equipment, together with a 100-watt transmitter, are available for installation at fixed stations.

ELECTRONIC WATCH TIMER

AN instrument for rapidly checking and adjusting the rate of clocks and watches has been produced by Furzehill Laboratories, Boreham Wood, Herts. A cathode-ray tube with a circular rotating time base is used and the tick from the timepiece under observation is picked up by a microphone, amplified and causes a bright spot to appear on the trace.

The time base is derived from a crystal-controlled oscillator associated with a number of frequency dividers and rotates at 10 c/s with an accuracy of 20 parts in a million (equivalent to 1.7 sec per day). Precession of the spot in a clockwise direction indicates that the watch is gaining and a scale is provided from which the rate can be calculated.

The microphone and watch clamp can be rotated through 90 degrees, so that the rate can be checked with the watch working in different planes. A small loudspeaker is included which enables the operator to listen to the amplified tick.



TYPE 6Q7G

BRIMAR VALVES FOR SIGNAL RECTIFICATION

TYPE	E/F	I/F	PURPOSE
ENGLISH			
10D1	13	0.2	DOUBLE DIODE
11D3	13	0.2	D/DIODE TRIODE
11D5	13	0.15	D/DIODE TRIODE
11A2	4	1.0	D/DIODE TRIODE
AMERICAN U.X.			
6B.7	6.3	0.3	D/DIODE PENTODE
75	6.3	0.3	D/DIODE TRIODE
85	6.3	0.3	D/DIODE TRIODE
INTERNATIONAL OCTAL			
1H5G	1.4	0.05	Batt. DIODE TRIODE
6B8G/GT	6.3	0.3	D/DIODE PENTODE
6B6G	6.3	0.3	D/DIODE TRIODE
6H6G	6.3	0.3	DOUBLE DIODE
6Q7G/GT	6.3	0.3	D/DIODE TRIODE
6R7G	6.3	0.3	D/DIODE TRIODE
12Q7GT	12.6	0.15	D/DIODE TRIODE
12C8GT	12.6	0.15	D/DIODE PENTODE
LOCTAL			
7B6	6.3	0.3	D/DIODE TRIODE
7C6	6.3	0.15	D/DIODE TRIODE
1LH4	1.4	0.05	Batt. DIODE TRIODE
MINIATURE			
1S5	1.4	0.05	Batt. DIODE PENTODE
6AL5	6.3	0.3	DOUBLE DIODE

THE valve which we illustrate, the 6Q7G, is a 6.3 volt, indirectly-heated, high impedance, double-diode-triode which gives its full output with a grid swing of 3.0 volts.

The list on this page shows other diodes with and without subsequent amplification. Equally comprehensive are our ranges for other purposes.

BRIMAR
(BVA)
RADIO VALVES

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

THE TRAVELLING WAVE VALVE

New Amplifier for Centimetric Wavelengths

By R. KOMPFNER

The work forming the subject of this article has been carried out for the Admiralty and is published by permission. It was initiated at the Physics Department, Birmingham University in 1942 and carried on, after a move in 1944, at the Clarendon Laboratory, Oxford University. All the investigations described were completed before the end of 1944, unless otherwise stated.

TWO main urges lie behind the trend to ever higher frequencies: the need for a wider range of frequencies in the transmission of intelligence of ever-increasing complexity, and the need for narrow beams of radiation. For instance, in order to transmit intelligence such as television signals, which at present comprise practically all frequencies up to four or five megacycles per second, we have to use carrier frequencies many times higher than the highest signal frequency. When the definition of the television picture is increased, as it surely will be, carrier frequencies will have to go up, too, in order to accommodate the wider band of frequencies which will have to be transmitted. The other main reason is that very high frequencies, or wavelengths of the order of centimetres, are essential for radar or radar-like applications if the structures which are to be used as aerials for transmitting and receiving are to be of reasonable size. Such structures have to be of a size of many wavelengths if a beam of radiation sufficiently narrow is to be produced. The valve is the heart of modern wireless, and the key to all these developments.

The need for centimetre waves became apparent some time before the war, and considerable effort was directed towards developing valves which could be used as amplifiers at these wavelengths. Oscillators, it was thought, would follow more or less automatically from amplifiers, since to convert an amplifier into an oscillator all that would be needed would be some feed-back from the output to the input in the correct phase to sustain oscillations.

The Klystron (see Fig. 1) was an immense step forward from the conventional triode. But it was soon realized that there are two major shortcomings of the Klystron as an oscillator and as an amplifier. As an oscillator not enough power was forthcoming.

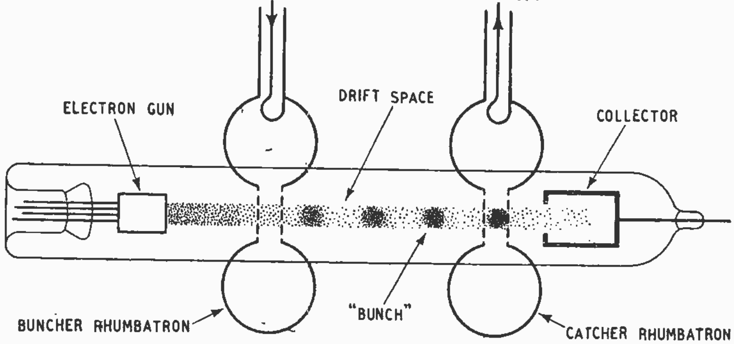


Fig. 1. Operation of the Klystron amplifier.

The conversion of the D.C. power of the beam (i.e., the product of beam current and beam voltage) into available R.F. power was considerably less efficient than simple theory predicted, and further, the D.C. power itself is very limited, due to the necessity for a long and narrow electron beam. Space-charge forces set a definite and rather low limit to the beam current, which can be passed through a number of small apertures such as occur in the Klystron. Thus the power output from Klystrons is frequently reckoned in watts rather than in kilowatts.

This was not good enough for radar and the invention of the multi-resonator Magnetron (see Fig. 2) superseded the Klystron in an incredibly short time as a high-power oscillator.

Apart from the utilization of a novel principle, the reasons for the enormous R.F. powers which can be obtained from the magnetron are: the circulating electron current in the valve is very largely due to its cylindrical

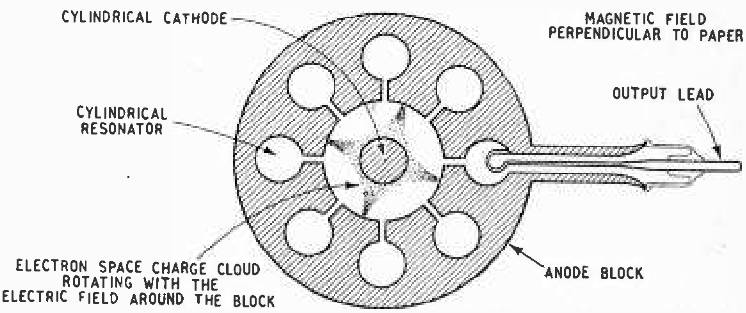


Fig. 2. The Magnetron oscillator.

The Travelling Wave Valve—
geometry and the efficiency as a converter of D.C. into R.F. power is very high. Thus the power output of magnetrons is usually reckoned in hundreds of kilowatts, and it is certainly true that, without the magnetron, radar as we know it now could never have arisen. How the Battle of the Atlantic, and the Battle of the Ruhr would have gone without radar, is not difficult to estimate, and how the war would have gone without winning these two battles is left to the reader's imagination. The writer apologises for this digression, but believes that it has some bearing on the story.

Insensitive Receivers

It is due to the enormous R.F. powers obtainable from the magnetron as transmitter, that comparatively little attention was paid to the receiving end of radar. Putting it in a somewhat exaggerated way: it just was not important enough to put any great effort into improving the sensitivity of radar receivers, since there was enough power—and some to spare—available from the radar transmitters to do most of the jobs radar was required to do. As an R.F. amplifier, the Klystron is very insensitive, and when it was shown that the ordinary crystal-and-cat's-whisker detector, used as a mixer or converter in a superheterodyne receiver, was better in respect of sensitivity than the Klystron, or any other valve, interest in R.F. amplification dwindled to next to nothing.

One of the main reasons for the lack of sensitivity of the Klystron as an amplifier was the inevitable inefficient energy exchange between the electron beam and the electric field in the rhumbatrons.

Before examining this question, it will be advantageous to define what is meant under sensitivity. The sensitivity of a practical receiver is defined in terms of how many times the noise power at the input exceeds the noise power at the input of an ideal receiver (i.e., one with the hypothetical minimum noise power). This factor is called the noise factor; radar receivers using crystal mixer input have noise factors somewhere between 10 and 100, while if a Klystron is used as R.F. amplifier at the input, the noise factor is somewhere between 1,000 and 10,000.

Little was therefore to be gained by improving radar receivers in respect of noise factor, since, at the most, an improvement of a factor 3 or 4 could be expected over a noise factor of, say, 10. (It seems unlikely that the ideal will ever be reached at the centimetric wavelengths.) On the transmitter side, with magnetrons, an increase in output power of 3 or 4, however, was relatively easily obtainable, and hence most of the research effort went in this direction.

Therefore it is not surprising that it was relatively late when it was realized that one of the basic principles of the magnetron, namely, that of interaction between a travelling field and an electron stream travelling at about the same velocity, could also be applied to the amplification of weak signals at the receiving end, making possible an amplifying valve of sensitivity comparable to that of the best crystal mixer receivers.

Klystron Shortcomings

A detailed examination of the Klystron as R.F. amplifier showed that the inefficient energy exchange between the electron beam and the electric fields in the rhumbatrons is due to the long time taken by the electrons in crossing these fields. Once this time, often called the transit time, approaches the time of a period of the oscillation, it is clear that the electron will gain during one-half of the time as much energy as it will lose during the other half, and the net result of the energy exchange will be nil. This is the same difficulty that lies behind the decrease in efficiency of the conventional valve at the higher frequencies.

It was therefore a very inviting thought to use the signal in the form of a travelling electric field (instead of a stationary one) and utilize the energy exchange between the travelling field and electrons which travel at about the same velocity.

Here we can find an analogy between valve development and wireless on the one hand, and engine development and flying on the other; it can, perhaps, be said that the step from interaction between stationary fields and electrons to interaction between travelling waves and electrons is reminiscent of the step from the reciprocating internal combustion engine to the gas turbine. And just as in the case of engines, the idea of travelling waves had been suggested many times in many different forms, but little had been done about it. However, with the advent of the centimetric wave technique the time was ripe and the logical development followed.

The first point to be noted about waves travelling with about the velocity of electron beams is that "reasonable" electron beams travel much slower than ordinary electro-magnetic waves. Under "reasonable" we understand electron beams of voltages between a few hundred and a few thousand volts. The actual relation between velocity v of an electron and voltage V needed to give it that velocity, for non-relativistic velocities, is:—

$$v = 5.95 \times 10^7 \sqrt{V} \text{ cm/sec}$$

where V is the beam voltage.

Thus 2,500 volts will give electrons a velocity of about 3.10^9 cm/sec; just about one-tenth of the velocity of light in free space.

Means therefore had to be developed for slowing down waves by roughly a factor 10, and the simplest and the most readily available structure was found to be a helix of conducting wire. Within wide limits, a wave will follow the wire, clinging to it, as it were, and therefore the progress of the wave in the axial direction is considerably slowed down as compared with the velocity along the wire, which is near enough equal to the velocity of light.

Slowing-down Process

A picture of the actual lines of electric force, which constitutes the travelling wave, is given in Fig. 3. It has to be realized that these lines of force move in the following way: they rotate about the axis of the helix and they progress from left to right. However, if we imagine ourselves also

The Travelling Wave Valve— moving from left to right, with the same velocity in the axial direction as the wave, we will continuously experience the same force. For instance, if we choose to travel with the point A, we will always experience an accelerating force (if we are negatively charged), whereas at the point B we would always experience a retarding force. At other points we would experience appropriate other forces as indicated by the direction and density of the lines of force.

Now let us consider what will happen to a thin electron beam travelling along the axis of the helix. Some portions of the beam will continuously be accelerated, others will be continuously retarded and the regions in between these two will experience neither one nor the other force. The inevitable result of the action of these forces is a displacement modulation of the beam, or, as it can be regarded, a density modulation. There are regions of the beam to the left of which the electrons are accelerated and to the right of which they are retarded. In these regions the density of charge will increase above the average. Correspondingly, there will be regions in which the converse conditions apply and the density of the charge will decrease below average. Thus the beam can be considered to have become amplitude modulated—the actual amplitude of the A.C. component of beam current growing at first approximately with the square of distance, reckoned from the beginning of the helix.

Experiments which were carried out with a helix of 18-S.W.G. copper wire of 9 mm outside diameter, and an electron beam of a few microamperes and 2,400 volts, showed that this view of the action of wave on beam was substantially correct, and that the resulting modulation of the beam could be made considerably more effective than the modulation to be expected from any practicable rhumbatron.

Now since it has been shown how A.C. energy can be imparted to an electron beam by means of a wave travelling along a helix, the opposite process, namely the extraction of A.C. energy from a modulated beam by means of a helix can be expected to occur with equal efficiency.

A rough picture of this process is as follows: Imagine a charge brought suddenly into the space within the helix. This charge will connect to the helix by means of lines of force, and these lines of force will spread out in time, one lot travelling along the helix in one direction, say, from left to right, the other lot travelling in the opposite direction. In other words, two waves are excited. Now, let the charge move along the axis of the helix, from left to right, with the axial propagation velocity of the waves. Then fresh lots of waves are continuously being excited; the ones travelling from right to left annihilate each other. The ones travelling from left to right, however, reinforce each other, building up a wave front of continuously increasing amplitude.

Now an amplitude-modulated beam can be regarded as a continuous uniform beam upon which there is superimposed a system of alternate positive and negative charges distributed in a sinusoidal manner. Each of these positive or negative charges will excite a wave as described before; the complete "induced" wave can be synthesized from the contributions due to the individual charges.

The pictures given so far, of the action of the wave on the beam, and the action of the beam on the wave, are only first-order approximations. They are nearly true when either the beam is very weak, or the helix very short; in reality these two actions are always present simultaneously, and the real picture is one of interaction between beam and wave. Suppose we start with a wave and an unmodulated beam. Almost at once there will be an amplitude modulation in the beam, and this will, also almost at once, induce a wave in the helix. This induced wave will again cause a beam amplitude modulation, and so forth, *ad infinitum*.

The theory which describes the complete process gives as result a wave which increases exponentially with distance, after some initial deviation from the exponential law.

In any real helix, in the absence of an electron beam, a wave will be attenuated; that is, its amplitude will *decrease* exponentially.

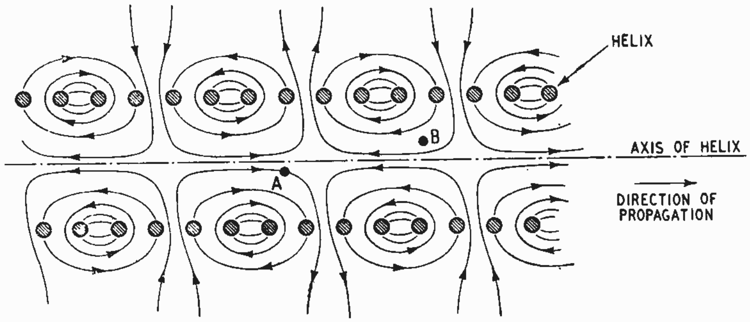


Fig. 3. Lines of force of a wave travelling along a helix (not to scale).

In the presence of an electron beam travelling at about the same velocity as the wave, the wave will *increase* exponentially. Hence one is justified in saying that the presence of the beam causes *negative* attenuation to be introduced into the helix.

Thus, by making either the helix long enough, or the beam current large enough, one can obtain a wave amplitude at the end of the helix which is substantially larger than that at the beginning. *Hence the system helix—electron beam is an amplifier.* Some of the D.C. energy of the beam is converted into A.C. energy in the wave by means of the interaction between wave and beam. A detailed examination shows that more electrons are being retarded than speeded up and thus the law of conservation of energy is satisfied.

The travelling wave tube, (see Fig. 4), as the complete device is

The Travelling Wave Valve—

called, consists in practice of nothing but a long and straight helix of wire supported in an evacuated glass envelope, containing also an electron gun for producing an electron beam and a collector for collecting as much as possible of the beam. Outside the tube proper are devices for matching the input and output leads to the helix, which may take many forms and are only indicated symbolically. It is, of course, important to procure proper matching (that is, reflectionless transitions) from input and output to the helix, as otherwise oscillations are easily excited when the helix is effectively an integral number of half-wavelengths long. Even if oscillations are not excited reflections at the ends will cause selectivity of the tube—that is, enhanced amplification at particular frequencies, destroying the broad-band amplification characteristic of the travelling wave tube, which may be a desirable property on occasion.

With Klystrons, amplification and bandwidth are conflicting requirements, each being roughly inversely proportional to the other. This is chiefly due to the fact that rhumbatrons are resonant structures, usually having rather high "Q"-values, in order to get high field strengths across the gap; but this unfortunately means that they will only amplify a relatively narrow band of frequencies.

The travelling wave tube, on the other hand, is in principle, a completely untuned device and the range of frequencies over which it amplifies is mainly determined by the "broadness" of the matching arrangements at input and output. Therein lies the importance of the travelling wave tube for the communications of the future.

The initial work undertaken here in England was mainly concerned with the travelling wave tube as a sensitive amplifier and the first tube—a demountable model continuously evacuated—was first tested in December, 1943, at the Nuffield Laboratory, Physics Department, Birmingham University.

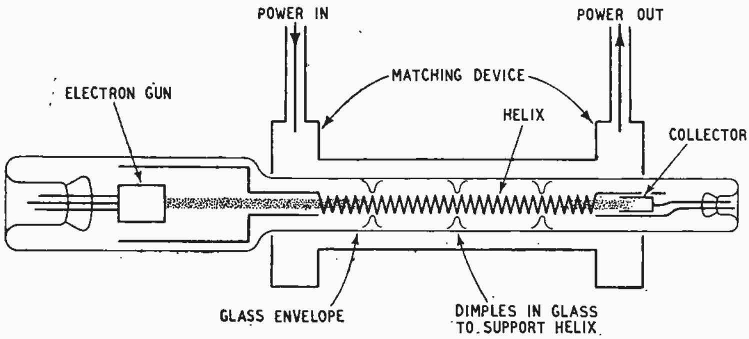


Fig. 4. Layout of the travelling wave amplifying tube.

The helix, 60 cm long, of 18-S.W.G. copper wire, 5 turns/cm, was wound on a $\frac{1}{4}$in mandrel, and a power amplification of 6 was given with a noise factor of 20. This happened at a beam voltage of 1,830 volts and with a beam current of 110 microamperes. The signal wavelength was 9.1 cm.

A short magnetic coil was used to focus the beam so that it impinged on the collector with the loss of only a few microamperes on the helix. Thick soft-iron shielding was necessary to keep away stray magnetic fields which are very troublesome with such a long and narrow beam.

A later tube, also continuously evacuated, gave a power amplification of 14 with a noise factor of 12, thus coming very close to the performance of a good crystal when used as a mixer.

The physical reason for the good noise factor of the travelling wave tube lies in the superior efficiency of energy transfer between electron beam and wave. Thus sufficient amplification is obtained with but a fraction of the beam current that would be required for a Klystron giving comparable gain. Less beam current means less shot-noise, and therefore less noise is added to the signal in the process of amplification than in a Klystron.

Work similar to that reported on above has since been undertaken by Bell Telephone Laboratories, New York, and results obtained there with travelling wave tubes have been quoted recently by J. R. Pierce and L. M. Field on the occasion of an Electron Tube Conference convened by the Institute of Radio Engineers of America.

Using a helix of iron wire of 30cm length, with an initial attenuation of 33db, and an electron beam of 1,600 volts and 10 milliamperes, a power amplification of 200 was obtained over a bandwidth of 800 Mc/s to points 3db down on the gain/frequency curve. No particular attention was paid to noise factor. However, an R.F. output of 200 milliwatts was obtained. A long solenoid was used to get the beam through to the collector. The mid-frequency was 4,000 Mc/s.

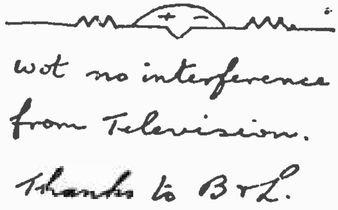
At this early stage of the development of the travelling wave tube, it is difficult to foresee all the possible applications and the consequences which will undoubtedly follow in their train. However, one particular field seems to have been waiting for just such a tube as the travelling wave tube, and that is television and multichannel communications transmission via centimetre-wave links or waveguides. Here the travelling wave tube might eventually play a part not unlike that of the magnetron in centimetric wave radar.

Acknowledgments

The writer is indebted to many for very helpful discussions and interest; at Birmingham chiefly from Professor P. B. Moon, Dr. R. R. Nimmo, Professor J. Sayers and Dr. G. Voglis, and at Oxford Dr. J. H. E. Griffiths, Dr. A. H. Cooke and Dr. B. Bleaney. Very able assistance in the actual work, experimental as well as theoretical, was given by Mr. E. E. Vickers, Mr. J. Hatton and Mr. H. Ashcroft at various times.

BELLING-LEE QUIZ (No. 5)

A selection of answers to questions we are continually being asked by letter and telephone

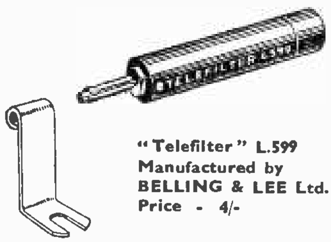


Q.23. Can Television interfere with the normal broadcast programme?

A.23. Yes, within a few miles of Alexandra Palace the television transmission may be imposed as an unwanted background on normal broadcast programmes. In this form it is untunable and must be rejected by a wave trap. This consists of a ¼-wave inductance in series with the aerial.

Such a filter is marketed by Belling & Lee Ltd. under the trade mark of Telefilter.

The other day we received anonymously a packet of twenty cigarettes together with the above "Chad," presumably from someone who was grateful for the relief obtained after fitting Belling Lee Telefilter. Should the donor recognise his handwriting reproduced above, we would like him to accept the thanks of the Service Department.



"Telefilter" L.599
Manufactured by BELLING & LEE Ltd.
Price - 4/-

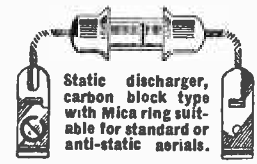
*Q.24. If a "Skyrod"*1 or Television*2 Aerial is erected on a building is there any added risk of being struck by lightning?*

A.24. Since the number of T.V. and Skyrod aerial installations has become considerable and following a period of thundery weather with lightning, the service department has been inundated with enquiries as to what users can do to protect themselves and their property against damage by lightning. These enquiries come in from members of the public, wireless dealers and wholesalers.

First of all, the nomenclature is unfortunate, in so far that a lightning conductor does not conduct or attract lightning, and a lightning arrester cannot arrest lightning.

One would expect interested people to realise that architects do not fit "lightning conductors" to chimneys, factories or other buildings to increase their chances of being struck, therefore why should those who fit a T.V. or Skyrod aerial, presumably with some visual resemblance to a "lightning conductor," expect increased danger?

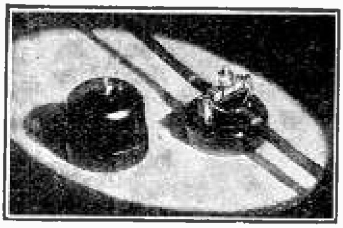
Readers who have visited Switzerland (and presumably other alpine countries where isolated wooden buildings are commonplace) will have noticed two or three spikes several feet high on roofs of isolated hillside dwellings, these are not aerials but "lightning conductors" to minimise the risk of a strike which inevitably would result in fire.



Manufactured by BELLING & LEE Ltd.
List No. L.350 selling at 8/6.

If a house is struck, in nine cases out of ten, it is a chimney that takes it. Technically this is due to the column of ionised (slightly conductive) warmer air which—winter or summer—is rising from it and drifting away down wind, ultimately rising far above any aerial. This is happening from every house all the time, therefore when a house is struck the first solid matter encountered by the charge is the chimney, which is usually shattered. Sometimes the charge travels down the chimney shaft and damages the decorations of the rooms en route. If the unfortunate house is on the phone the wires are generally fused, in spite of the proven "lightning arrester"*4 fitted by the G.P.O. *All this happens whether or not there is an aerial lashed to the chimney.*

When you take into account the many millions of houses, and the



Another type of static discharger specially designed for use with Television aerials and Belling & Lee*3 twin-feeder. List No. L.376. Price 9/6.

odd one or two that are damaged by lighting, you realise that the risk is negligible. As tangible proof of this, damage by lightning is generally included in every householder's comprehensive insurance policy, and no increased risk is recognised by the addition of an aerial, T.V., Skyrod, or horizontal.

As an additional "vote of confidence" every Belling-Lee aerial system is insured by us for a period of twelve months, up to a sum not exceeding one hundred pounds, against damage to the aerial system or radio or television receiver due to lightning. Following normal procedure this comes into operation only in the event of there being no collateral insurance or after any existing insurance cover has been exhausted.

*1 Skyrod (Reg. Trade Mark)
Type L.355/CK 12ft. collector, downlead, 2 transformers, pole clamps and earth wire, £7 2 6
Also supplied with chimney lashings and brackets or with an 18ft. collector at additional cost.

*2 Viewrod (Trade Mark).
Dipole, reflector and cross arm with chimney lashings, L.502/L each £5 5 0
Supplied also without reflector and/or chimney lashing from £2 3 6

*3 L.336 Balanced twin feeder per yard 6d.

All prices quoted are subject to alteration without notice.

*4 Static discharger is a more accurate title.

TO BE CONTINUED.

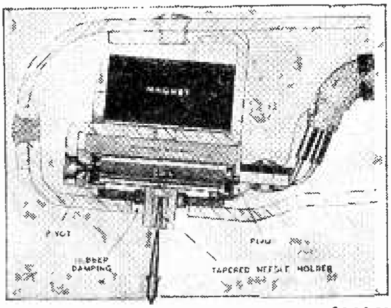
BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD ENFIELD MIDDX

GA

It's easy to make Pick-ups — if you know how.

The know-how in the manufacture of

Lexington MOVING COIL PICK-UPS



is the result of long experience and precision watch-making standards which give a finely constructed instrument the details of which are shown in the sectional diagram.

DE LUXE MODEL

- Robust design. Accidental dropping on record will not damage Pick-up.
- Extremely low moment of inertia (80 milligrams total weight of movement).
- Pure sine wave with no harmonic distortion.
- Automatic needle or sapphire changing opens new fidelity field to the amateur.
- Can be used with normal record changer without fear of damage

£5.0.0 plus 25/- P.T.

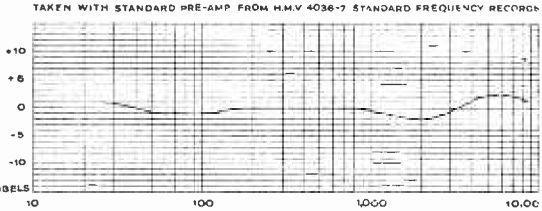
Sapphire needles with specially tapered shanks are available, price 15/3, including P.T.

JUNIOR MODEL

Identical in design and workmanship to the De Luxe, the only difference is that it is not equipped with the Automatic Sapphire needle Inserter and Extractor device and metal sole plate. Made to take standard steel and fibre needles this model enables every music lover to enjoy the fine reproduction which only a moving coil pick-up can give.

£3.3.0 plus 15/9 P.T.

CURVE OF LEXINGTON MOVING COIL PICK-UP
TAKEN WITH STANDARD PRE-AMP FROM H.M.V 4036-7 STANDARD FREQUENCY RECORDS



PRE-AMPLIFIERS having an inverse of the recording characteristic incorporated are available for use with these pick-ups when connected to commercial apparatus.

POWER AMPLIFIERS. Our new range giving the highest fidelity yet obtainable is now available in three models, 8, 15 and 30 watts.

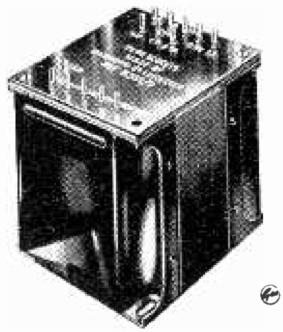
Illustrated brochure upon request. Trade enquiries invited.
Obtainable through your local Dealer

COOPER MANUFACTURING CO.
134, WARDOUR STREET, LONDON, W.1
Phone: GERrard 7950

FOR POLISHING THE SPURS ON THE HIGH HEELED BOOTS OF A COWBOY NAMED D'ARCY FROM WYOMING . . .

We have never received quite such a foolish enquiry and we use it only to attract your amused attention and to show you that we make Transformers for almost every purpose. So no matter how simple your requirements - no matter how small or large - do let us have a look at the problem next time. Illustrated is a special Transformer for Aeronautical Research designed for operation at three cycles per second.

PARMEKO LTD
OF LEICESTER.

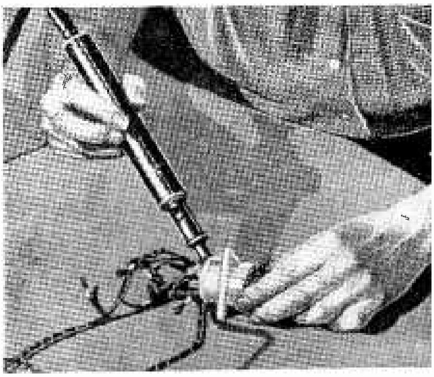


MAKERS OF
TRANSFORMERS.

MINIATURE SPOT-WELDING TOOLS

For Jointing in Radio Assembly

By R. W. HALLOWS, M.A.Cantab., A.M.I.E.E.



HAVING noticed a mention in the *Wireless World* of a miniature spot-welding tool which was brought out in Germany during the war, I determined to obtain particulars of it by hook or by crook. Thanks to the good offices of "F.I.A.T." and "B.I.O.S.," I have at length succeeded in so doing. Readers will remember that the use of the "Smallweldpencil," as it was called, was suggested as a possible alternative to soldering in radio assembly work.

The tool, which is made in the two forms illustrated in the figures, is about 10in. in length overall by one inch in diameter. The vibro-electrode welder (Schwingelektrode) is intended for joining wires up to 0.8 mm in diameter; say, No. 21 S.W.G. and smaller. The Welding Pencil (Kleinschweissgriffel) is designed for larger jobs. It will, in fact, tackle almost any kind of spot-welding, provided that the surface area of the joint does not much exceed 10 square millimetres — say $\frac{1}{8}$in × $\frac{1}{8}$in.

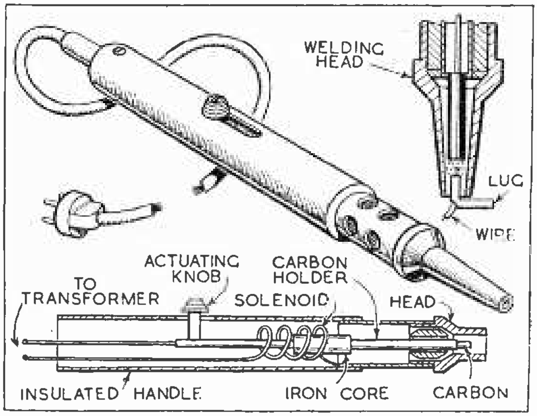


Fig. 1. The welding pencil, with details of its construction.

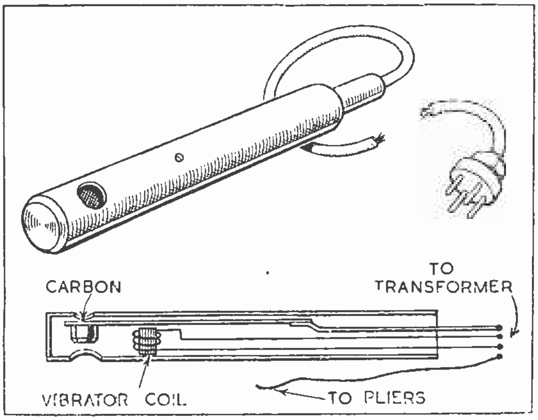


Fig. 2 (right). "Vibro-electrode" welder; the sectional sketch shows the vibrator.

The construction of the welding pencil is illustrated in Fig. 1. A hollow body made of insulating material serves as a grip for the tool. Fixed to its business end is the steel welding head, also hollow. The actuating knob allows a rod lying centrally within the handle to be pushed forward, thus carrying the carbon electrode into the aperture at the end of the welding head. Mounted on the rod is the iron core of a solenoid. The tool is worked from 110 V or 220 V 50-cycle mains by means of a transformer. As the voltage for welding does not exceed 35V there is no risk of shock.

A simple example, such as the fixing of a lead to a tag, will serve to explain the action of the welding pencil. The wire having been positioned on the tag, the aperture of the head is placed over both and the tool is so held that the walls of the head make good electrical contact with at least one part of the "work." The actuating knob is now pressed gently downwards with the forefinger until the carbon makes contact with the work. The circuit is: transformer secondary — carbon — work — head — solenoid — transformer secondary.

As the "making" of the circuit brings the solenoid into play the carbon is slightly retracted and an arc is formed. The actuating knob rebounds off the cushion of the finger tip (it is emphasized by the makers that the pressure on the knob *must* be gentle) and so the process continues for $\frac{1}{4}$ sec to 2 secs, according to the nature and cross-section of the work. The finger then releases the knob, which returns to its "off" position under the pull of the solenoid. The head is left covering the weld for $\frac{1}{2}$ sec or so to minimize oxydation.

In the vibro-electrode tool (Fig. 2) the movements of the carbon electrode are not brought about by opposing the pull of a solenoid by light fingertip pressure; instead, a small electro-magnet is used to produce the necessary vibration. As this tool is generally employed for joining one lead to another the work is held in a special pair of pliers connected by a flex and a plug to an earth socket on the terminal board of the transformer.

For the larger tool interchangeable welding heads with

Miniature Spot-Welding Tools— apertures of various diameters are available and 2mm, 3 mm or 4mm carbon electrodes may be used according to the work in hand. Besides the joining of wire to wire and wire to tag, small metal parts and sheet metal of the gauges normally used in wireless construction may be firmly fixed by means of a series of welded joints. The following direct welds are possible; it is necessary to use heads and carbons of the smallest sizes for those marked with an asterisk.

Iron to iron, nickel and brass*.

Copper to copper, silver and bronze.

Nickel to nickel, brass,* iron.

Silver to silver, copper and bronze.

Brass to brass*, nickel and iron.

Bronze to bronze, silver and copper.

In most cases where welding is impossible (e.g., iron-copper, silver-nickel, copper-brass) hard-soldering can be done with the aid of the welding pencil, silver, bronze or copper being used as the medium. Zinc does not lend itself to either welding or hard-soldering. Aluminium can be welded to itself and to iron, copper or bronze by the use of a special carbon electrode.

Both tools are, or at any rate were, made by the Siemens-Halske A.G. of Berlin.

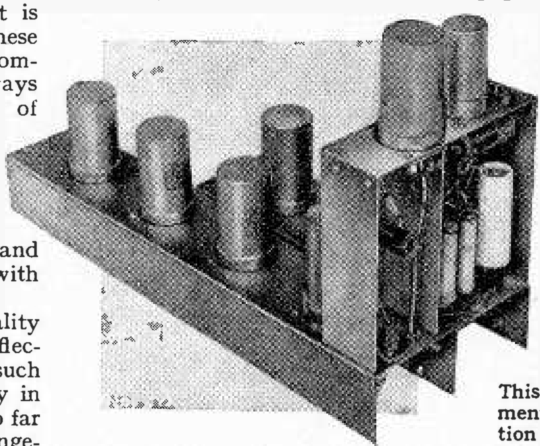
Television Receivers

Publication of Constructional Articles

THEORETICAL explanations of the individual parts of a television receiver are now being given regularly in *Wireless World*. But, although these articles make clear the requirements of individual stages, it is not always apparent how these stages fit together to form a complete equipment, nor is it always obvious how the integration of the parts to form a whole reacts on the design of the stages themselves. It is thought that these difficulties are best removed by the study of a complete design, and a receiver is being developed with this end in view.

The set will be of a high-quality type with electromagnetic deflection, and the design will be such that a good deal of flexibility in construction is permissible. So far as possible critical circuit arrangements will be avoided, even if this entails the use of more valves, and a unit construction will be adopted. This last offers many advantages, for the smaller size of the individual chassis makes the construction easier, and with careful arrangement the accessibility for adjustment and maintenance is improved. More important, perhaps, is the flexibility which it gives, for widely differing conditions can easily be catered for by the use of alternative units. Thus alternative receiving units can cater for long- and short-range reception, and the requirements of both 9in and 12in tubes are easily met.

The presentation of the design in the pages of *Wireless World* will be in the form of circuit diagrams and detailed photographs rather than as mechanical drawings and practical wiring diagrams. There are various reasons for this. One of the chief of these is the present component supply position. As one cannot guarantee the availability of any particular part, a rigid mechanical design is impossible, and it is necessary for any individual constructor to modify the layout and dimensions to suit those parts which he can obtain.



This photograh shows a development model of the receiver portion of the equipment. It comprises vision and sound R.F. channels and detectors together with the V.F. stage.

The photographs will indicate a layout which has been found satisfactory and will illustrate important points of detail, and so amplify the text. In the case of some components, which are not purchasable at all at the moment, rather greater detail will be given. These components are mainly special coils and transformers.

The present plan is, first, to continue the articles on the theory of the individual stages; secondly, to describe the construction of special components; and, thirdly, to describe the various units comprising the complete receiver. These stages will actually overlap and merge into one another, and the plan is not a rigid one, but is open to modification as circumstances dictate.

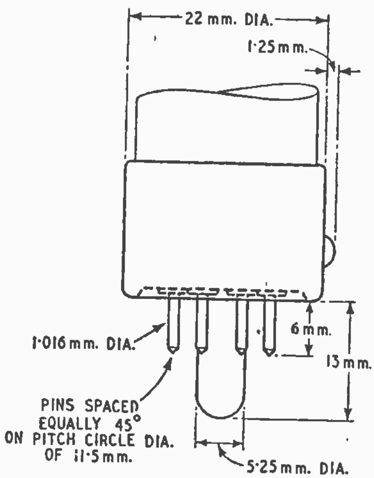
It will be appreciated that the development of high-quality television apparatus and of the special components is quite a lengthy business. It will be clear, too, that the description of all this must occupy quite a large amount of space in *Wireless World*. The paper supply position is likely to improve soon, but it will still be impossible to devote very many pages in each issue to the one subject of television. Consequently the description of the set and components must necessarily take a good many months to complete.

This explanation of the television plans for *Wireless World* is being given largely because it is impossible to provide a fully detailed description of a receiver within any short period, and it is felt that those readers who are keenly interested in this branch of electronics should understand the position. For their guidance it may be added that it is hoped to start dealing with the special components—probably deflector coil construction—in the January, 1947, issue.

Valve Standardization

First Steps by the B.V.A.

DISCUSSION is still proceeding on the types and characteristics of the valves which will be included in the new standard range to be



Principal dimensions of the new type B8A standard B.V.A. valve base.

produced by the British Radio Valve Manufacturers' Association. In the meantime a sufficient measure of agreement has been reached on the physical dimensions of the bases which will be used for some details to be published. The B.V.A. emphasizes that the proposals are tentative, but it is thought that any future modifications will be of a minor character.

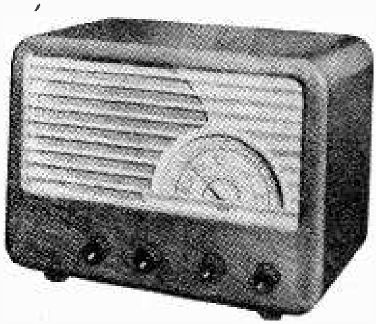
The first point of interest is that the bases will be of "all-glass" construction in which thin solid pins are sealed directly into bosses in the glass base.

Most of the new standard types will have an entirely new small eight-pin base (type B8A) with a central spigot and a locating boss on the side of the shell. A bayonet-type valve holder will be required and a side elevation of the new base is shown in the drawing.

Where a valve with a large bulb is required, as in the case of output valves and power rectifiers with higher heat dissipation, a larger base (type B8B) will be used. The dimensions of this base are similar to the existing eight-pin "Loctal" base, and from a tentative schedule of pin connections for use with all B.V.A. valves it would appear that existing conventions have been followed.

Tentative base allocations for the proposed B.V.A. standard valves are as follows:

Type	*Base*
Variable-mu R.F. pentode ...	B8A
High-slope R.F. pentode (wide band amplifiers)	B8A
Self-oscillating frequency changer(s)	B8A
Double diode triode	B8A
Output pentode(s)	B8A and B8B (according to type)
Rectifier(s)	B8A and B8B (according to type)
Oscillator triode (television) ...	B8A
Double diode, separate cathodes	B8A



A FOUR-VALVE, plus rectifier, superhet for A.C. mains (Model 516) has been introduced by Sobell Industries, Plantation Road, Amersham, Bucks. It covers the usual short, medium and long waveranges and has an output of 4 watts. The price is £20, plus tax £4 10 4. An A.C./D.C. version will also be available, price, £21, plus tax £4 14 10.

SHORT WAVE CONSTRUCTORS' MANUAL

THE reappearance of the Eddystone Short Wave Manual is a welcome sign of the better availability of new components for the construction of amateur transmitting and receiving equipment.

While the designs given are modern in conception, the circuit technique is of necessity on strictly economical lines. A well-planned 28 Mc/s crystal-controlled transmitter is included, as well as one for 58 Mc/s, but this relies on a master oscillator for its frequency stability.

Other equipment includes a frequency meter covering 56 to 60 Mc/s, a 3-valve 5- and 10-metre convertor and a 4-valve T.R.F. versatile short-wave receiver. base connections for the post-war special types of short-wave valves of particular interest to the amateur.

The manual is issued by Stratton and Co., Ltd., West Heath, Birmingham, 31, and the price is 2s 6d.

World of Wireless

TELEVISION RADIO LINK

FURTHER confirmation that the G.P.O. has not abandoned the idea of employing radio links to extend the television service to the provinces was provided during a recent conference when W. A. Burke, the Assistant P.M.G., stated that both cable and radio links were being developed.

He mentioned this when referring to a demonstration of a television radio link which he and A. J. Gill, G.P.O. Deputy Engineer-in-Chief, had seen during their recent visit to the U.S.A. and Canada. The demonstration provided by the N.B.C., was over a distance of 84 miles using three intermediate transmitters working on a frequency of 7,000 Mc/s. In their opinion the received picture was indistinguishable from the original.

A citizens' mobile radio-telephone service, which is being inaugurated in 47 cities and on five major highways in the States, was also tested by Mr. Burke and Mr. Gill who made calls to their respective homes in this country from moving cars in Washington. It is stated that by the end of 1947 some 4,500 cars will have been fitted with the necessary equipment.

METEOR DETECTION BY RADAR

THE arrival in our atmosphere of an unusually large shower of meteors from the comet Giacobini-Zinner, which had been predicted for October 9th, was taken advantage of by the ionosphere research group of the Ministry of Supply to test a theory that meteors were detectable by radar.

Recent investigations carried out by the Department of Scientific and Industrial Research and the ionosphere research group, had associated spurious transient echoes from a height of about 60 miles with meteors. Many photographic records taken on October 9th have yet to be examined, but the visual observations confirm that the expected increase in echoes did occur.

As a matter of exactitude the echoes are not reflections from the meteors themselves, but from the accompanying streak of incandescent gas.

The apparatus at the Richmond Park, Surrey, station of the ionosphere research group consists of a modified G.L. (gun laying) radar set operating on 70 Mc/s and pulsed 150 times a second. This low pulse frequency is necessary as the C.R.T. time base in the receiver is extended to cover the equivalent of about 150 miles.

PRINTED WIRING

THE reference by "Diallist" in our October issue of a method for printing receiver wiring, which has been developed in America, has revealed that a similar system was evolved in this country as far back as 1941 by Henderson and Spalding, 32, Shaftesbury Avenue, London, W.C.2.

Circuit connections are printed with acid resisting ink on a thin bakelite panel, which is either metallised or coated with metal foil according to requirements, and the printed panels are immersed in acid to remove the exposed metal. A further process removes the ink leaving a clear metal pattern of the circuit wiring. Cross-over connections are made by printing on the reverse side and connecting through by means of small soldered-in rivets.

Bakelized paper, metallized or foil-coated, has also been used.

PERSONAL PORTABLE. This four-valve M.W. superhet, Model 106, produced by the Romac Radio Corporation, weighs approx. 4½ lb and is carried by a P.V.C. shoulder strap in which the aerial is wound. The dimensions are : 9½in long, 5¼ in high and 2in deep.

RADIOPHONE TO SHIPS

A SHORT-RANGE radiotelephone service between inland telephone subscribers and coasting and other short-voyage ships was introduced by the G.P.O. at the end of September.

The service area of each of the four transmitters at Cullercoats, Humber, Portpatrick and Seaforth, has a radius of approximately 150 miles. It is proposed to extend the service to other ports later.

MARCONI EXPORTS

MANY valuable contributions to the country's export drive are announced by Marconi's W.T. Co.

The company is to instal a complete station on the island of Timor, which will form the first link in a new radio network for the provision of a telegraph/telephone service between Portugal and her colonial possessions in Timor, India, Africa and China. The three transmitters will be erected near Dili.

Short- and medium-wave transmitters and studio equipment for a broadcasting and telecommunications system in Iraq are to be installed by Marconi's at a cost of approximately £35,000.

Broadcasting equipment for the Jornal do Commercio of Recife, Brazil, consisting of one 20-kW medium-wave transmitter and two 25-kW short-wave transmitters, together with studio apparatus, is also to be installed by Marconi's. The installation includes a frequency-modulated V.H.F. link between the studios in Recife and the transmitters some 20 miles way. Another 20-kW transmitter has been ordered by the Brazilian Radio Sociedade da Bahia.

Six 5-kW medium-wave broadcasting transmitters valued at £40,000 are to be supplied to the South African Broadcasting Corporation, which is expanding its services in the Union.

Four telegraph/telephone transmitters, complete with aerial equipment, are to be supplied to the Chinese Government to supplement the country's internal communications. They are fitted with remote control equipment enabling them to be operated from a distance of up to 25 miles.

PERSONALITIES

Lord Reith has been appointed chairman of the Commonwealth Communications Council, which, with the nationalization of Cable and Wireless, will become the Commonwealth Telecommunications Board. Since his resignation from the director-generalship of the B.B.C. in 1938 he has held various Ministerial posts and was, for a short while prior to leading the Government commission of investigation into commonwealth telecommunications, a director of C. and W.

W. Duncan, senior maintenance engineer at the B.B.C. station at Westerglen, Scotland, has been appointed engineer-in-charge of the Londonderry, Northern Ireland, station.

Frank S. Adams has severed his connection with the McElroy-Adams Group and is forming a company to manufacture radio and telecommunications equipment. His address is The Croft, Wilton, Salisbury. Tel.: Wilton 3283. He is not related to H. R. Adams, the managing director of McElroy-Adams.

IN BRIEF

Guernsey Television.—We hear from F. T. Bennett, of Guernsey, that the interference caused by the local G.P.O. transmitter with the reception of television in Guernsey, to which reference was made in our last issue, has now been completely overcome. He is loud in his praise of the G.P.O. engineers' efforts to provide interference-free reception "for one receiver well outside the service area."

Scientific Films.—A catalogue of films of general scientific interest has been compiled by the Scientific Film Association, 34, Soho Street, London, W.1, and published by Aslib (Association of Special Libraries and Information Bureaux), 52, Bloomsbury Street, London, W.C.1. A few of the 595 films listed cover radio subjects. The catalogue, giving data regarding hire, distribution and suitability for different audiences, is obtainable from S.F.A. or Aslib, price 5s 3d, by post.

West Indies.—With the opening by Cable and Wireless (West Indies), Ltd., of a direct circuit between the British island of St. Kitts and the Dutch island of St. Maarten—both in the Leeward Islands—nine radiotelephone circuits now interlink West Indian islands.

Marconi transmitters, receivers and Marconators—direct-reading direction-finders—are to be fitted in eighty Vickers-Armstrong "Viking" aircraft.

China's Telecommunications.—Two-thirds of North China's telegraph and telephone lines having been destroyed, commercial telecommunications are now conducted by radio, with the exception of the Peiping-Tientsin-Tangshan lines.

Society of Inventors.—A Midland branch of the society has been formed in Birmingham and meets on the fourth Thursday of the month at 7.0 in the Chamber of Commerce, New Street.

G.R.S.E.—At the annual general meeting of the Guild of Radio Service Engineers it was announced that the membership had more than trebled since January.

School Broadcasting.—The Central Council for School Broadcasting announces that there are now over 13,000 schools registered as listening to the B.B.C. schools broadcasts. This total—a record—is some 1,300 more than last year. There are, in addition, 1,684 schools registered in Scotland.

City and Guilds.—The 1945 report of the City and Guilds of London Institute records that, although there was a slight decrease compared with 1944, the number of examinees for the five subjects grouped under telecommunications was 15,033—almost half the total number of examinees for all subjects. The year's total of 256 entrants for the radio service work examination was an increase of 41 on the previous year.

"Electronics."—The January, 1940, issue of *Electronics* is required to complete a library's volumes. Offers should be addressed to "E. H. B.," c/o The Editor.

Back Numbers.—Our Publisher asks us to state that he will be pleased to purchase from readers 1946 issues of *Wireless World* prior to the current number.

British Telecommunications Research, Ltd., is the title of the new research organization formed by British Insulated Callender's Cables and the Automatic Telephone and Electric Co. (See our September issue.)

An Overseas Edition of *Murphy News*, printed on air-mail paper, has been produced for the Company's distributors outside Britain.

Glasgow Exhibition.—Among the radio manufacturers exhibiting at the Technical exhibition, to be held in the Kelvin Hall, Glasgow, from November 15th-27th, are: Allander Industries, Ardente, Coastal Radio, Measuring Instruments (Pullin), Morgan Crucible Co., Marconi Instruments, Radio-Aid, Laypak, Truvox, and Scophony.

British Industries Fair.—The first post-war Fair is to be held from May 5th to 16th, 1947. The lighter industries, including radio, will be exhibited at Earls Court and Olympia, London, and the engineering and hardware sections at Castle Bromwich, Birmingham. Enquiries regarding the London exhibition should be addressed to the Export Promotions Department, Board of Trade, 35, Old Queen Street, S.W.1. Tel.: VICtoria 9040.

SPECIAL ATTENTION has been paid to the quality of the sound channel in the Ekco Model TSC30 television console which employs a 9-in tube. The cabinet is fitted with an anti-resonant chamber and the frequency response is said to be substantially flat from 80 to 8,000 c/s. Price, £58 16s., plus £13 7s. 7d. tax

World of Wireless—

Aerialite, Ltd., has now opened a sales office and showroom at 91-93, Baker Street, London, W.1. Tel.: WELbeck 7986.

Marconi Instruments, Ltd., has opened offices and a showroom at 109, Eaton Square, London, S.W.1.

Masteradio.—The service department of Masteradio, Ltd., has been transferred from the company's works at Watford to 319-321, Euston Road, London, N.W.1.

MEETINGS

Institution of Electrical Engineers

Radio Section.—Symposium of papers on direction-finding by Drs. R. L. Smith-Rose, R. R. Pearce and F. Adcock and W. Ross and C. Clarke on October 30th.

"Pulse Testing of Wide-band Networks," by Dr. D. C. Espley, E. C. Cherry and M. M. Levy, on November 6th.

"Voltage Characteristics of Polythene Cables," by R. Davis, Dr. A. E. W. Austen and Prof. Willis Jackson, on November 20th.

"The Economics and Subjective Requirements of Television Picture Sizes," discussion to be opened by D. C. Birkinshaw, M.B.E., on November 26th.

Ordinary Meeting.—"Colonial Telecommunication Systems," by C. Lawton and V. H. Winson, on November 21st.

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

Cambridge Radio Group.—"Ground Radar," by Dr. D. Taylor, on October 29th at 6.30 at the University Engineering Laboratory.

"Radar Navigation," by Dr. R. A. Smith, on November 19th at 6.0 at the Cambridgeshire Technical College (Room 301).

London Students' Section.—"Trend of Modern Telecommunications," by A. H. Mumford, C.B.E., on November 18th at 7.0 at the I.E.E.

Television Society

"An Improved Television Signal Generator and its Uses," by F. H. Townsend, G. B. Goff and S. R. Kharbanda, on October 29th at 6.0 at the I.E.E.

Amateur Activities

SLOW MORSE PRACTICE

SINCE publishing the note in the September issue giving the R.S.G.B. schedule of slow morse transmissions for practice reception we have received the following additional information. Three additional stations in Essex: G3MD, 1,960 kc/s; G5FW, 1,915 kc/s; and G2QI, 1,820 kc/s; and one in Lancs: G6AI, 1,819 kc/s, are participating. The frequency employed by G2BJY (Staffs) is 1,905 kc/s, not 1,930.

As the revised schedule gives additional transmitting times we are publishing it in full:—

Sundays:	0900	G3LP, G3JK
	1000	G3MD
	1030	G5UM
	1130	GW3GL
	2100	G6AI
Mondays:	2100	G6AI
	2130	G2CPF, G2BJY
Wednesdays:	2130	G2CPF, G3LP, GW3GL
	2200	G5FW
Thursdays:	2100	G6AI
Fridays:	2200	G2QI
Saturdays:	2130	G2BJY

41-METRE BAND

COMPLAINTS have been made on both sides of the Atlantic about the continued "encroachment" of broadcasting stations into the 41-metre band. Likewise broadcasting authorities have accused transmitters of causing interference with their transmissions—as was instanced during the recent B.B.C. broadcast of the Nuremberg trials.

Commenting in its overseas journal *London Calling* on the complaints from American amateurs the B.B.C. states:—

"The complainants appear to have overlooked the revised allocations of frequencies made at Cairo in 1938. Under the Madrid regulations of 1932, the whole band from 7,000 kc/s to 7,300 kc/s was reserved exclusively for amateur use, but under the Cairo Conference regulations, which became effective on September 1st, 1939, the band from 7,200-7,300 kc/s was shared between amateurs and broadcasting.

"While, therefore, the B.B.C. is justified in using these frequencies for its broadcasting services, it naturally does not wish to interfere with the activities of amateurs, and will always seek to avoid such interference by choosing frequencies in other broadcasting bands when these are suitable and available.

"As solar activity is now increasing, the B.B.C. expects to be able to maintain its services to the Americas during the next few years without recourse to the 41-metre band, thus reducing to a minimum interference with amateur activity."

It should be stated that broadcasting in the 7.2-7.3-Mc/s band in the "American continent and the territories and possessions of the States of that continent" is not permitted under the Cairo regulations.

"Q" CODE

RECOMMENDED additions to the "Q" code have been published by the R.S.G.B., which asks that publicity should be given to these recommendations.

They are:—

QHI.—Move higher in frequency.
QHI?.—Shall I move higher in frequency?
QLO.—Move lower in frequency.
QLO?.—Shall I move lower in frequency?
QBK.—I can work break-in.
QBK?.—Can you work break-in?

It is also stressed that the use of the following existing signals should be encouraged:—

QSQ.—Send words once.
QSV.—I will send a series of Vees.
QHM.—I am searching for replies from the high frequency end of the band to the middle.
QLM.—I am searching for replies from the low frequency end of the band to the middle.
QMH.—I am searching for replies from the middle of the band to the high frequency end.
QML.—I am searching for replies from the middle of the band to the low frequency end.

NEW ZEALAND AMATEURS

ADDITIONAL frequencies were recently made available for New Zealand amateurs, who are now permitted to operate in the following bands (frequencies in Mc/s):

3.5— 3.96	W/T
7.0— 7.3	W/T
14.0— 14.4	W/T
29.0— 30.0	W/T and R/T
50 — 54	W/T and R/T
166 — 170	W/T and R/T
420 — 450	W/T and R/T
1345 —1425	W/T and R/T

Transmissions on 80 metres (3.5-3.96 Mc/s), which were previously restricted to New Zealand contacts only, may now be made overseas.

The use of the 5-metre band (58.5-

PART OF AN EXHIBIT arranged by the T.C.C. Television Society in the factory canteen. Various television components and chassis were shown and four television sets were working. The purpose of the exhibit was to demonstrate to employees just how T.C.C. capacitors are used in television equipment.

60 Mc/s) is discontinued, but in lieu of it the 50-54 Mc/s band has been allocated.

The 160-metre band has not been restored, but it is hoped that the 21.1-21.5 Mc/s portion of the 14-metre band will shortly be made available.

New Zealand amateurs are permitted to transmit in certain low-frequency bands for the first six months of operation, after which, if considered proficient by the New Zealand Amateur Radio Transmitters' Society, they are granted "high-frequency" permits. Special permits were also issued just prior to the war for W/T operation in the 20-metre band only.

Amateur Transmitters.—The number of licensed amateur transmitters in Great Britain and Northern Ireland at the middle of October showed an increase of nearly a thousand on the pre-war total. The present figure is 3,869.

Chinese Amateurs.—We hear from K. T. Chu, acting president of the Chinese Amateur Radio League, that it has now returned to the capital, Nanking, from Chungking, the wartime capital. The address of the C.A.R.L. is 40, May Yuan Villa, Kuo-Fu Road, Nanking (2), China. A copy of the League's journal, "Radio World," has also been forwarded to us.

Czech Amateurs.—The headquarters' station of the Czechoslovak Amateur Radio Society (C.A.V.) transmits on 3.6 Mc/s every Thursday between 2000 and 2100 G.M.T. News relating to amateur activities is transmitted on C.W. and R.T.

A British Amateur, C. G. Allen, G8IG, conducted two-way communication with the American superfortress, *Dreamboat*, during her non-stop flight from Honolulu to Cairo via the North Pole. Working on 14.290 kc/s, with a power of 120 watts, G8IG, who is sales manager of McMichael Radio, contacted the aircraft when she was over Alexandria at 7.15 a.m. on Sunday, October 6th.

"Sponsored" Amateur Radio?—The QSL cards used by members of the Bournemouth and District Amateur Radio Club sports an illustration of Bournemouth with the inscription "Bournemouth—Britain's All-Season Resort." They have been supplied by the Corporation to transmitting members of the Club.

CLUBS

Aberdeen.—The temporary secretary of the recently formed Aberdeen Amateur Radio Society is A. G. Anderson, 87, Braemar Place, Aberdeen, from whom details can be obtained.

Birkenhead.—Details of the re-formed Wirral Amateur Transmitting and Short-Wave Club, which meets monthly at the Y.M.C.A., Whetstone Lane, Birkenhead, are obtainable from the Sec., B. O'Brien, G2AMV, 26, Coombe Road, Irby, Heswall, Cheshire.

Blackpool.—Meetings of the Blackpool and Fylde Amateur Radio Society are now held on the first and third Tuesday of each month at the Bellevue Hotel, Whitegate Drive, Blackpool, at 7.30. Hon. Sec., H. D. Ashworth, G4PY, 4, Albion Avenue, Blackpool.

Ilford.—Meetings of the Ilford and District Radio Society are now held weekly on Thursdays at 8.0 at St. Albans Hall, Albert Road, Ilford Lane. The November meetings are:—14th, "Measurements in the Radio Field," by J. De Gruchy, of Everett, Edgcumbe and Co.; 21st, "Television Receiver Construction," by E. G. Coe; 28th, "New Developments in Speakers and Records," by H. A. Hartley.

Jersey.—Details of the recently formed Jersey Radio Society, which has a membership of over 40, are obtainable from the secretary, E. Banks, GC2CNC, "Fort Rock," Tabor Lane, Ronte des Genets, St. Brelades, Jersey, C.I.

Leicester.—A demonstration of the Wilkins and Wright "Coil" pick-up is to be given at the meeting of the Leicester Radio Society on October 29th at Charles Street United Baptist Church at 7.30. Sec.: O. D. Knight, 16, Berners Street, Leicester.

Manchester.—Readers in the Manchester, Prestwich, Whitefield and Bury areas are invited to the meetings of the Whitefield and District Radio Society on Mondays at 7.30 at the Stand Grammer School for Girls, Higher Lane, Whitefield. Hon. Sec., E. Fearn, 4, Partington Street, Newton Heath, Manchester, 10.

Reading.—Meetings of the Reading and District Amateur Radio Society will in future be held on the second Wednesday and last Saturday of the month at 6.30 at Palmer Hall, West Street, Reading. The new secretary is L. A. Hensford, B.E.M., G2BHS, 30, Boston Avenue, Reading, Berks.

Stoke-on-Trent.—Meetings of the Stoke-on-Trent and District Amateur Radio Society, re-formed in May, are held on Thursdays at 7.0 at the Tabernacle Church, High Street, Hanley. Sec.: D. Poole, 13, Oldfield Avenue, Norton-le-Moors, Stoke-on-Trent, Staffs.

Surrey.—Members of the Surrey Radio Contact Club were recently afforded an opportunity of seeing at the Mullard valve works, Mitcham, the latest methods of producing small transmitting valves suitable for amateur use. Of particular interest was the testing section, where life tests were being conducted on the valves at frequencies of 100 Mc/s or more.

West Middlesex.—Meetings of the West Middlesex Amateur Radio Club, of which Sir Ernest Fisk is president, are held on the second and fourth Wednesdays in each month at 7.0 at the Southall Labour Hall Rooms. Hon. Sec., Norman Priest, 7, Grange Road, Hayes, Middlesex.

Yeovil.—Amateurs in the Yeovil district interested in the formation of a club are invited by W. Kirkland, of 31c, Middle Street, Yeovil, to communicate with him.

LETTERS TO THE EDITOR

Is "Security" Dead? ✦ Wartime Inventions

Aftermath of "Security"

SINCE the end of the war your contributors and correspondents have at intervals pointed out with some force the discrepancy between the rates of release of the results of war research to the British and American technical Press. Their criticisms appeared to be allayed by the announcement of the Radiolocation Convention of the I.E.E., at which it was tacitly assumed that all results of value would be made public.

How rash that assumption was became immediately obvious to those who had been responsible for the radar research involved, especially to those few who, as I did, had to listen to every word of the Convention. Large parts of every subject were omitted; many topics were dealt with very sketchily. And the natural assumption *after the Convention* was that a security level was still being maintained on the mass of information which had been withheld.

Now it appears this assumption was incorrect. It will be remembered that at the Convention Dr. F. C. Williams gave an "Introduction to Circuit Techniques for Radiolocation." A delightful lecture—but as those in that particular line of business recognized, it only skimmed over the surface. The Miller or Blumlein Integrator, perhaps the most important single circuit development of the war, was dismissed in ten minutes, with no hint of the thousand and one ways in which it can be used—most surprising for Dr. Williams, who more than anyone might have been expected to dwell on it! Its use in the form of the Phantastron was not mentioned.

Until yesterday I, and I have no doubt thousands of others "in the know," had assumed that the Phantastron was still Secret with a capital S: and I should have no more dreamed of writing about it in this letter than I should have of handing the Nazis a centimetre magnetron in 1941. But in *Proc. I.R.E.* of August, 1946, you will find a paper on "Radar," by Schneider, in which the Phantastron is fully described. A British development—an American periodical.

We do not begrudge our American friends the knowledge of our war developments, nor yet (obviously) of those of their own country. But surely we, the British company of radio technicians and scientists, especially those who served their country outside the barbed wire, instead of inside it—surely we should know, too, what British enterprise, skill and cunning (radar pulse work *does* need a modicum of craftiness, as well as academic and practical skill!) have produced. Most vital is this, I think, in the circuit field, since it affects television to such a large extent. And many still have their time-base condensers connected between anode and cathode. Cannot we enlighten them? (I have often thought that a television receiver designed by T.R.E. would be a most beautiful creation!).

There is, finally, the question of why this information, and literally reams of parallel "gen," has not yet been published here. First of all, it may be that the papers composing the I.E.E. Convention are to be so expanded for publication that they will furnish just that outlet for which

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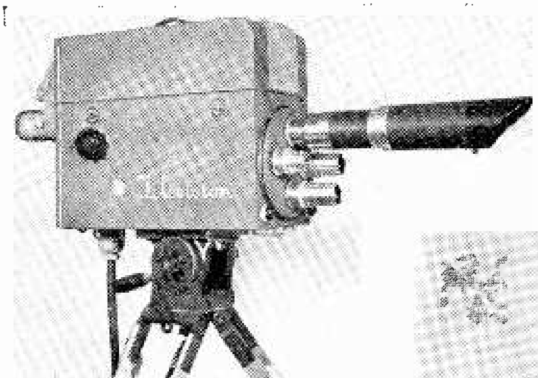
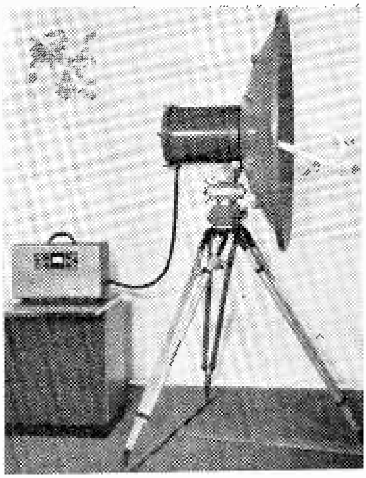
U.S. TELEVISION GEAR

TWO of the latest additions to the television transmission equipment produced by the Radio Corporation of America are shown in the accompanying illustrations.

Among the many points of interest in the new R.C.A. Image



A telephoto lens has been fitted in one of the four openings in the lens turret of the R.C.A. camera. *Below:* In the O.B. transmitter the output from a hooked waveguide is fed into the parabola.



Orthicon camera is the revolving lens turret which permits of speedy changing from one lens to another by means of a control at the back of the camera. Just below the turret are the "ready" and "on the air" lights.

For the transmission of signals from the scene of an outside broadcast to the main transmitter or from studio to transmitter, R.C.A. has produced a wide-band microwave relay link. The weatherproofed cylindrical unit behind the parabola houses either a transmitter or receiver, the controls for which are in a small separate case. Micrometer adjustment of the parabola is provided in both the horizontal and vertical planes to ± 15 deg.

I have been pleading. If so, well and good. If not, it is fairly obvious that either the right method was not chosen in the first place for dissemination of information—that criticism was made in your columns as soon as the plan was proposed—or that a Security Level higher than Restricted is still being maintained on large quantities of technical information. If the former—surely the columns of the *Wireless World* are still open? If the latter—why Secret here and Open in the U.S.A.?

ROBERT A. GORDON.
London, N.W.2.

"Miller" or "Blumlein" Integrator?

IN questioning the right of A. D. Blumlein to the credit for the so-called "Miller" Integrator circuit, R. J. F. Howard, writing in your September issue, cites British Patent 575,250. The provisional application for this patent was dated February 17, 1942, whereas I have it on what I believe to be very good authority that A. D. Blumlein used a condenser from anode to grid to obtain a linear fall of voltage not later than November, 1940, and that from that date other workers developed a variety of linear time-base circuits on the same principle.

Most circuit development work done during the war years was, of course, under cover of secrecy, which makes it even more difficult than usual to establish proof of original invention. So that the matter should not be left in a rather ambiguous position, it would be helpful if anyone having further evidence would come forward with it.

M. G. SCROGGIE.
Bromley, Kent.

Surplus Components

THE fears expressed in your Editorial in the June issue that the release of surplus components jeopardises the livelihood of the industry is surely unfounded. If an impecunious experimenter like myself can collect together a few parts at low cost as the nucleus of, say, a signal generator, he will not mind paying "new" prices for the components required to complete the job. The sale of a new signal generator will not be lost, for he could not afford the professionally turned-out product anyway; but if he is stimulated by the possession of a few basic components to exercise his ingenuity and keep alive his interest in experimental radio within his modest means, who can possibly be the loser?

HENRY MORGAN.
London, S.E.

NEW "QUALITY" RECEIVER

THE new "Silver Dragon" receiver announced by the Morton Cheyney Co., Stafford, is designed to combine the functions of a high-fidelity receiver with those of a communication receiver. There are sixteen valves excluding the rectifiers and each set is individually constructed and calibrated. There are six degrees of selectivity with bandwidths of 5 to 24 kc/s, the latter given by a T.R.F. circuit consisting of the R.F. stage and an infinite impedance detector feeding the audio - frequency amplifier. The output stage consists of two triodes in push-pull giving 10 watts with less than 2 per cent distortion.

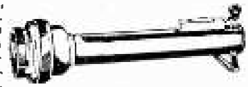
Automatic frequency control and volume expansion have been included, and there are independent bass and treble tone controls. In addition to medium and long waves the set covers 10.5 to 80 metres on three short-wave ranges.

The console is available in two alternative cabinets and costs, complete with 12in loudspeaker, £78 plus £16 15s 4d tax. The chassis may be obtained separately for £52 plus £11 3s 7d. tax.

BOOKS RECEIVED

"Radio Valve Vade Mecum—1946," by P. H. Brans. The latest edition of this comprehensive valve data book contains, in addition to the British, American, Russian and Continental receiving valves listed in earlier editions, the civil equivalents of American as well as British service types and also a list of valves used in the German and Italian armies during the war, together with their characteristics or civil equivalents.

Purchasers of the 1946 edition are entitled to a free copy of the quarterly supplements which it is proposed to issue. The agents in this country are Ritchie, Vincent and Telford, Ltd., 136a, Kenton Road, Harrow, Middlesex, and the price is 12s 6d, postage paid.



RANDOM RADIATIONS

By "DIALLIST"

The Ignition Menace

IF you ask a number of live radio salesmen what has been the greatest brake on the popularity of television in the past, you will, I fancy, receive the same answer from most of them. They will tell you that what did more than anything else to put off the prospective buyer was the snowstorm on the screen and the volley of hateful noises from the loudspeaker that occurred whenever a motor vehicle went past. Most likely they will add that there is not going to be a boom in television sales until something is done about it. We are, I firmly believe, on the verge of the era of the very high frequencies. Years ago I predicted that, though long-wave and medium-wave stations would continue to be used for some time, the bulk of the broadcasting of both sound and vision would eventually be done on frequencies of 30 Mc/s and above. The general V.H.F. broadcasting of sound would bring many boons; but the same enemy that has done so much to hinder the progress of television stands in its way. On frequencies of 40 Mc/s and above almost the only kind of interference that is at all serious is that from motor car ignition systems. Ordinary atmospherics are virtually unknown—though I have known charged raindrops blown against the aerial by a gusty wind to cause similar effects on rare occasions. The one really baleful influence is the combination of battery, coil, distributor and sparking plug with which every driver of a motor vehicle has now a perfect right to broadcast interference where and when he pleases. And though it is so easily preventible we allow it to go on! Some readers may not know that the ignition systems of all Service vehicles have been fitted with suppressors for some years. Vehicles used for war purposes must be efficient and suppression has had no evil effect on their performance. That it has succeeded in "silencing" them electrically I can testify from personal experience with 55-84-Mc/s radar. Why a Defence Regulation did not make suppression compulsory for civilian vehicles is a mystery. No one would have grumbled and it could have been kept in force once the war was over. It is certainly a matter of urgent importance that action should be taken without delay; every new car that goes on to the road with its ignition system unsuppressed increases the difficulty of setting matters right.

□ □ □

Pilot Lamps

AS readers have pointed out, the initial heavy flow of current through a cold filament for two or three milliseconds after switching on cannot possibly lead to burning-out, so long as the filament is of uniform thickness throughout. The resistance increases as the temperature rises and so cuts down the flow of current. Microscopic examination of a filament that has been in use for some time shows often that its diameter is far from being the same from end to end and there may be pronounced thin spots here and there. It is at one of these thin spots that the filament eventually gives way at the moment of switching on. Some pilot lamps, particularly those with short, stout filaments, last far better than others. At the present time pilot lamps, like so many other things, are not easy to obtain in large quantities and manufacturers have to take what they can get. Actually most pilots, if run at their rated voltage, give more light than is needed and it is sound policy to cut down the voltage to the lowest figure that will provide adequate illumination.

□ □ □

Sunspot Hiss

DID you happen to hear Sir E. V. Appleton's talk on sunspot hiss which was broadcast a week or two ago? Most likely you didn't, for it was part of "Science Survey" and his subject was not previously announced. What he had to say was of great interest to S.W. and U.S.W. enthusiasts. For some time now a team of British physicists has been investigating sunspot hiss. Their work is not yet completed, but already they have reached conclusions of considerable importance. It has been found that during their passage across the face of the sun large spots may be the scenes at intervals of markedly violent outbursts of activity. Such outbursts, which are usually accompanied by the projection of "flares," last for half an hour or so and coincide with both short-wave radio fade-outs and the occurrence of sunspot hiss. Fade-outs and hiss have been found to begin at the exact moment when the start of an outburst of activity is observed visually through the telescope. Therefore, both must be due to radiation travelling at the speed of light. Such radiation affects the F reflecting layer like breathing on a mirror. A day or so after such an outburst displays of Aurora Borealis are commonly seen. Therefore, the Aurora is due, not to electromagnetic radiation, but to a bombardment of the ionosphere by atoms ejected from the surface of the sun and travelling much more slowly.

—and the Milky Way

It is found that the electromagnetic radiation responsible for fade-outs and hiss "peaks" at about 5 metres. As the type of anti-aircraft radar known as GL2 is designed for working on frequencies of this order and has a directional aerial array, the British team found an excellent instrument for their investigations ready to hand. They are working, too, on Milky Way hiss, which was first observed in America about 15 years ago. A hiss, much less intense than that due to sunspots, is found to be audible when the aerial array is directed towards the Milky Way. Areas of maximum intensity have been discovered in Sagittarius and in one other portion of the Milky way. The cause of this kind of hiss is still a matter of controversy. One school of physicists holds that it is due to spots and outbursts of activity in the stars themselves. Others maintain equally stoutly that it originates in the inter-stellar activities of atoms and electrons. Sir Edward Appleton said that he had so far taken no active part in the argument; but he indicated that at the moment he was inclined to favour the latter theory.

More American Service Equivalents

SINCE the original list on page 305 of the Sept. issue went to press the following additional valve types have come to hand and we give them in the hope that they may be of use until complete lists are available.

Service Number	Civil Type	Service Number	Civil Type
VT2	WE-205B	VT149	3A8GT
VT4B	211	VT181	7Z4
VT5	WE-215A	VT195	1005
VT17	860	VT196	6W5G
VT19	861	VT204	HK24G
VT22	204A	VT208	7B8
VT34	207	VT217	811
VT38	38	VT218	100TH
VT39	869	VT220	250TH
VT41	851	VT227	7184
VT43	845	VT230	350A
VT51	841	VT232	E-1148
VT54	34	VT239	1LE3
VT60	850	VT240	710A
VT67	30	VT246	918
VT72	842	VT248	1808P1
VT106	803	VT249	1006
VT108	450TH	VT251	441
VT128	1630(A-5588)	VT252	923
		VT254	304TH
VT129	304TL	VT256	ZP486
VT130	250TL	VT257	K-7
VT141	531	VT266	1616*
VT142	WE-39DY1	VT267	578
		VT277	417
VT143	805	VT279	GY-2
VT144	813	VT282	ZG489

* Not 866 Jr. as in previous list.

"Linear Saw-Tooth Oscillator"

TWO errors appeared in the component values for Fig. 5 of the article published in the June issue under the above heading. The third paragraph in the centre column of p. 178 should read:—"The arrangement of Fig. 5 is satisfactory at 10 kc/s with $C=C_1=100$ pF; $C_2=0.1$ μF; $R=4$ MΩ, $R_1=R_2=R_5=10$ kΩ; . . . ."

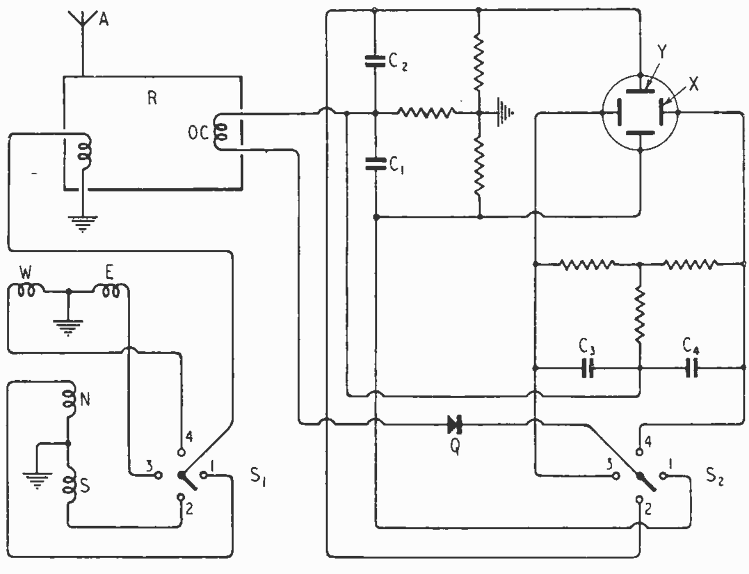
RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

CATHODE-RAY INDICATORS

SIGNAL voltages to be compared are fed cyclically to two pairs of condensers, each pair being connected in series across the X and Y plates respectively of a cathode-ray tube.

As applied to a direction-finder, N-S and E-W aerials are coupled in rapid succession through a rotary switch S1 to a receiver R, which is also fed by a sense-determining aerial A. One end of the output coil OC is connected, through a rectifier Q and the rotating arm of a synchronous switch S2, first to one and then to the other of the two series condensers C1, C2 across the Y-plates, and then similarly to the two condensers C3, C4 across the X-plates of the C.R. indicator. The other end of the output coil is taken to the midpoints of each pair of condensers, suitable shunt or leak resistances being provided as shown. The relative direction of the distant transmitter is then shown as a spot-point on the fluorescent screen; or the spot can be drawn out into a radial line.



Direction-finding display circuit.

Marconi's Wireless Telegraph Co., Ltd., and N. H. Clough. Application date, October 16th, 1940. No. 574710.

ARTIFICIAL LINES

A SMALL network, simulating a line many wavelengths long, and suitable for attenuating very high frequencies, consists of a pair of conductors shunted by a series of equally spaced resistances of graded value.

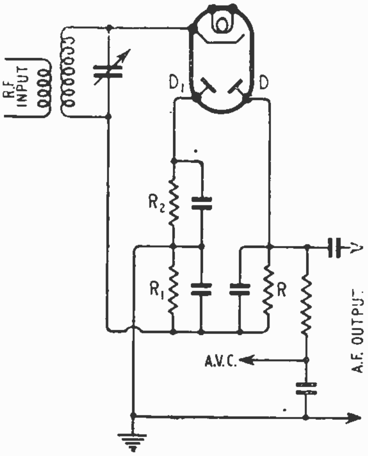
By way of example, two conductors each 10 inches long are bridged by thirteen parallel resistances, which vary in value from 3,400 ohms at the input end to 60 ohms at the far end; this will dissipate 10 watts of energy at a frequency of 330 megacycles, without appreciable end-reflection, the surge impedance of the line being 215 ohms. The characteristics of the line can be varied within limits by immersing it in a cooling fluid having a selected dielectric constant.

Standard Telephones and Cables, Ltd. (assignees of C. B. Watts, jun.). Convention date (U.S.A.), August 17th, 1942. No. 573451.

NOISE ELIMINATORS

DISTURBING noises are eliminated by a circuit arrangement which does not appreciably affect the full strength of the desired signals. As shown, one anode D of a double-diode rectifier feeds a load resistance R; the other anode D1 feeds two resistances R1 and R2, of which R1 is (like R) equal to 100,000 ohms, whilst R2 is 10 megohms. The mid-point between R1 and R2 is earthed, so that the voltages developed across R and R1 are of opposite polarity to ground.

During normal reception, the A.F. and D.C. voltages built up across R1 will be negligible compared with those produced across R2, whilst the voltages across R will be approximately equal to the sum of those across R1 and R2 in series. Rectified signals developed between the anode D and



Noise suppression circuit.

ground are thus passed on to the A.F. amplifier in full strength, subject only to the 1 per cent loss due to the reversed polarity of the R1 voltages.

On the other hand, an impulsive disturbance is short-circuited by the comparatively large condenser shunting R2 so that it appears at full strength across R1, where it is nullified by the corresponding voltage developed across R.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), October 31st, 1942. No. 575188.

RADIATOR FOR MICROWAVES

ACCORDING to the invention, an aerial showing maximum field-strength in the end-on direction consists of an unsheathed rod of polystyrene, or like insulating material, made of constant cross-section for part, preferably half, of its length, and then tapered down towards the free end, where it is rounded off. The aerial is energized by a wire, which is passed through the butt end of the dielectric and connected to the inner and outer conductors of a coaxial feeder.

A suitable rod for a wavelength of 9.8 cm is made circular in cross-section and 71 cm long. Its diameter is kept constant at 4.44 cm for half its length, and is then gradually tapered to 3.2 cm at the free or open end.

Western Electric Co., Inc. Convention date (U.S.A.) December 17th, 1942. No. 5755354.

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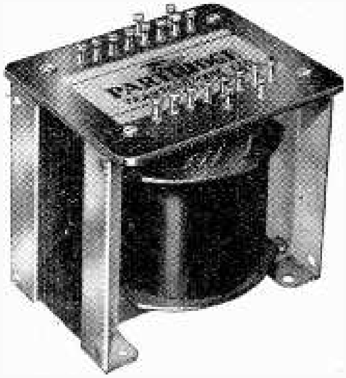

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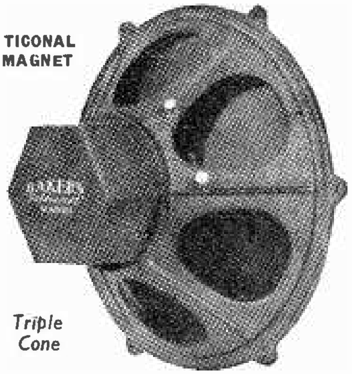

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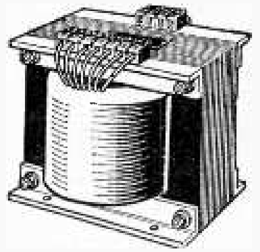

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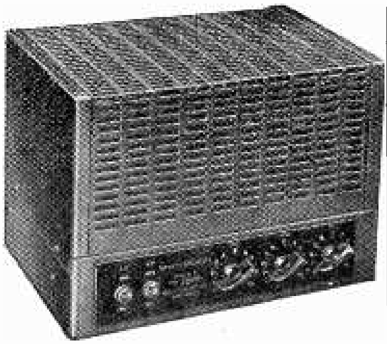

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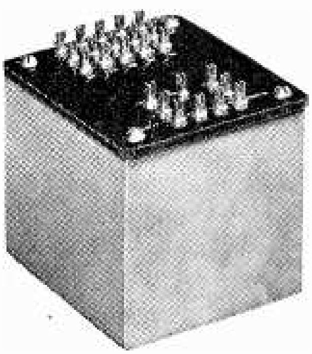

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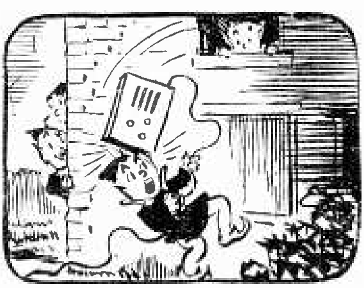

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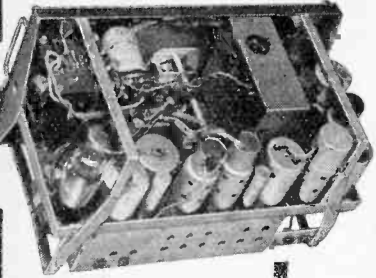

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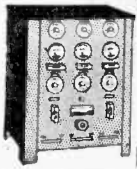

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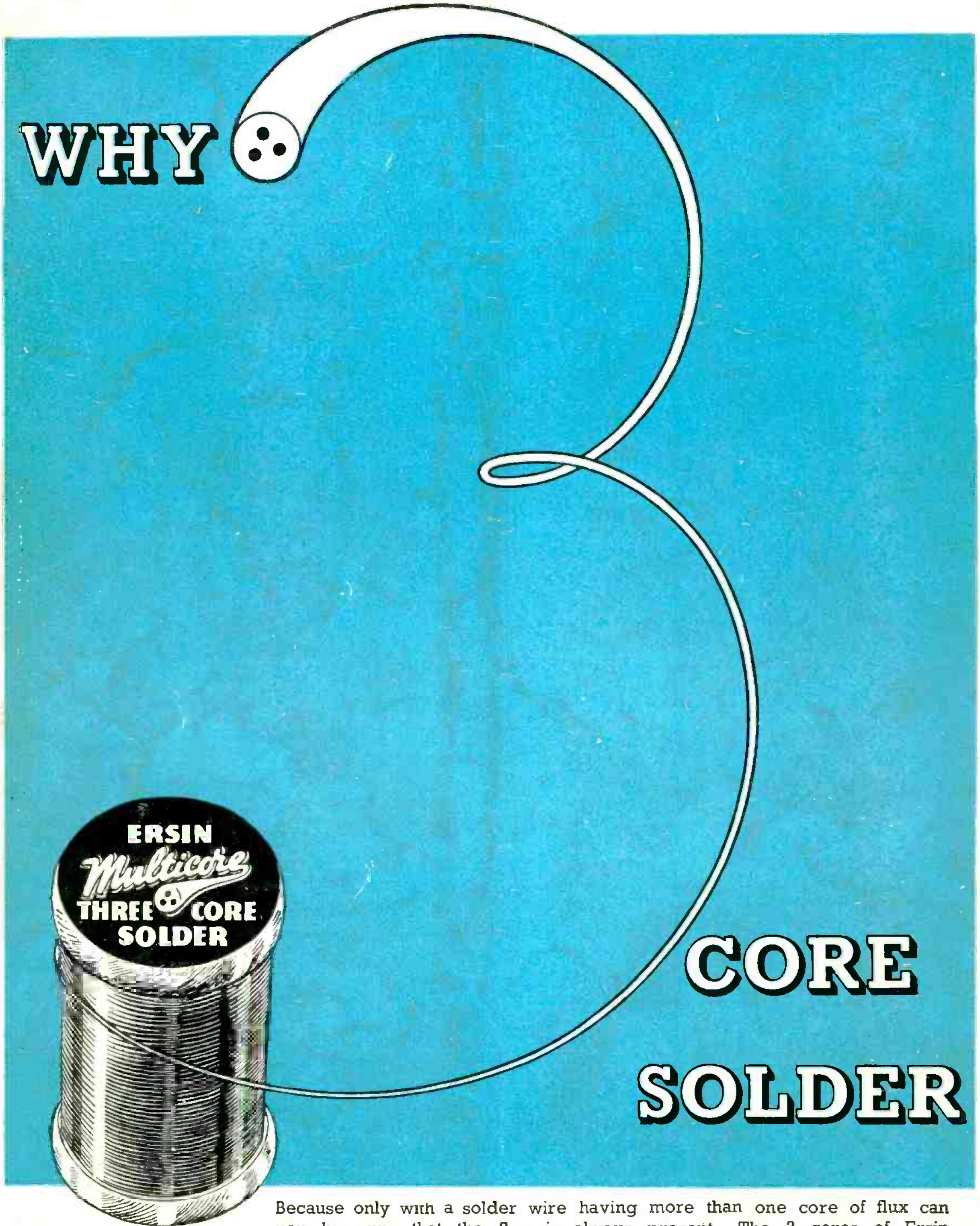
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