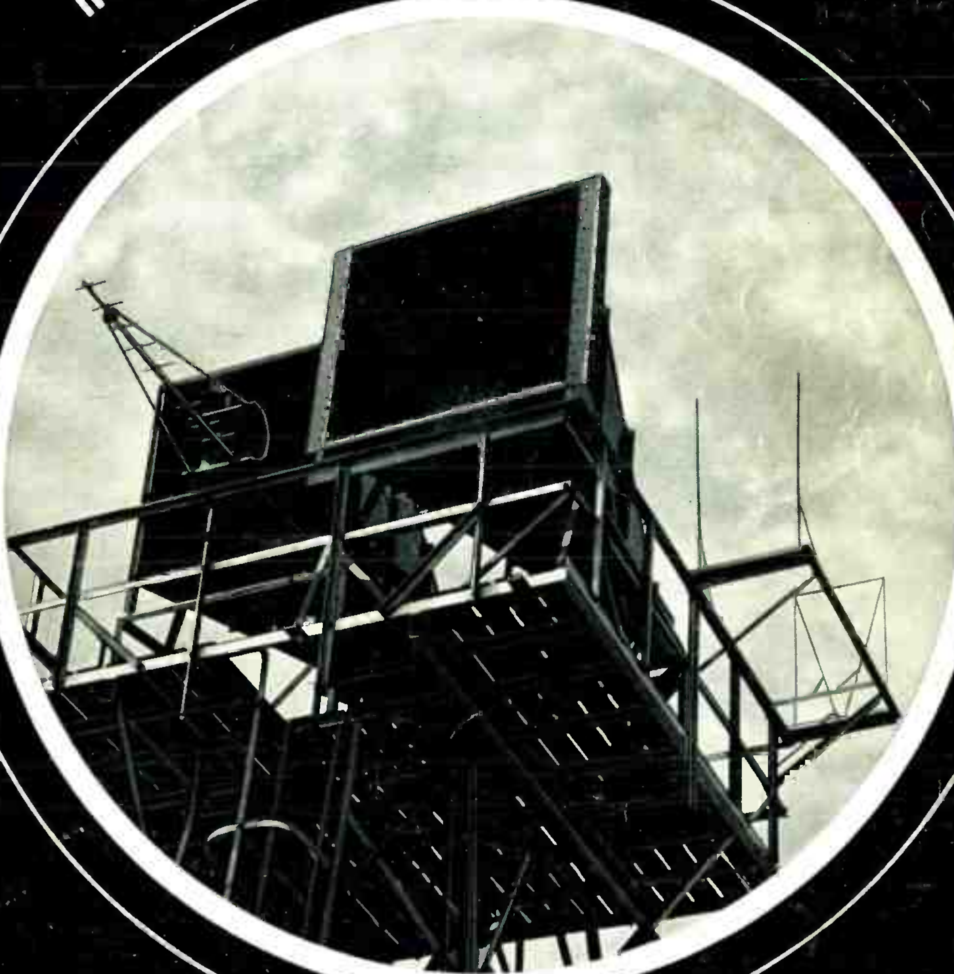
Wireless World

RADIO AND ELECTRONICS



AUG. 1947

1/6

Vol. LIII. No. 8

IN THIS ISSUE: TELEVISION AERIALS

World Radio History

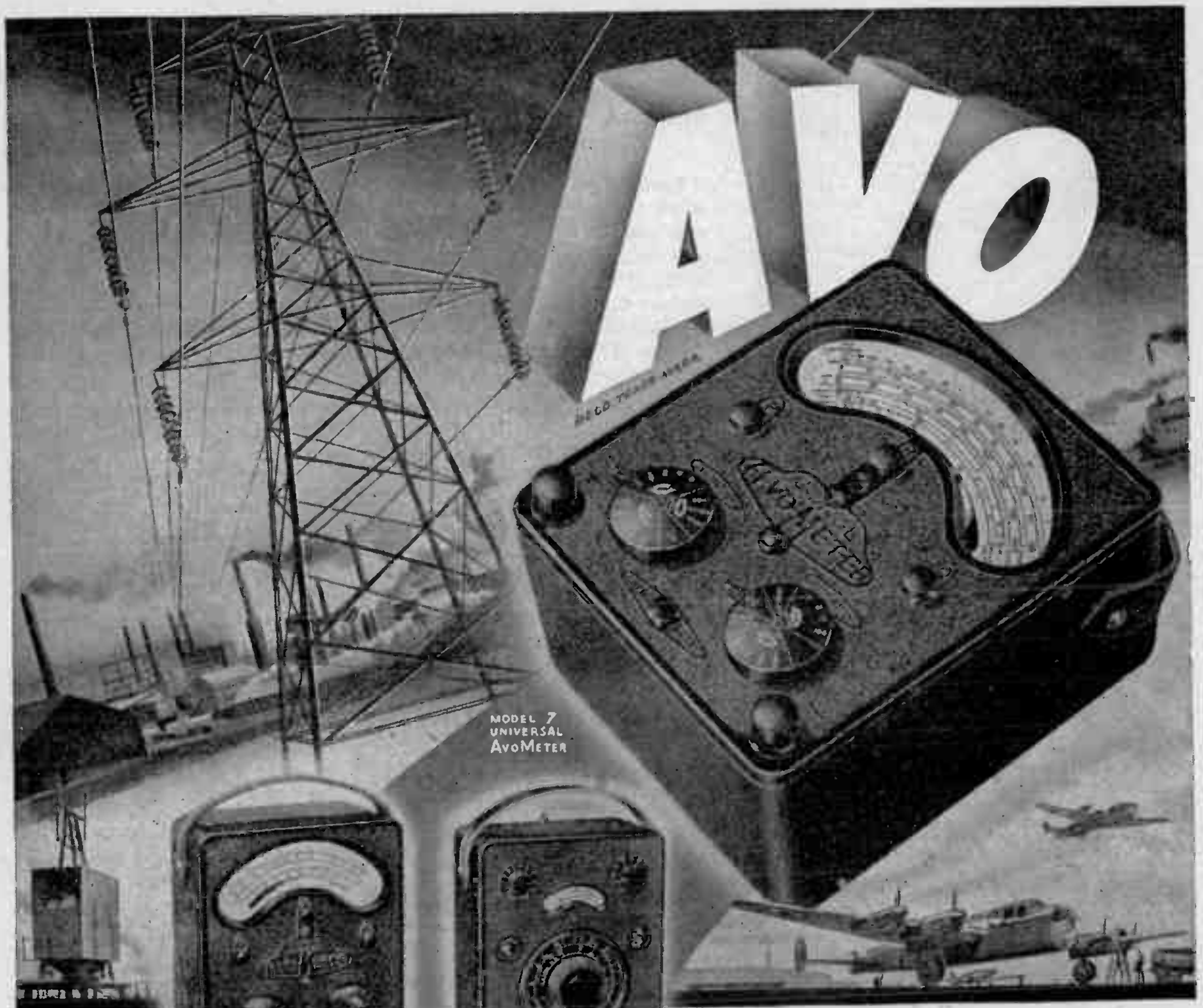
FIT RoLa AND RELAX

The Research Engineer knows that the best speaker for any set is one that offers complete reliability plus true tonal fidelity. After exhaustive tests his advice is always the same—fit Rola and relax!

RoLa SPEAKERS

THEIR QUALITY SPEAKS FOR ITSELF

BRITISH ROLA LTD · 8, UPPER GROSVENOR STREET · LONDON, W.1



RADIO manufacturers, service engineers, workshop and laboratory technicians are familiar with the precision and dependability of "AVO" Electrical Testing Instruments. Long years of successful experience in the design and manufacture of first-grade instruments have produced a consistently high standard of accuracy which has become a tradition as well as a standard by which other instruments are frequently judged

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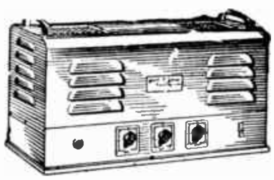
but we prefer to call it "AUDIOSCOPE"

"Audioscope"—maybe we have invented a new word, but the meaning, when applied to WODEN AMPLIFIERS, is that their "audioscope" embraces not only perfected reproduction of any sound but such excellent amplification that it will reach the widest audience in hall or open space without the loss of the slightest undertone or the distortion of music's highest C. Designed for a long life of trouble-free service and built in the WODEN belief that Finest Materials + Expert Craftsmanship must = Quality. Now it's up to you to send us your name and address for further particulars . . . why not do so TO-DAY ?



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Mains supply 200-250 v. A.C. 50 cps. Transformer tapped at 0, 8, 15 and 200 ohms. Response 50-10,000 cycles ± 2 db. Undistorted output of 60 watts. Finished in Light Grey Stove Enamel and Chromium. Retail Price £47 . 10 . 0.

20 WATT "JUNIOR" AMPLIFIER
Undistorted output of 20 watts. Transformer tapped at 0, 8 and 15 ohms. Flat from 50-10,000 cycles ± 1 db. Controls consist of Mic. and Gram. Feeders and Tone. Finished in Light Grey Stove Enamel and Chromium. Retail Price £27 . 10 . 0.

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BUILT FOR THOSE WHO KNOW

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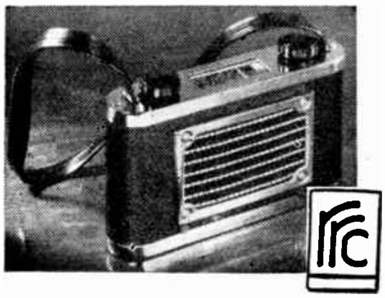
THE ROMAC MODEL 126
"*Personal*" RECEIVER



The Romac Personal Receiver is an entirely new departure in portable radio. The shoulder strap method of carrying has ingeniously been used to provide an "invisible" aerial. **This convenient feature is exclusive to Romac Models.**

Price £17 3s. 8d. Plus £3 16s. 4d. Purchase Tax.
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Reception conditions range from excellent to very poor ; signal strength from strong to very weak, and to cope successfully with all such conditions, you need a pair of highly sensitive and dependable headphones.

If you want maximum reception results you should insist that your local dealer supplies you with a pair of the rightly famous S. G. BROWN Type 'F' headphones. Sea, land and air W/T operators, servicemen, experimenters and radio amateurs all vouch for their dependability.

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Price **25/-** per pair.

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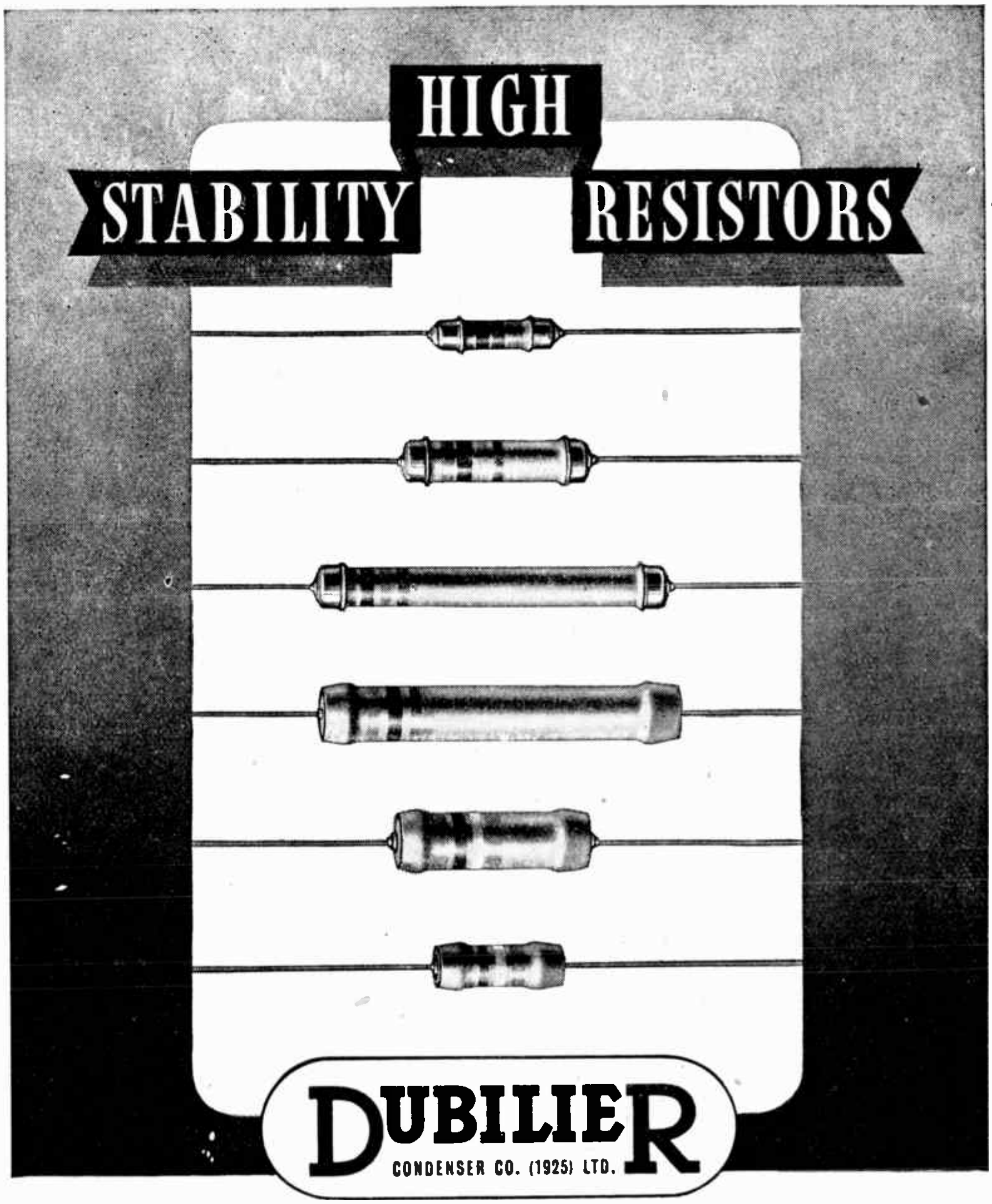
Phone: ACOrn 5021

S. G. Brown, Ltd.
VICTORIA ROAD, NORTH ACTON, LONDON, W.3



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For operation in certain special conditions, a high degree of stability is the chief characteristic required of fixed resistors. For example, in television, electronic and instrument applications where maintenance of maximum stability is desired over long periods of continuous use, high stability in resistors must be the primary qualification. The particular process of manufacture to which Dubilier High Stability Resistors are subjected ensures this great stability of resistance value, coupled with a low temperature coefficient of resistance, a negligible voltage-coefficient and a low "noise level".

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'Phone : Acorn 2241. 'Grams : Hivoltcon, Phone, London. Cables : Hivoltcon, London. Marconi International Code.

D11

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Triangular cabinet construction in solid mahogany of pleasing finish. (Available in solid oak—any shade to order.) Uses separate speakers for bass and treble, with new cross-over system at 1,000 c/s. Very pleasing balance between bass and treble. All bass resonance above 50 c/s eliminated. Size of cabinet 25½" x 18½" deep x 44" high. PRICE £47.10.0.

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Volts: 2 mV to 1000 V

Amps: 20 μA to 5 Amps

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Resistance

1 ohm to 1 Megohm or 10 Megohms with external battery.

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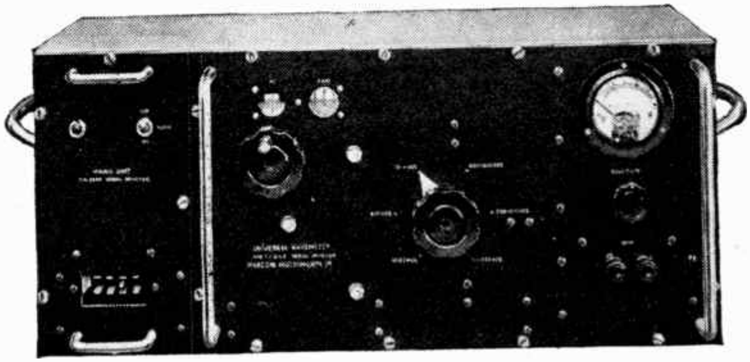

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Brief Specification:

Frequency Range: 100 kc/s - 20 Mc/s by means of Calibration Charts.

Accuracy - - - - - 1 in 10^3

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Scientific Gx:

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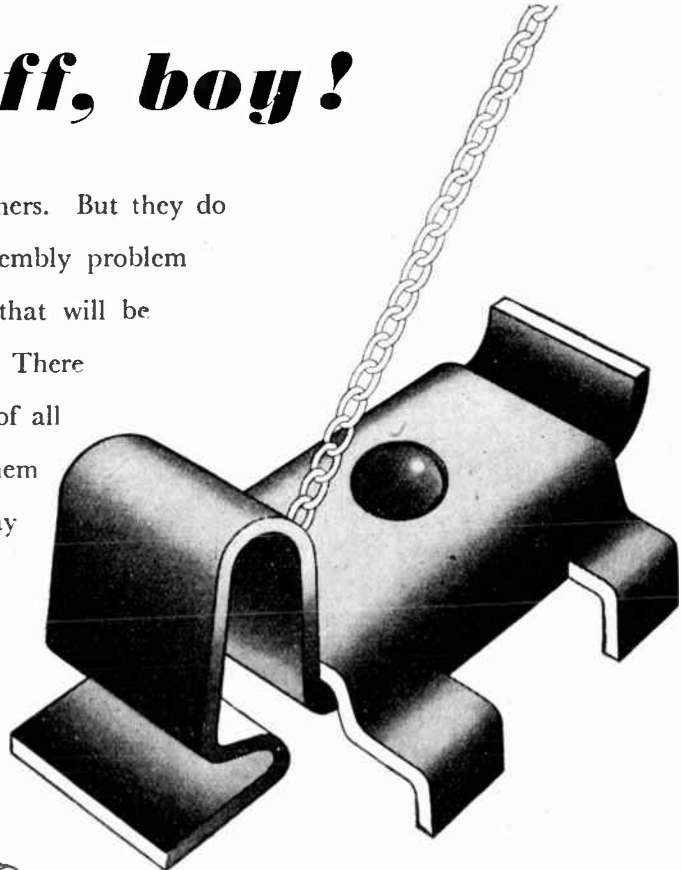
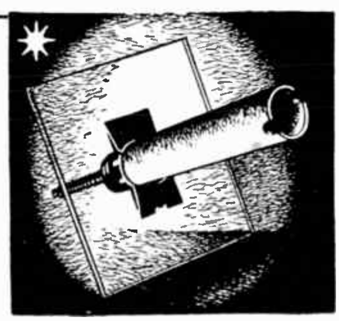


THAT'S Fixed THAT! The "doggie" looking Spire fixing illustrated above is actually made for a motor-car manufacturer to hold door trim in position.
The Electrical Industry thinks highly of the Coil Former support — Spire Fix No. SO1652 — shown in the small picture. It provides the simplest and quickest assembly, the firmest support. The core-adjustment is a matter of a turn of the screw, and when made is securely held by the Spire impression on the bottom of the support. Available in various sizes. (To make its operation quite clear, we have shown this Spire fixed to a transparent plate.)



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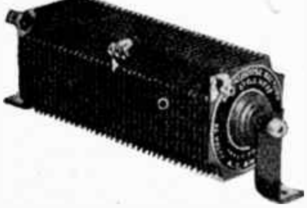

Units available for A.C., A.C./D.C. receivers, battery eliminators. Outputs up to 600 volts at 120 mA.

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These rectifiers enable chargers to be built capable of dealing with from 1-6 2-volt cells at currents up to 4 amps.

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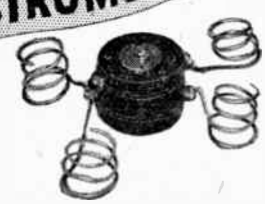

These small rectifiers enable a D.C. instrument movement to be adapted to read A.C. and yet retain all its advantages.

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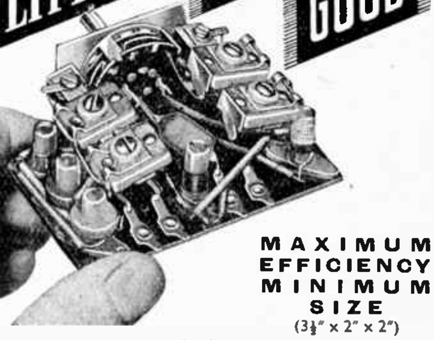

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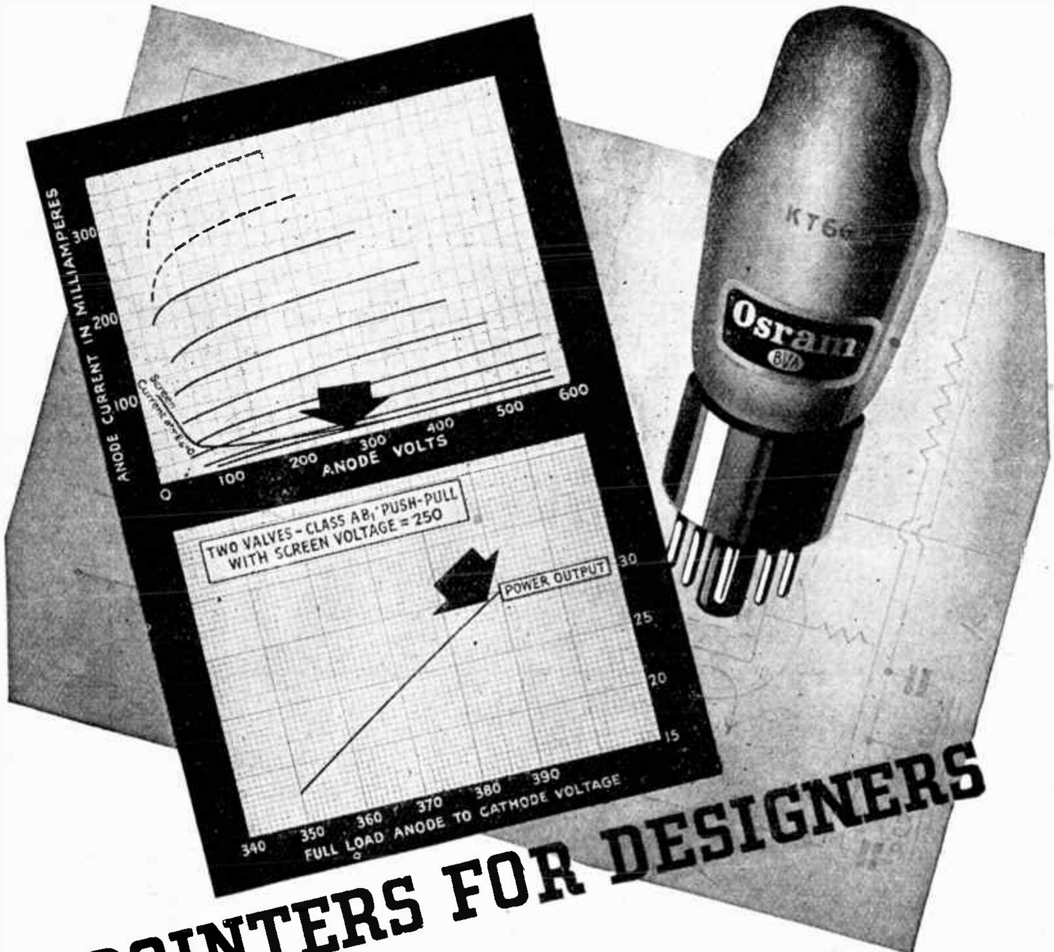

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THE KT66

A beam power tetrode for use principally in the output stage of an audio frequency amplifier, or as a low-power transmitter. Indirectly heated cathode 6.3v. 1.27 amps.

- "Aligned" control and screen grids resulting in a low screen current and improved efficiency.
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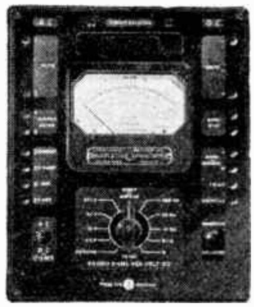

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Drayton Regulator & Instrument Co. Ltd., West Drayton, Mdx.

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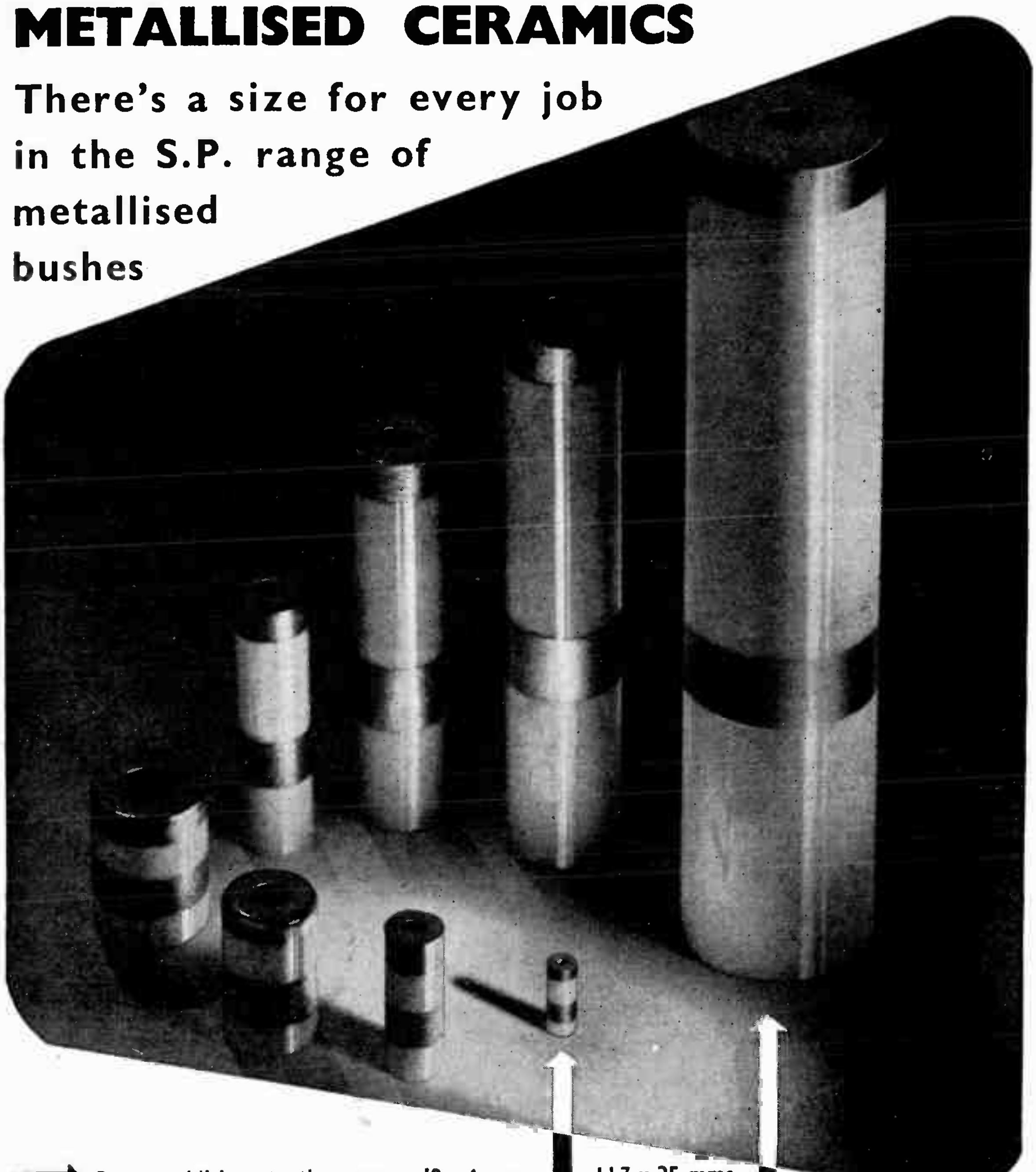

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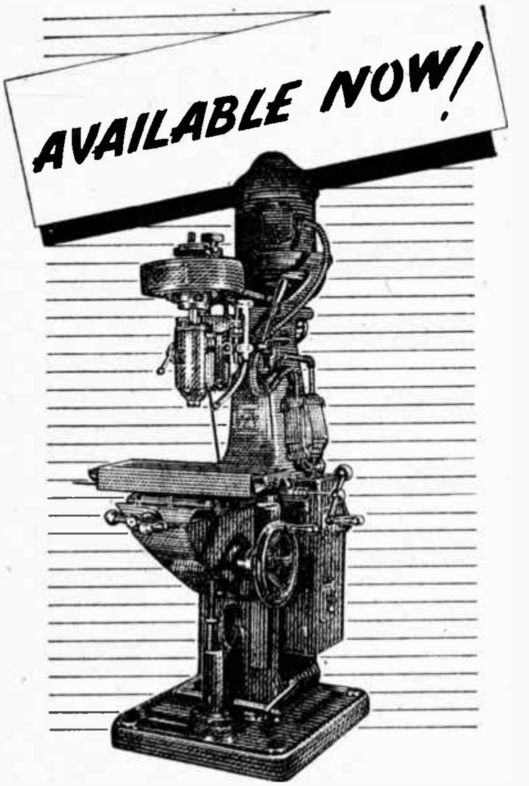

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No. 1 M.K. II H.T. UNITS. Rotary Transformer with all smoothing and filters, 11 volts input, 230 v. 30 m/A output, in metal case 4½" × 7" × 10¾". Brand new and unused. **£1 10s.**, plus carr. 5/-.

TRIPLETT Model 666H Pocket AC/DC Volt-ohm-Milliammeter. 0-5,000 volts AC/DC at 1,000 ohms per volt. 0-500 Milliamperes at 100 millivolts. 0-300 ohm and 0-250,000 ohms with internal 1½ v. battery. Complete with test prods and attractive black leather carrying case with strap handle. Brand new **£9 9s.**

METERS, 0-500 Micro-Amperes Moving Coil, 2" dia. flush mounting, 2¼" dia. overall. Res. 500 ohm. Brand new **£2.**

METERS, 0-500 Micro-Amperes Moving Coil, 2" dia. flush mounting, 2¾" dia. overall. Scale reads 0-15 and 0-600 v. For use with external resistors. Made by Simpson Electrical Co., U.S.A. Brand new **£2 10s.**

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HEADPHONES, 100 ohm Magnetic. (See above for suitable transformer.) Brand new, **10/6.** Brown's type A adjustable, **19/6.**

MORSE KEYS. No. 2 MKII 8 amp. rating. ⅜ sq. × 4½ Beam silver contacts. Black moulded knob mounted on 1⅜ × 3½" moulded base. Brand new, **3/6.** Miniature Morse Keys (see our previous advertisement) now reduced to **9d.**

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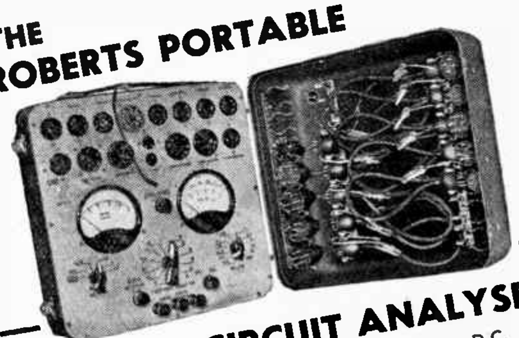

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- Tests Valves for Current, any Electrode, A/C & D/C. 11 Ranges 0—2.5 Amps.
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- Checks Resistance any Electrode. Valve to Valve or Chassis 3 Ranges 0—1 meg.
- Can be used as Universal Meter 2000 Ohms. per volt.
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NO NEED TO REMOVE CHASSIS FROM CABINET FOR TESTING

Best materials and workmanship. Guaranteed for 12 months. Dimens. : 12 × 12 × 6 ins., weight 11 lbs. Manufactured by :—

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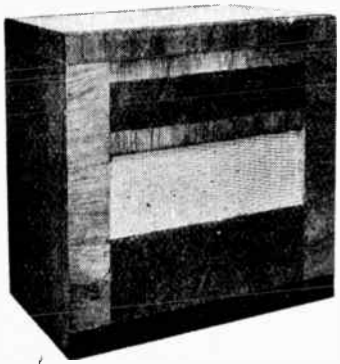

RADIOGRAM CABINETS. Dignified appearance and good workmanship. Size : 31½in, high, 18¼ deep, 33 wide. French polished, veneered walnut. Price **£26.** Also available complete with electric motor with auto stop, **£30 3s. 9d.**, or with electric motor, auto stop and magnetic pick-up, **£32 13s. 4d.**
Ditto with Rothermel Crystal Pick-up, **£35 2s. 1d.**, or with 8 record-mixer changer, **£45 7s. 6d.**

METERS. A huge purchase of military surplus meters allows us to offer the following bargains. All meters are by the best makers and are contained in bakelite cases. Prices are about one-quarter of original cost.

Range	Ext. Diam.	Res.	Fitting.	Type.	Price.
300 v.	3½"	15K	Flush	M.I. A.C.	7/6
500 mA.	3"	—	Proj.	M.C. D.C.	12/6
250/250 mic/A.	2"	100	Flush	M.C. D.C.	7/6
40 v.	2"	8 K	Flush	M.C. D.C.	7/6
2½ a.	2"	—	Flush	Thermo. H.F.	7/6
4 a.	2½"	—	Port.	H.W. H.F.	3/6
3 KV.	3½"	1 meg.	Flush	M.C. D.C.	20/-
20 a.	2"	—	Flush	M.C. D.C.	7/6
40 a.	2"	—	Flush	M.C. D.C.	7/6
25 a.	3½"	—	Flush	M.C. D.C.	7/6
25 a.	3½"	—	Proj.	M.C. D.C.	7/6
25 a.	3½"	—	Flush	M.I. D.C.	7/6

FERRANTI 1 MILLIAMP METERS, 3½in. external diameter, flush mounting, with self-contained Westinghouse bridge rectifier. Scale marked 0-10 volts with fifty divisions, fitted in well-made wooden box 6 × 5 × 5in. **35/-.**

PARMEKO SUPER QUALITY DRIVER TRANSFORMERS, 6-1 ratio. C.T. primary and split secondary. Weight, 3 lb., handle 15 ma primary current, **15/-.**

D/C TO A/C CONVERTERS. Input, 18/24 v. D/C, Output, 230 v. 50 cycles 100 watts, **£5.** Similar model, output 200 watts, in silence cabinet, **£10.**

POWER PACKS. Input, 210-240 v. 50 cycles. Output 250 v. 80 m/a, 6.3 v. 3-5 a. Fully smoothed. Contained in substantial screening box, with full wave valve, **£2 10s.**

MAINS TRANSFORMERS. All 230 v. 50 cycles input.
Type 2.—40 v. 2 amps. (Excellent for rewinding.) **15/-**
Type 4.—865-0-865, tapped at 760 and 690 v., 500 milliamps with L.T. trans. 4 v. 3 a. twice. **£3 15s.**
Type 36.—1750-0-1750 v. 330 m/a. **£3**
Type 8.—6 v. 10 a. and 4 v. 10 a. **15/-.**
Type 3.—500-0-500 v. 150 m/a 4 v. 2½ a., 4 v. 1a. 4 v. 5 a. **35/-.**
Type 5.—450-0-450 v. tapped at 300 v. 150 m/a, 4 v. 3-5 a. 4 v. 3-5 a. **30/-.**
Type 35.—350-0-350 v. 250 m/a 4 v. 3-5 a. 6.3 v. 5-7 a. 6.3 v. 1-2 a., **35/-.**

OSCILLOGRAPH POWER UNITS.—Input, 230 volts Consist of kit of parts incorporating mains transformer, metal rectifiers, voltage doubling condensers.
Type 406.—Output, 1000 v. and 6.3 v., **20/-.**
Type 407.—Output, 2000 v. and 4 v., **25/-.**

P.M. HORN LOUDSPEAKERS. Handle 8 watts, weather proof horn mouth, 33 × 13½. 33in. deep, soiled but unused, 3 ohm V.C., **£3 10s.**
Similar model, but with 15 ohm 10 watt unit, **£4 10s.**

RECTIFIERS. 2 v. heater, half-wave 2,000 volt, **12/6.**

R.A.F. 1155 RECEIVERS. Brand new, complete **£17 10s.**
A/C POWER PACK (230 v. input) for above, **£2 10s.**

MIDGET RADIO KIT. Build your own midget radio A complete set of parts, including valves, loudspeaker and instructions. In fact, everything except cabinet necessary to build 4-valve Medium and Long Wave T.R.F. radio operating on 200-250 v. mains, A/C or D/C. Valve line-up, 6K7, 6J7, 25A6, 25Y5. Wavelengths covered 200-557 and 700-2,000. Size 10 × 6 × 6in. Completely drilled chassis. Price, including tax, **£7 7s. 6d.**

SUPERHET MIDGET RADIO KIT. A complete kit of parts for a 5-valve superhet. Covers 16-50 and 200-557 metres, AC/DC 200-250 v. 6K8, 6K7, 6Q7, 25A6, 25Y5. Size, 10 × 6 × 6in. Completely drilled chassis. Price including tax, **£8 5s.**
An attractive brown bakelite cabinet as illustrated above can be supplied for either kit at a cost of **25/-**

SHORT-WAVE CONDENSERS. High-grade ceramic insulation, super midget type, single gangs available in 10, 20, 50, 75 (75 pf. has double spindle for ganging) Price **2/6.**
2-GANG, in 4.8, 9.6, 27.1, 50, 75 p.f. Price **5/-.**
2-GANG. Full size, 160 p.f. Price **5/-.**

AIR-DIELECTRIC CERAMIC TRIMMERS, 25, 50, 75 pf. Price **1/-.**

WAVE CHANGE SWITCHES. Available with any of following wafers : 2-pole 3-way, 3-pole 3-way, 4-pole 2-way, 2-pole 4-way, 1-pole 4-way, with shorting bar; 2-pole 5-way : 1-gang, **4/-** ; 2-gang, **5/6** ; 3-gang, **7/-.**

TYPE 100.—A rotary transformer with completely smoothed output, contained in a soundproof metal screening box. Input 6 v. D/C ; output 220 v. 50 m/a D/C, **£3 10s.**

TYPE 113. A rotary transformer input 6 or 12 volts With 12 v. input, output is 600 v. 250 m/a. with 6 v. input, output is 300 v. 200 m/a, **30/-.**

TYPE 114. Input 12 v. D/C, output 230 v. 50 cycles A/C 30 w., **45/-.**

TYPE NO. 111. A rotary transformer designed for an input of 6 or 12 volts D/C. With 6 volts input the output is 200 v. 50 m/a. With 12 v. input the output is 480 v. 40 m/a. These ratings are continuous. This unit may be run for up to 3 hours with 12 v., input when 80 m/a may be drawn at 400 v., **20/-.**

SPECIAL OFFER. P.M. SPEAKERS AT HALF USUAL PRICES. 4in., **17/6** ; 5in., **15/-** ; 6in., **17/6** ; 8in., **20/-.** Output trans. for same, **6/-.**

500 MICROAMP METERS. Moving coil, 2in. diameter flush mounting. Available by the following manufacturers : Met.-Vick 500 ohms ; Ferranti 79 ohms. Weston 116 ohms. Either type **21/-.** Special quotations for quantities. The following accessories are available to convert the above meter into a multimeter. Set five multipliers plus/minus 2½ per cent. to read 10 v., 50 v. 100 v., 250 v., 1,000 v., **7/6** the set. Bridge type meter rectifier, **10/-.** Separate 0-10,000 ohms scale chart, 1,000 ohms. Present resistance, and fixed resistor to convert meter into ohm-meter with 1½ v. battery, **3/6.**

VIBRATOR POWER PACKS. Type 301. Input 12 v. D.C., output 230 v. 50 cycles 30 watts. In steel case with complete noise suppression. Price **45/-.**
Type 302.—Input 6 volts, output 150 v. 25 m/a. In steel cases, with complete smoothing, **40/-.** **Type 303.** Input 12 volts, output 300 v. 100 m/a. In steel case, with noise suppression, no smoothing. Price **42/6.**
Type 303. 12 v. input, output 150 v. 40 m/a. In steel case, combined with single valve amplifier (no valve supplied). Price **35/-.**

METAL RECTIFIERS.

Output Volts	Current	Type	Price
600	40 m/a.	H.W.	5/-
280	40 m/a.	H.W. or V.D.	5/-
325	65 m/a.	H.W. or V.D.	5/-
36	75 m/a.	Bridge	1/6
16	1 amp.	Bridge	12/6
48	1½ amp.	Bridge	25/-
16	5 amps.	Bridge	30/-
16	8 amps.	Bridge	37/6
4	½ amp.	H.W.	5/-

VITAVOX SPEAKERS.
A few only Type K12/20 at **£8.**

PREMIER PEDESTAL PLAYING DESK. A well made mahogany finished pedestal cabinet, containing a quality electric gramophone motor and pick-up in upper compartment, and record space in lower. Price **£18 18s.**

ALUMINIUM CHASSIS. Substantially made of bright aluminium, with four sides.

7 × 3½ × 2in.	4/6	9½ × 4½ × 2in.	5/6
10 × 8 × 2½in.	7/-	12 × 9 × 2½in.	7/9
14 × 9 × 2½in.	8/3	16 × 8 × 2½in.	8/6
20 × 8 × 2½in.	10/6	22 × 10 × 2½in.	13/6

MANSBRIDGE TYPE CONDENSERS. Huge purchase of military surplus paper condensers. Super quality oil filled.

Capacity	Working Voltage	Size	Price Each	Per Doz.
2 mf.	1,000	4½ × 1½ × 1	2/6	20/-
2 mf.	600	3½ × 1½ × 1	1/9	14/-

TYPE 103 ROTARY TRANSFORMER. Normal rating is 19 v. D/C input. Output, 300 volts 30 m/a and 6.5 volts 3 a. D/C. By applying between 200 and 250 volt D/C to the H.T. output side, the two low-tension windings may be used to charge accumulators. The 19-volt side will charge a 6-volt accumulator at 2-3 amps, the 6.5 side a 2-volt accumulator at 1-2 a. With a 12-volt input to the 19-volt side, 180 v. at 30 m/a and 4 v. at 3 a. may be obtained. With a 6-volt input to the 6.5 side, 160 v. at 30 m/a may be obtained. By extending the spindle which is flush with the frame and applying 200 to 250 v. D/C mains to the 300 v. side, the unit becomes a powerful high-speed electric motor, suitable for small drilling machines, etc. Similarly, it may be used with 6 or 12 v. input to the 6.5 v. or 19 v. side. It employs a powerful ring magnet and is of substantial construction, costing originally over **£5.** A fortunate purchase enables us to offer these fine units at **10/-.**

VALVES. Hard-to-get types, metal, 6K7, 6L6, 6H6, 5Z4, 6J7, 6SR7, 6L7, 12SJ7, 6C5, 6SK7.

MAGNETIC PICK-UP HEADS. Fit gramophone tone arm, **17/6.**

ROTARY TRANSFORMERS. May be used as 230 v A/C motors.
Type 505.—5,000 revs. 1/40 h.p., **15/-.**
Type 506. 5,000 revs., 1/20 h.p., **30/-.**
Philips Amplifiers. Military surplus, soiled condition. Perfect working order, 6- or 12-volt battery operated, speech only, output 8 watts, push/pull output. Incorporate 220 v. 80 m/a vibrator pack. **35/-.**
3 Valves for same (OZ4 and two EL35), **35/-.** High output carbon hand mike for same, **5/-.**

2-VALVE SHORT-WAVE BATTERY KIT. A complete kit of parts for a 2-valve receiver, covering 15-600 metres including valves, coils, drilled chassis, H.T. and L.T. dry batteries to last approximately 6 to 12 months. A pair of double headphones and full instructions. Price **£3 10s.** An extra coil can be supplied covering 600-1,900 metres, at **4/-.**

SUPERHET TUNING PACKS. Completely wired and aligned. 13-40, 40-120, 190-570 metres. R.F. stage 465 kc. ; 9 connections only. Complete with 3-gang condenser, calibrated, engraved Perspex dial, and 8 M drive. Litz wound polystyrene insulation permeability tuned I.F.'s, 7 k/c bandwidth. Price complete **£3/17/6.**

ENAMELLED COPPER WIRE from 16 to 22 gauge, available in one pound reels or bulk. Write for quotations.

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LOUDSPEAKER SEPARATOR

A new device for dividing the Bass and Treble between two Loudspeakers at low impedance, thus eliminating modulation distortion imposed on the treble by large coil movement in the bass.

It is recommended for use with two speakers of equal sensitivity and similar size. Not snitable for Horn type speakers.

The Separator results in greater efficiency, stronger top note response and improved clarity of reproduction and extends the range and intelligibility of P.A. speakers.

The impedance of two 3 ohm speakers connected to the Unit becomes 6 ohms, but when two 15 ohm Speakers are used the total impedance remains 15 ohms.

Size : 8" × 5" × 4"

Cross-over at 1,000 c.p.s.
Maximum Input 30 watts
at 3 to 15 ohms impedance.

Made and Guaranteed by

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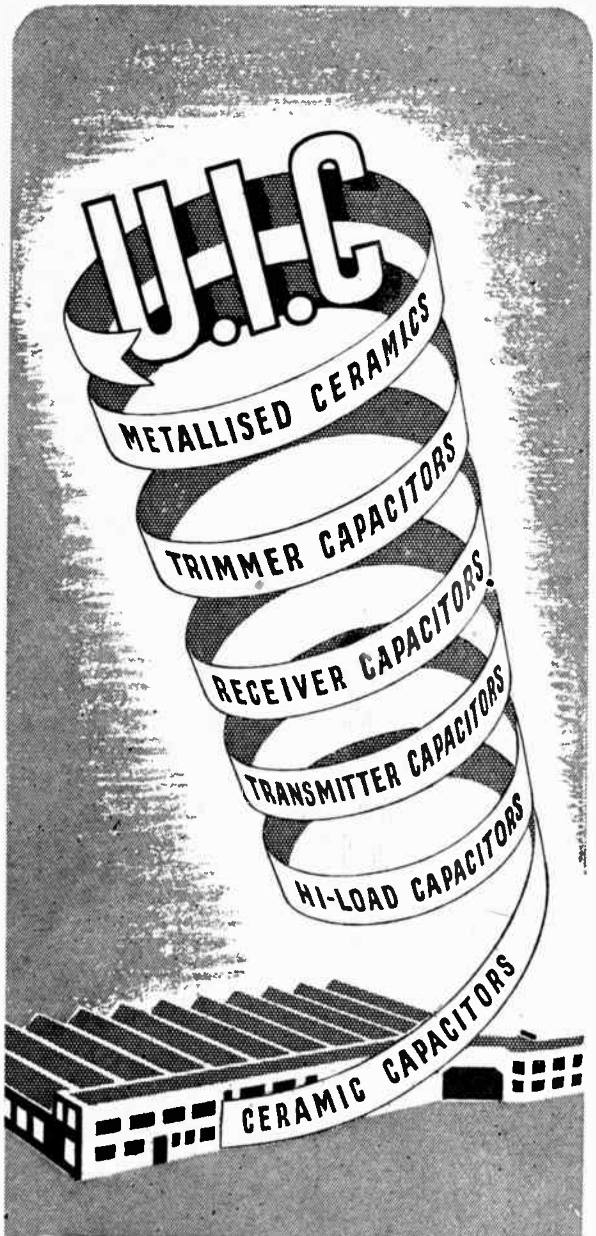

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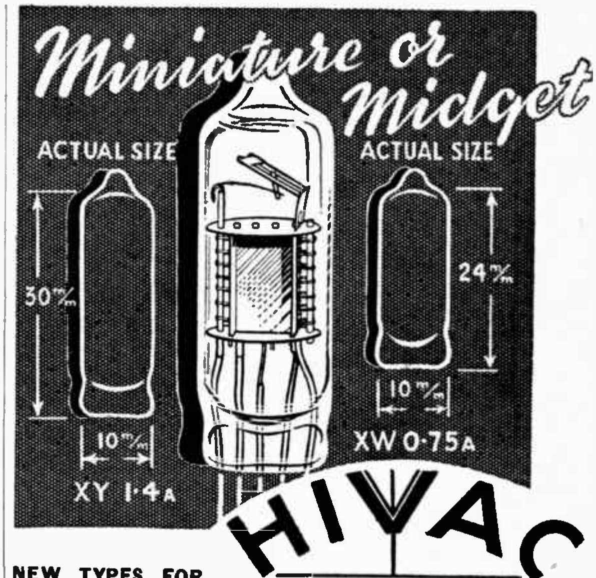

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Ex-ARMY TEST SET—NEW

For circuit continuity and general testing. In hardwood carrying case. Carriage paid **£3.10.0**

Super Quality Heavy Duty TWIN-ELEMENT SLIDING RESISTANCES

5.4 ohm at 20 amp.	47/6
12 ohm at 10 amp.	39/6
70 ohm at 5 amp.	35/-
Single Element 14 ohm at 5 amp.	13/6

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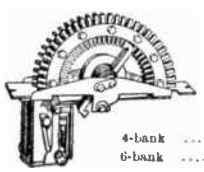
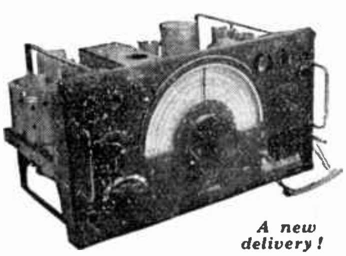


4- or 6-bank, 26 constants. Have various applications including automatic tuning, circuit selection, etc. Operates on 25-50v.

4-bank	28/6
6-bank	30/-

Type R1155
10-VALVE COMMUNICATION RECEIVER



A new delivery!

These sets are equal to new, need only a power pack for immediate use (see "W.W.," July, 1946). Freq. range, 7.5 mcs. or 1,500 kcs., complete with 10 valves, including magic eye. Enclosed in strong metal box. Each receiver is aerial tested. **£15.15.0**

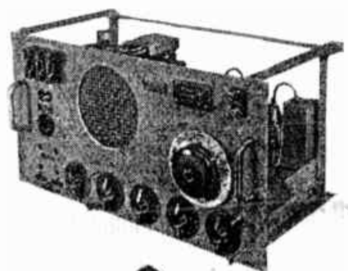
Carriage and packing 7/6 extra. No C.O.D.

POWER PACK 220-250 v. A.C. for above is available to CALLERS ONLY.

RADAR VIEWING UNITS

Consisting of 6in. diameter Electrostatic C.R. tube, 7 valves including four EF50, potentiometers, resistances and other associated components. In metal cabinet 18 × 8 × 7½in.
Bargain price **£3.7.6**

Type R208
6-VALVE SHORT-WAVE RECEIVER
Precision-built Communication Type
Range 10—60 megacycles



Suitable for AC 100-2[illegible] 6-v. battery operation. Metal rectifiers, B.F.O., Bu[illegible]peaker, Super Slow motion dial. Provision for pho[illegible]etc. A real super job in grey metal cabinet. Complete with Valves and Vibrator ready to use **£18.0.0**

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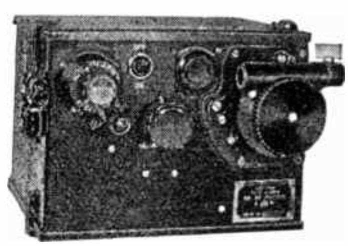
Ex-GOVT. TELEPHONE HANDSETS

Self-Energising. Needs no battery or current. Less Wall bracket. Each **15/-**

ELECTRO MAGNETIC COUNTERS

Ex-G.P.O., every one perfect, electro-magnetic, 500 ohm, coil, counting to 9,999, operated from 25v.-50v. D.C., many industrial and domestic applications **5/6**

Type R1147B
7-VALVE U.H.F. RECEIVER
Range approx. 200 megacycles



A Real Opportunity!

Beautifully constructed and fitted with micro-condenser drive. Valve type two EF50, two EF36, one each EBC33, RL7, RL16. In black metal case 8 × 7 × 6in. Set, complete with valves........... **£2.7.6**

TUNING CONDENSERS single .0005, best-quality Air Spaced, ¼" Spindle. Each **3/6**

Ex-GOVT. HIGH-SPEED RELAYS. Each **6/6**

For details see March issue.

Model *AN/APA-1
AMERICAN Aircraft RADAR UNIT

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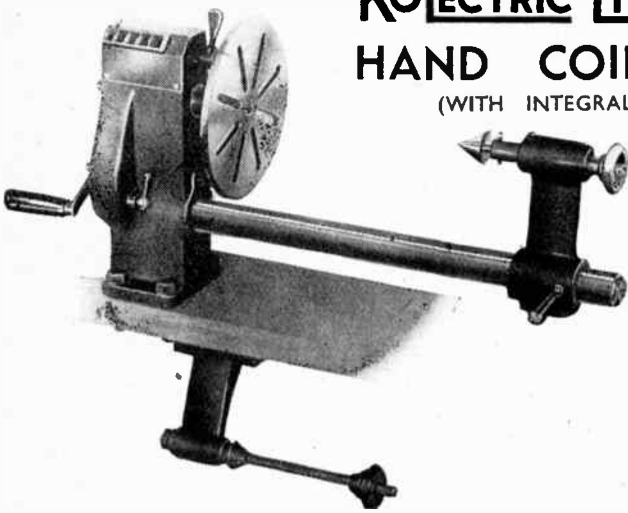

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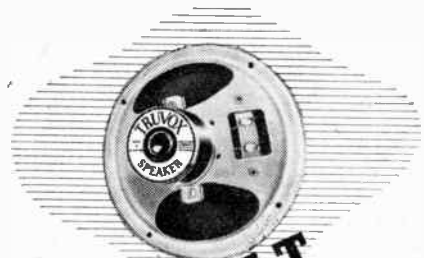

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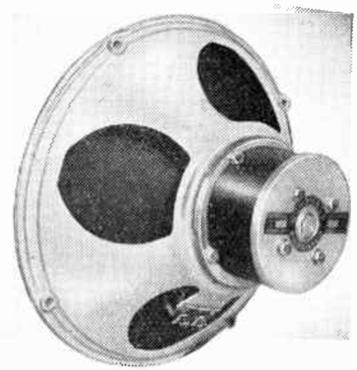

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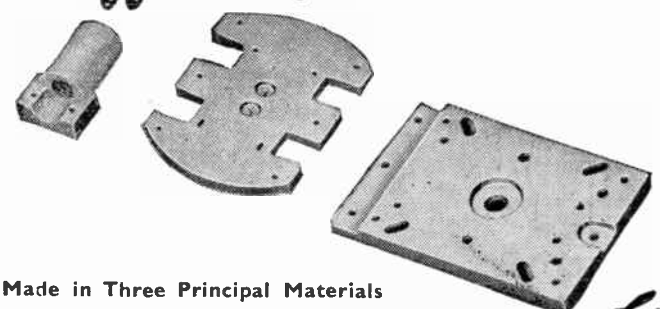

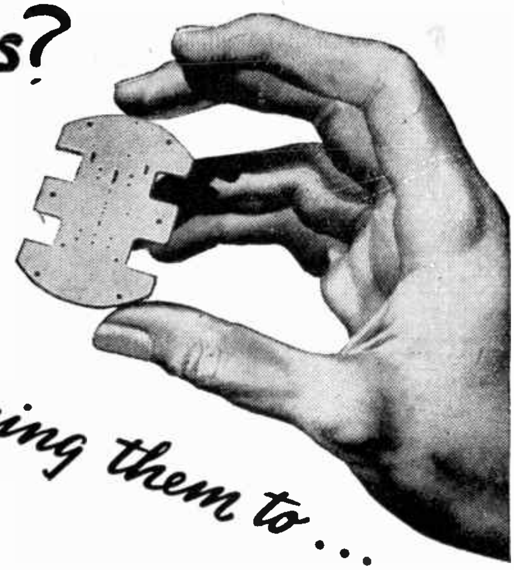

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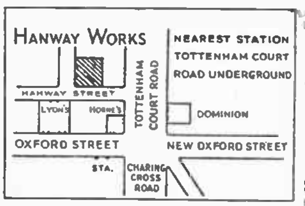

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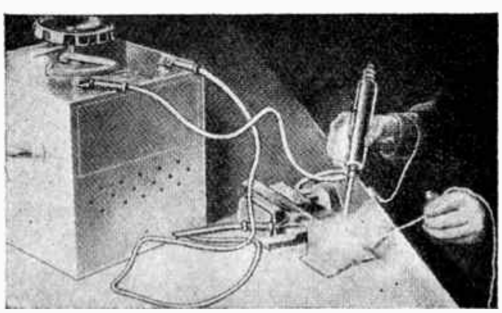

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Wireless World *July, 1946*

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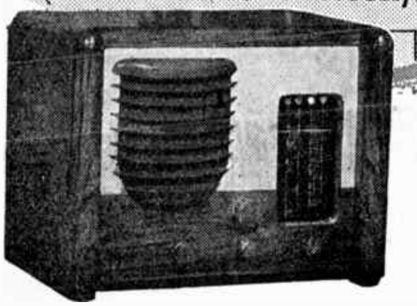
A.C. Table Model Superhet

(Five Valves + Rectifier)



The following are brief extracts from a report which appeared in the July 1946 issue of "Wireless World" on the Sobell 615 6-valve A.C. Table Model Superhet :—

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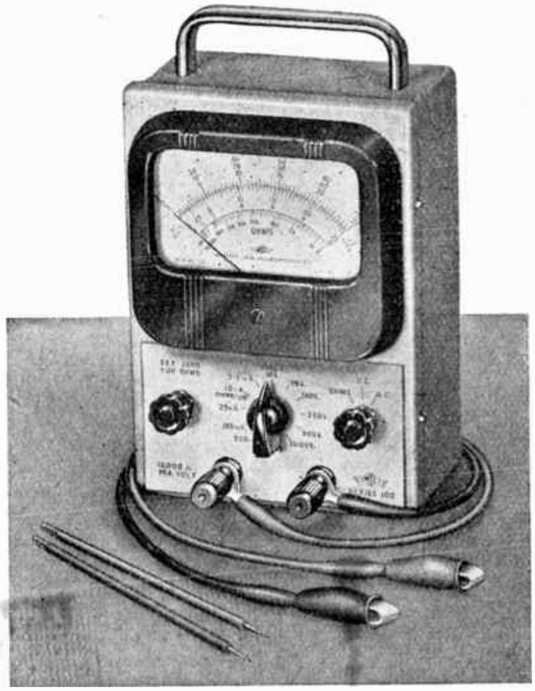

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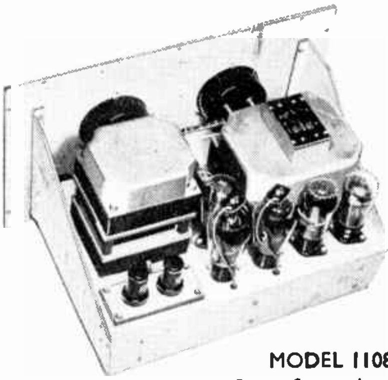

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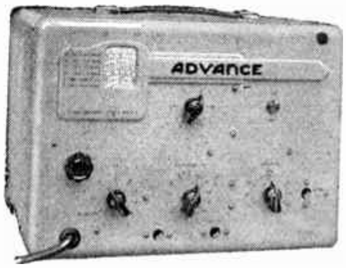

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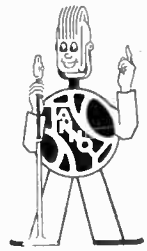

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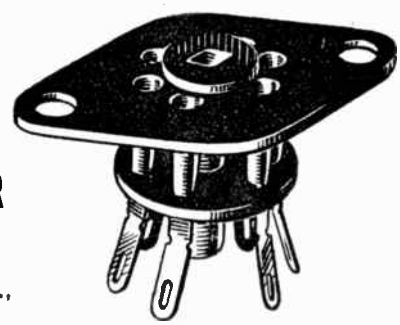

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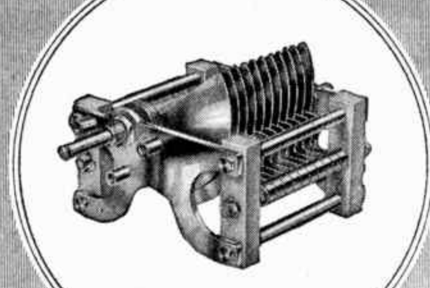

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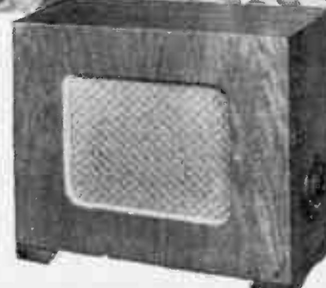

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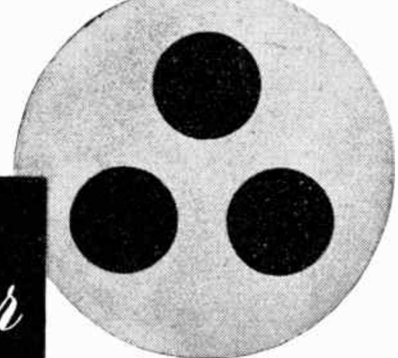

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World Radio History

Wireless World

Radio and Electronics

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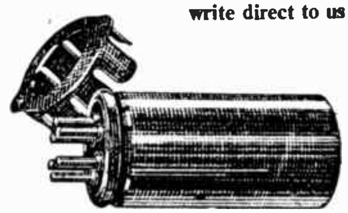

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VALVES AND THEIR APPLICATIONS

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

No. 8: Mullard TWIN-TRIODE ECC34

THE ECC34 is an alternative to the ECC32 where a lower resistance pair is wanted ($r_a = 5200\Omega$; $\mu = 11.5$); for example, in a multivibrator for a rather higher top frequency. But its primary purpose is economical frame time-base generation in television receivers. An example of this was described in "*Wireless World*," Dec. 1946, p. 403-407 (Pye Model B16T). One valve in the pair is used to generate the saw - teeth by the blocking oscillator method; the other is a current amplifier for energizing the frame deflector coil.

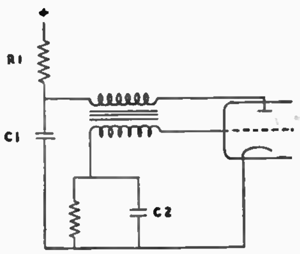

FIG. 1

Fig. 1 shows the blocking oscillator part in its simplest terms. C1 charges through R1 until its voltage is enough to cause current to flow in the valve, which immediately starts into violent oscillation. The first half-cycle discharges C1, and charges C2 so negatively that the second half-cycle cuts the valve off and allows C1 to charge again. And so on.

Obviously the voltage across C1 is exponential, so the amplifier not only has to provide the necessary deflecting current but must also straighten out the waveform. This is done, in the set mentioned, by a negative feedback network, the circuit of which, and the other details of the time base, are given in the article referred to.

Experimenters may be interested in a linear voltage sweep that is rather less tricky to design. Fig. 2 shows that it is unusually simple and economical. It is particularly suitable for very low frequencies—the values shown are for 0.2 c/s—but will cover up to thousands of c/s by reducing C1, C2, R1 and R3. With the Fig. 2 specification it gives a 100-volt sweep across a low-impedance output, for a consumption of only 8 mA at 250 V, while its linearity is equivalent to a charging amplitude of only $12\frac{1}{2}$ volts in 250. This is thanks to V1 being a so-called Miller time base, the working stroke being formed by C1 discharging through R1 (and R2). The output is coupled through C2 to V2, which periodically recharges C1 through itself and R2. The only disadvantage is a not-very-fast flyback; with the optimum C2 it is of the order of 6%. Increasing C2 causes a delay at the end of each sweep; if necessary this delay can be made many times longer than the sweep itself.

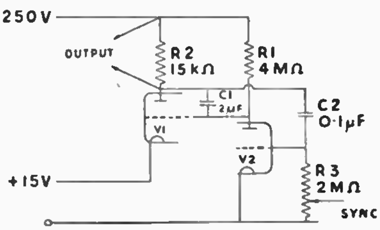

FIG. 2

The frequency can be varied in steps by C1 and C2, and continuously by R1. Supply voltages ought to be reasonably steady at the working frequency.

Mullard

This is the eighth of a series written by M. G. Scroggie, B.Sc., M.I.E.E., the well-known Consulting Radio Engineer. Reprints for schools and technical colleges may be obtained free of charge from the address below. Technical Data Sheets on the ECC34 and other valves are also available.

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MONTHLY COMMENTARY

What is a Broadcasting Station?

A FEW readers of the *Wireless World* booklet "Guide to Broadcasting Stations" have expressed regret that it does not give data on meteorological and standard-frequency stations. The short answer seems to be that these are not strictly broadcasting stations, but, if there is any widespread demand for such data, they will be included in subsequent editions. Having said that, one is left with an uneasy feeling of uncertainty as to the exact definition of the term "broadcasting station."

The Post Office has officially defined "authorized broadcast station," an expression which appears in the broadcasting receiving licence, as

> **a station in any part of the world which is operated under the authority of any Administration in accordance with the International Radio-communication Regulations.**

That disposes of the word "authorized" but leaves us still in doubt as to the precise legal and technical significance of "broadcasting station," which, so far as we know, has not been officially defined by the Post Office. The British Standards Glossary (B.S.204:1943) does not give the term, but defines "radio broadcasting" as

> **the transmission by means of electro-magnetic waves of a programme of sound, vision or facsimile for general reception.**

That definition is helpful, but perhaps rather lacking in completeness. The Postmaster-General's Licence to the B.B.C. does not get us much farther; the nearest definition given there is that of "broadcast matter" which means

> **music, lectures, speeches . . . weather reports, news, information, entertainments . . . images . . . spectacles or objects in movement or at rest . . .**

in fact, "any other matter transmissible by wireless telegraphy" (*sic*).

But, after all, it should not be too difficult to find a definition that ought to be acceptable to all law-abiding nationals of countries signatory to the International Telecommunications Convention. Turning to the International Radio-communication Regulations (Revision of Cairo, 1938) we find "Broadcasting Service" means

> **a service of broadcasting of emissions intended to be received by the general public. . . .**

This definition then goes on to embrace sound, television and facsimile broadcasting, and so agrees closely with B.S.204. What is important is that the Regulations make it clear that many other transmissions addressed to a general or limited public are in a different category. This is called "Special Service" and includes

> **radio beacons, direction-finders, time signals, meteorological reports, notices to mariners, press messages for general reception, medical advice . . . calibrated frequencies, emissions for scientific purposes, etc.**

Thus, by international agreement, stations performing such services are not classed as broadcasting stations.

All this is of much more than mere academic interest. The legal aspect alone is important. For example, does the ordinary broadcast receiving licence confer authority to listen to the "Airmet" weather bulletins from Borough Hill and to the standard-frequency transmissions from the U.S. Bureau of Standards station WWV? If we are to accept the ruling given in the Regulations, and also to take the licence at its face value, the answer seems to be an unequivocal "no." But, equally definitely, it will be agreed that the public should have facilities for using, without cumbrous formalities, these and many other wireless services that are provided for general use.

Some months ago we protested against the restrictive—even dictatorial—terms of the broadcast receiving licence, and, as a result, some rather trivial changes in wording were introduced. That was not enough; we think that the position should be finally regularized by the issue of a simple form of licence covering reception of all transmissions addressed to CQ and intended for public use.

World Radio History

Push-Pull Phase-Splitter

New High-Gain Circuit

By E. JEFFERY

THE advantages of resistance-capacitance circuits for phase-splitting in push-pull amplifiers are now well recognized, a wide variety of circuits for this purpose having been evolved in the last decade or so. If these circuits are investigated it is found that they possess varying degrees of merit in producing symmetrical output voltages, but share the common disadvantage of inherently low gain. In fact, low gain would appear to be almost inherent in any phase-splitting arrangement. The circuit to be described in this article, however, will be shown to possess a very high degree of symmetry with, at the same time, a large amplification from only two valves. An overall amplification of more than 1,000 times can very easily be achieved with standard low-g_m valves.

In order to facilitate analysis and to effect a just comparison with other types, the circuit will be compared with, and developed from, a normal cathode-follower phase-splitter preceded by a pentode A.F. stage.

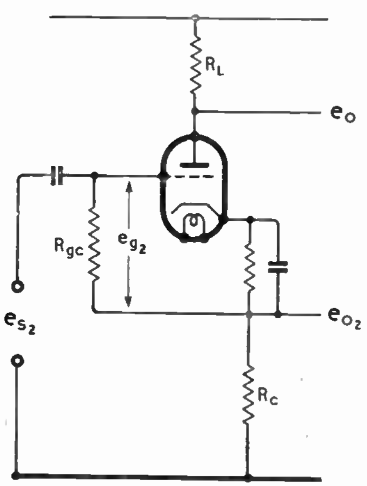


Fig. 1. The basic cathode-follower type of phase-splitter.

For the purposes of this article the amplification of a phase-splitting system will be regarded as the ratio of either output voltage (assuming the two to be sensibly equal) to the signal input voltage (i.e., amplification $= \frac{e_{01}}{e_s}$ or $\frac{e_{02}}{e_s}$ in Fig. 2). In other words, the gain of the system as a whole is twice that given. The cathode follower, Fig. 1, is perhaps the most generally used circuit because of its simplicity and the high degree of balance obtainable between e_{01} and e_{02}, at normal frequencies, being dependent, only on the accuracy of R_L and R_C. It possesses, of course, the inherent disadvantage of a cathode follower in that its gain is slightly less than unity (Appendix Equation (2)).

If we now consider such an arrangement to be preceded by a pentode stage the circuit becomes that of Fig. 2 and the overall gain is nearly that of the pentode alone, about 100 times.

Let us now consider the factors which limit the gain of the circuit of Fig. 2. It is well-known that the input impedance of a cathode-follower is extremely high, approximately 10 × (impedance between grid and cathode); consequently if the grid-cathode impedance is made 250 kΩ the impedance to the right of "LM" in Fig. 2 is 2.5 MΩ. In other words, the input circuit of V_2 does not appreciably shunt R_1 and the gain obtainable from V_1 is determined almost entirely by R_1. The value of this resistance cannot, however, be increased indefinitely, owing to the fall in steady anode voltage of V_1 and a practical maximum is about 250 kΩ — 500 kΩ. Since the A.C. resistance of the pentode is very high (say 2.5 MΩ) it follows that only a small fraction of the amplification factor can be realized as gain (since gain $= \frac{\mu_1 R_1}{R_{a1} + R_1}$). This is unfortunate, because the amplification factor is extremely high, about 4,500 being quite a normal value for a pentode.

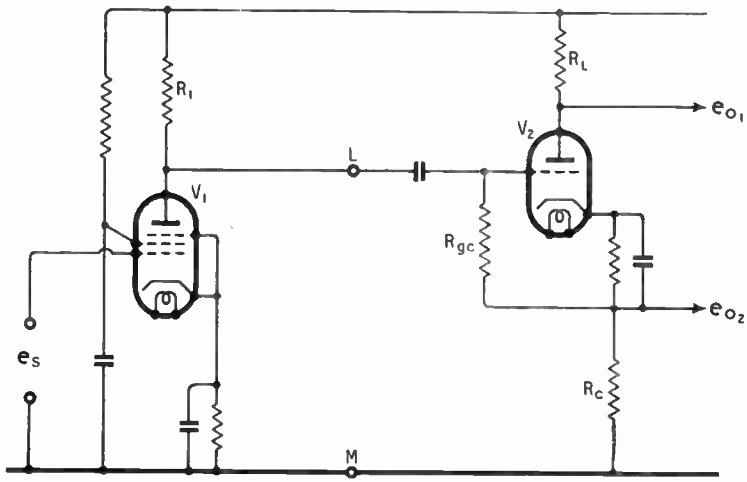
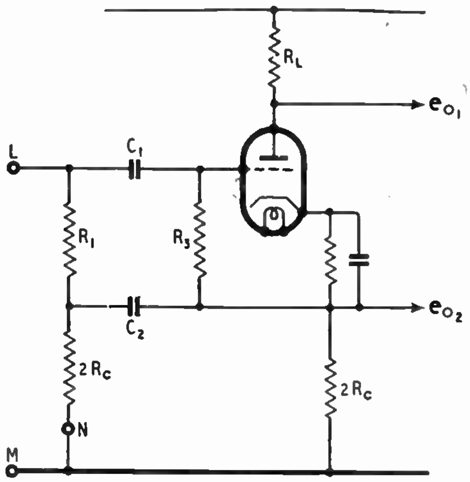


Fig. 2. The combination of a phase-splitter with a preceding A.F. stage is shown here.

Suppose, however, it were possible to use the very high input impedance of a cathode-follower as the actual load on V_1. Then, since this impedance is comparable with the A.C. resistance of the pentode, the amplification obtained would be greatly increased.



If the circuit to the right of LM in Fig. 2 is rearranged as shown in Fig. 3, the parallel impedance of R_1 and R_3 replaces the grid-cathode impedance R_{gc} while the effective cathode load is still R_c. Consequently the A.C. conditions have not been changed by the rearrangement and the input impedance is still approximately $10 \times R_{gc}$ (where $R_{gc} = \frac{R_1R_3}{R_1 + R_3}$). It is assumed that the reactances of C_1 and C_2 are negligible at the lowest working frequency.

We cannot, as the circuit stands at present, connect the point L directly to the anode of V_1 since there is no means of supplying anode current to V_1. It will be seen, however, that N is at earth potential and there is no reason why we should not return this end of the resistor to + H.T., which is also at earth potential, so far as A.C. is concerned. In this way we can provide a D.C. path to the anode of V_1 without disturbing the A.C. conditions on V_2, while V_1 still sees the input impedance of V_2, acting as a cathode follower, as its dynamic load.

The final phase-splitting circuit becomes that of Fig. 4, in which the component values are those used in the experimental model.

Using an EF 36 strapped as a triode for V_2, $R_{a2} = 10\,k\Omega$ and $\mu_2 = 28$; with the component values of Fig. 4 Equation (1) gives the input impedance R_{in} as 2.05 MΩ. It will be noted that $R_{gc} = \frac{R_1R_3}{R_1 + R_3} = 168$ kΩ.

Then the amplification of V_1 is given by: $\mu_1 \frac{R_{in}}{R_{a1} + R_1} = 2030$ (where $\mu_1 = 4{,}500$ and $R_{a1} = 2.5$ MΩ).

The gain of V_2 as given by Equation (2) is 0.9; therefore the

Fig. 3. A modified phase-splitter in which the coupling resistor R_1 becomes part of the grid-cathode impedance of the cathode-follower.

overall gain of the system $\frac{e_{02}}{e_s} = 2030 \times 0.9 = 1860$. It is of interest to note that Equation (3) in the Appendix, which was derived directly from the equivalent circuit of Fig. 6(b), gives the same value as that obtained by the foregoing physical argument.

The degree of asymmetry between e_{01} and e_{02} must be regarded

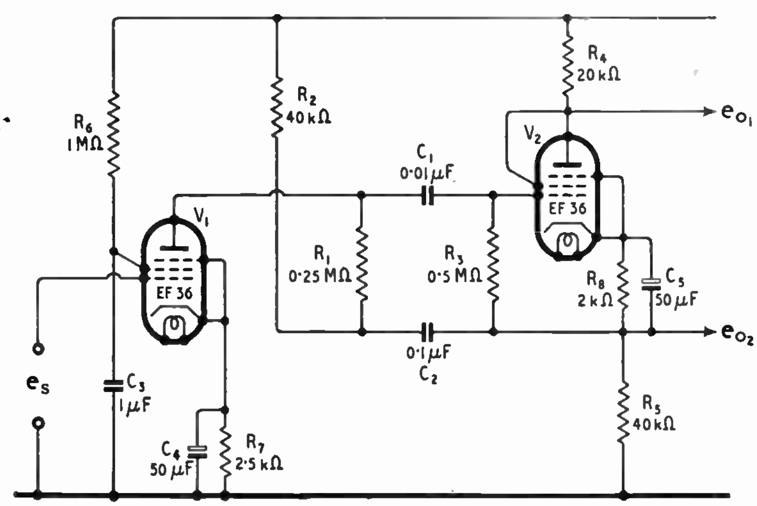


Fig. 4. The practical form of the high-gain phase-splitter and preceding stage.

as of even greater importance than mere gain. Inserting numerical values in Expression (4) of the Appendix we obtain $\frac{e_{01}}{e_{02}} = 0.989$. The inherent unbalance is less than 1.2 per cent. and therefore completely negligible. It may be wondered why any asymmetry should exist in the system; however, a consideration of the equivalent circuit of Fig. 6(b), shows that the sum of the alternating anode currents flows in the cathode load whereas the anode current of V_2 alone flows in the anode load. The ratio of the alternating components of the anode currents of V_2 and V_1 is, however, very large.

Design Considerations

The circuit was specifically developed to drive valves of the PX 25 class, and the values are therefore chosen to give a large peak output rather than maximum gain. If it is required to drive valves requiring a smaller grid swing no doubt much higher values of gain can be achieved. It should be pointed out to those evolving their own designs that the dynamic load on V_1 is very much greater than the D.C. load, while the A.C. load on V_2 is less than the D.C. load.

For smaller output voltages, say up to 25V R.M.S. at each output point, the component values are not critical while other types of valve have been substituted with only minor circuit changes; e.g., bias and screen resistors. It is of interest to note that the EF.36 strapped as a

World Radio History

Push-pull Phase-splitter—
triode gave better results from a linearity point of view than any of the triodes investigated.

As with most cathode-follower systems, it is advisable to reduce the heater-cathode voltage of V_2 by using a separate heater supply for the stage, connected to an appropriately decoupled point on the H.T. supply.

In order to avoid loss of gain it is desirable to by-pass the cathode bias resistors of each stage.

Table I gives the results obtained with the circuit of Fig. 4.

TABLE I

H.T. Supply Voltage	Max. output Voltage e_{o1} (or e_{o2})		Input Voltage for max. output (R.M.S.)	Gain
	R.M.S	Peak		
400	37.5	53	0.031	1210
290	25.6	36	0.023	1110

It will be noted than the measured gain is somewhat less than the calculated value, the discrepancy is not however more than can be accounted for by variations in the actual values of components from those assumed.

Application of Circuit

The circuit has been used over a number of years in a wide variety of amplifiers and has proved to be remarkably stable and free from undesirable traits.

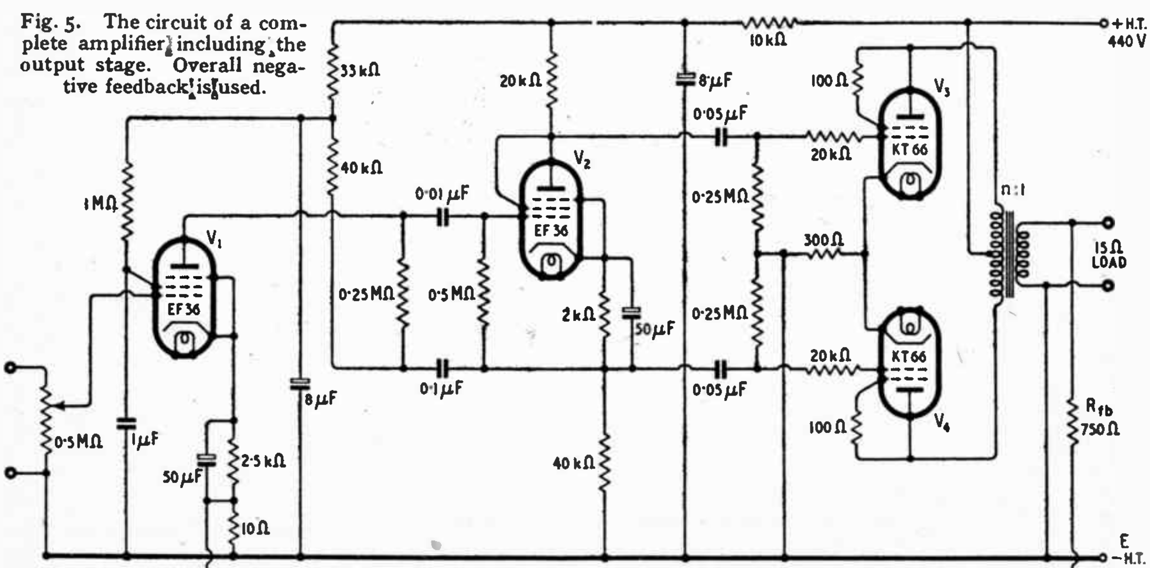


Fig. 5. The circuit of a complete amplifier including the output stage. Overall negative feedback is used.

A complete design is given in Fig. 5. KT 66 valves strapped as triodes have been used in the output stage, this method of connection giving a performance roughly equivalent to that of the PX25 type with the added advantages of shorter grid swing, indirectly-heated cathodes and octal base.

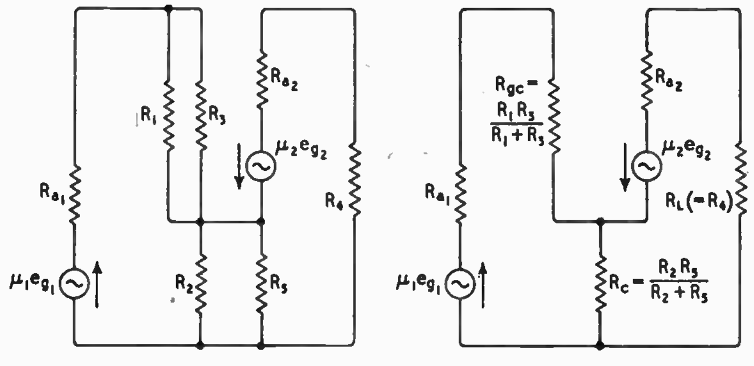


Fig. 6. The equivalent circuit of Fig. 4 can be drawn in the forms shown at (a) and (b).

Without negative feedback an output of 14.5W is obtained with less than 0.025V (R.M.S.) input. If negative feedback is applied as shown in Fig. 5 the required input voltage for maximum output is raised to 0.25V (R.M.S.). The negative feedback reduces the distortion content to 0.5 per cent at maximum output, while the output impedance becomes $120/n^2$ ohms. It is illuminating to note that this latter value is less than that obtained by operating the same valves as a cathode-follower stage. Using a good quality output transformer the response, with overall negative feedback, was measured to be within ± 1 db from 25–20,000 c/s. If an output transformer of poorer quality is used the degree of feedback may have to be slightly reduced in order to satisfy the Nyquist stability criterion.

Where a greater output is required the KT 66 valves can be operated as tetrodes in the normal manner and 35 W can then be obtained. The author favours however the use of four valves operating as triodes in parallel push-pull where a large output is desired.

No originality is claimed for the circuit, as a search of the literature has shown that it appeared in the U.S.A. some years ago; however, so far as the author is aware no analysis of the circuit has previously been published.

APPENDIX

The input impedance of the cathode-follower phase-splitter of Fig. 1 is well known to be:

$$R_{in} = \frac{R_{a2} + (\mu_2 + 2)R_L}{R_{a2} + 2R_L} \times R_{gc} \quad \ldots (1)$$

when $R_L = R_0$

If, as is frequently the case, $R_L = R_c \simeq R_{a2}$ then $R_{in} \simeq \frac{\mu_2 + 3}{3} \times R_{gc}$.

For a triode, with μ_2 between 20 and 30, $R_{in} \simeq 10\ R_{gc}$.

The amplification is given by:

$$\frac{e_{01}}{e_{s2}} = \frac{e_{02}}{e_{s2}} = \frac{\mu_2 R_L}{R_{a2} + (\mu_2 + 2)R_L} \quad \ldots (2)$$

If again $R_{a2} = R_L$ this becomes

$$\frac{\mu_2}{\mu_2 + 3}$$

Then if $\mu_2 = 20$, gain $\simeq 0.9$.

Amplification of Pre-amplifier and Phase-splitter Together.

The equivalent circuit of Fig. 4 is shown in Fig. 6(a) and 6(b). e_{g2} is the voltage developed across R_{gc}. Taking into account the sign of this voltage e_{01} and e_{02} can be found in terms of e_{g1} ($= e_s$) and e_{01}/e_{02} represents the degree of unbalance of the system.

By writing the basic circuit equations from Fig. 6(b) expressions for amplification and unbalance are readily obtained. Thus if $R_L = R_C$:

$$\frac{e_{02}}{e_s} = \frac{\mu_1^2(\mu_2 R_{gc} - R_c)}{(R_{a1} + R_{gc} + R_c)\left(\frac{R_{a2}}{R_{gc}} + 2\right) + (\mu_2 R_{gc} - R_c)} \quad \ldots \quad \ldots \quad \ldots (3)$$

and

$$\frac{e_{01}}{e_{02}} = \frac{\mu_2 R_{gc} - R_c}{\mu_2 R_{gc} + R_{a2} + R_c} \quad \ldots (4)$$

Manufacturers' Literature

The following lists have been received from Standard Telephones and Cables, Connaught House, Aldwych, London, W.C.2:—

"Beam Approach Receiving Equipment Type KR/2."

"Quartz Crystals in Evacuated Glass Envelopes."

"Valves for Communications and Industry."

"The Royal Train"—a souvenir booklet, giving an account of the part played by Exide batteries, from The Chloride Electrical Storage Co., Grovenor Gardens House, London, S.W.1.

Short-wave Conditions

Expectations for August

By T. W. BENNINGTON

(Engineering Division B.B.C.)

DURING June the average daytime maximum usable frequencies were slightly lower than those for May, whilst due to the longer duration of daylight, the night-time M.U.F.s were about 1½ Mc/s higher than during that month. Communication on frequencies higher than 21 Mc/s was infrequent, particularly in east/west directions, and would, on an average, only have been possible over long distance routes to places in the high latitudes of the Southern Hemisphere. Medium frequencies—like 17 Mc/s—remained usable for very long periods, and 15 Mc/s could be used throughout the night on many circuits. Some medium distance communications on very high frequencies by way of Sporadic E occurred during the month.

There was less ionosphere storminess than during the previous three months, but June was on the whole more disturbed than is usual during this period of the year. The storms were mostly of short duration, and the most disturbed periods were the 1st, 5th-6th, 14th, 17th-18th, 20th-22nd, and 25th. Several "Dellinger" fadeouts occurred, the most severe being at 1035 on the 5th, and 1036 on the 14th.

Forecast.—During August the working frequencies for long-distance transmission should, generally speaking, be much the same as during July, although there will be a tendency for the daytime usable frequencies to be a little higher, and the night-time usable frequencies a little lower.

Working frequencies for *long distance* transmission should therefore continue to be relatively low by day and high by night, although towards the end of the month the higher short-wave frequencies—like 28 Mc/s—may begin to become more useful during the day, particularly to the southward of this country. Medium frequencies—like 17 Mc/s—should be usable for very long periods, and 15 Mc/s may remain of use throughout the night on many circuits.

The E and F1 layers will continue to control transmission over medium distances—between 600 to 1800 miles—for several hours during the day.

Sporadic E is likely to be somewhat less prevalent than during July, but communication by way of this medium may still be possible at times on very high frequencies up to a distance of about 1,400 miles.

Below are given, in terms of the Broadcast bands, the working frequencies which should be regularly usable during August for four long-distance circuits running in different directions from this country. All times in these reports are in G.M.T. In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this 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:—

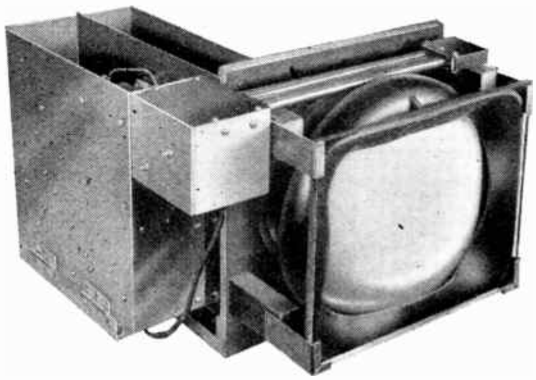
Montreal:	0000	15 Mc/s	(22 Mc/s)
	0300	11 ,,	(19 ,,)
	0900	15 ,,	(22 ,,)
	1000	17 ,,	(24 ,,)
	1900	21 ,,	(29 ,,)
	2100	17 ,,	(24 ,,)
Buenos Aires:	0000	17 ,,	(24 ,,)
	0200	15 ,,	(22 ,,)
	0700	11 ,,	(20 ,,)
	0900	15 ,,	(23 ,,)
	1000	17 ,,	(26 ,,)
	1100	21 ,,	(29 ,,)
	1500	26 ,,	(34 ,,)
	2000	21 ,,	(29 ,,)
	2200	17 ,,	(26 ,,)
Cape Town:	0000	17 ,,	(24 ,,)
	0200	15 ,,	(21 ,,)
	0300	11 ,,	(18 ,,)
	0500	15 ,,	(23 ,,)
	0600	21 ,,	(30 ,,)
	0800	26 ,,	(34 ,,)
	1900	21 ,,	(30 ,,)
	2200	17 ,,	(26 ,,)
Chungking:	0000	15 ,,	(20 ,,)
	0100	11 ,,	(19 ,,)
	0300	15 ,,	(21 ,,)
	0400	17 ,,	(24 ,,)
	1300	21 ,,	(29 ,,)
	1700	17 ,,	(24 ,,)
	2100	15 ,,	(20 ,,)

Ionosphere storms are not usually prevalent during August, and those that do occur do not, as a rule, cause any major interruption to radio communications.

At the time of writing it would appear that the most likely periods during which disturbances may occur are 1st-3rd, 7th-8th, 11th, 16th-18th, 22nd, 26th, 28th-30th.

World Radio History

Television Receiver Construction



6—Cathode-Ray Tube Mounting

THE equipment is built in three units, apart from the power pack, which are carried by a framework providing also the mounting of the cathode-ray tube. Two of the units—the line and frame time-base units have already been described. The third unit is the combined sound and vision receiver and will be dealt with in a further article.

The general framework not only holds the units and tube together, but it carries a few components and all the inter-unit wiring. This is shown in Fig. 1. The power input is brought to a tag-board by a 5-way cable and from there distributed to the three units—6.3 V, − H.T. and + H.T.$_1$ directly, and + H.T.$_3$ through the focus coil after which it becomes + H.T.$_2$.

As one heater lead is earthed in each unit it is necessary in making the interconnections to take particular care to see that all the earthy leads on the one hand and all the non-earthy ones on the other hand are joined together. If they are mixed up the 6.3-V supply will be short-circuited.

The focus coil is shunted by C_2 of 50 μF capacitance and by R_2 and R_3 in series; the latter forms the Focus Control. The grid of the tube is taken to the slider of the potentiometer R_4 across the H.T. supply and is by-passed to earth by C_5; this potentiometer forms the Brightness Control. Neither R_3 nor R_4 is mounted on the framework. They form the only panel controls of the set on the vision side and they are connected by a 4-way cable. They can thus

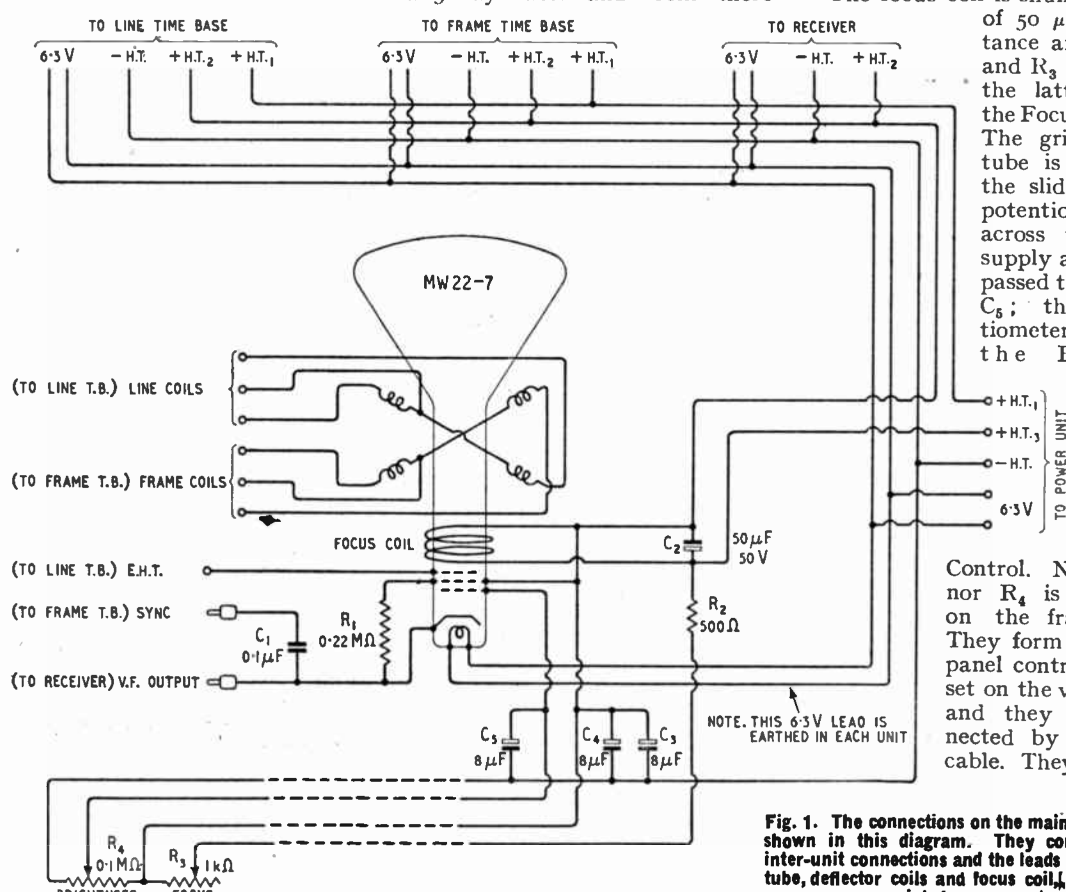
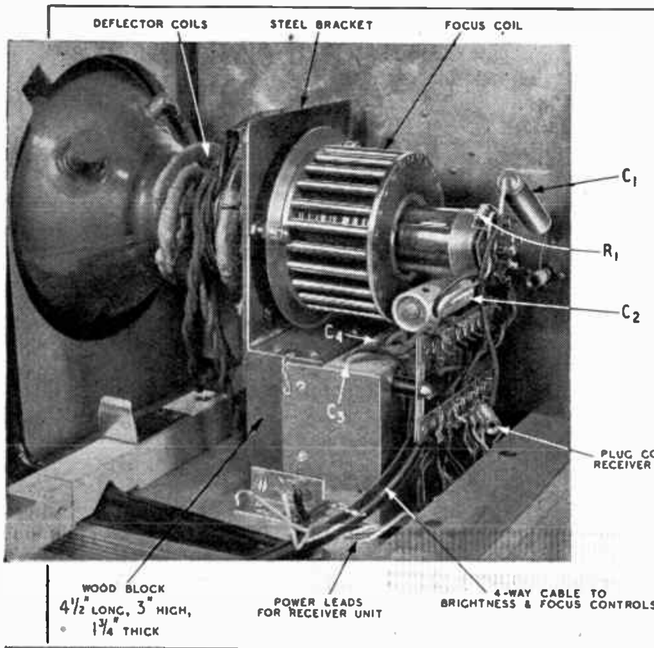
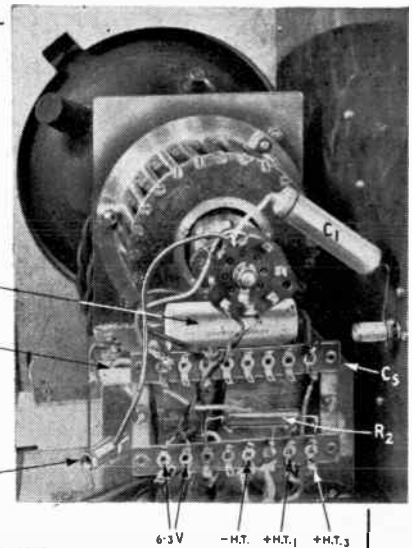


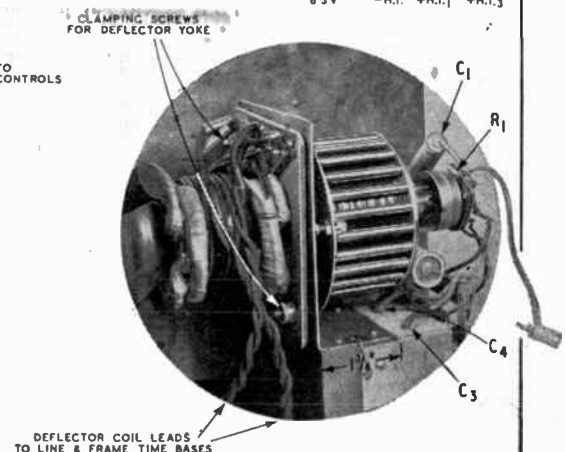
Fig. 1. The connections on the main frame are shown in this diagram. They comprise the inter-unit connections and the leads to the C.R. tube, deflector coils and focus coil, and a few associated components.

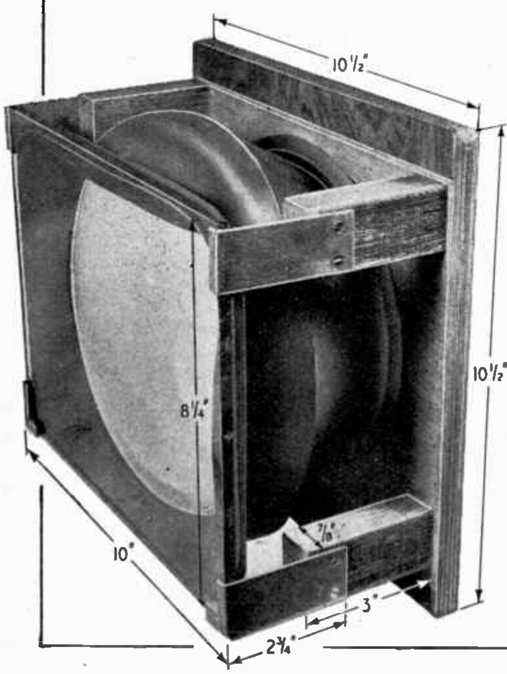
World Radio History

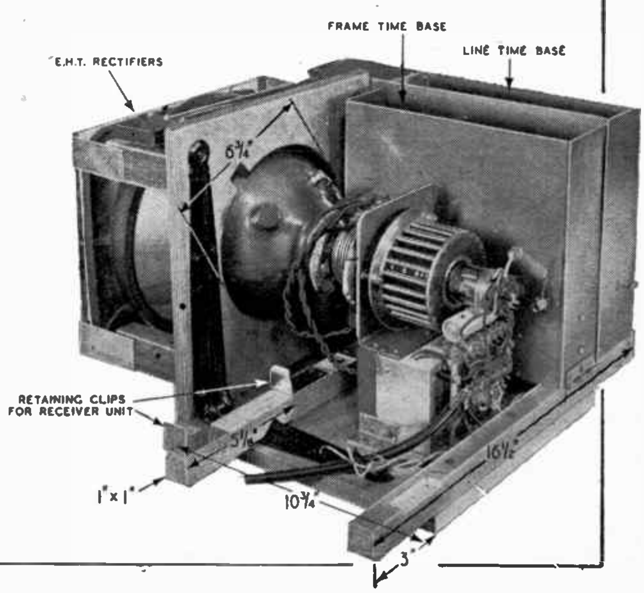




A view of the complete receiver assembly, except for the receiver unit, is shown below and the picture above shows the general arrangement of components around the C.R. tube. Other photographs depict the C.R. tube mounting, the focus and deflector coil assembly, and the tube base and tag board.







World Radio History

Television Receiver Construction—
be mounted in any convenient position on the containing cabinet. They will vary according to individual requirements.

The cathode of the tube is connected by a short lead terminating in a wander-plug to a socket on the Receiver Unit and also through a 0.1-μF capacitor C_1 and another wander-plug to the Sync socket on the Frame Time-Base Unit. The capacitor must have a low capacitance to earth and so is inserted in the lead and supported by its connections. The resistor R_1 of 0.22 MΩ is merely to prevent the tube cathode circuit from becoming open if the wander-plug is inadvertently removed with the set switched on.

The tube used is the 9-in Mullard MW 22-7 and it has a tetrode gun. The first anode requires about 200–250 V and is connected directly to + $H.T._2$; the second anode needs about 5 kV and is joined to the E.H.T. supply in the Line Time-Base.

Other tubes can be used with the obvious alterations dictated by physical size, provided that the electrical requirements are similar. It is necessary that the tube neck should not exceed 35.5 mm, since the focus and deflector coils are designed for this. This diameter is more or less standard, however. The angle subtended by the picture width at the centre of the deflection yoke should not exceed 48° otherwise it may not be possible to obtain a picture of the full width.

Larger tubes than the 9-in can be used with obvious alterations to the mounting. The deflection angle is usually about the same so that no scanning difficulties arise. The brightness will be less with a larger tube, however, but should be adequate for most purposes up to the 12-in type. Ideally one would increase E.H.T. with a larger tube, but this would entail an increase of scan power which is difficult to obtain without using more valves and increasing the demands on the H.T. supply.

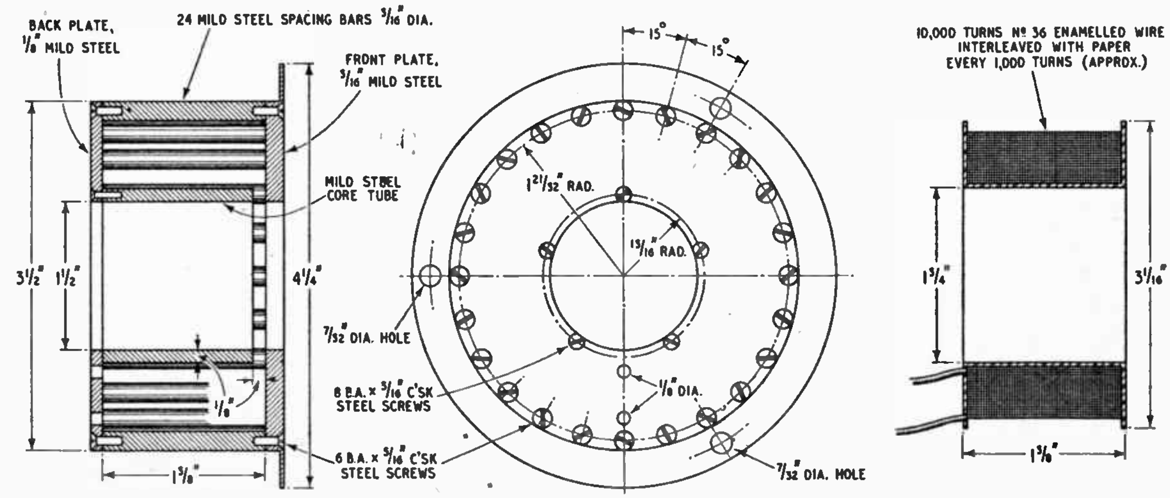
Tubes with different heater voltage ratings are easily accommodated by providing an extra suitable winding on the mains transformer. One word of warning is needed, however; before the war some tubes had the cathode internally connected to one side of the heater and this practice may still be adopted in some. A tube of this type is unsuitable for this set, since it must have the V.F. signal fed to the cathode, which demands a tube with an adequate heater-cathode insulation.

In order to make use of a tube with heater and cathode joined it is necessary to fit an extra stage of unity gain to reverse the phase of the signal. A D.C. restoring diode is also needed, since it is inadvisable to connect the tube grid directly to the anode of a V.F. stage.

It is not necessary that the tube used should have a tetrode gun. The more usual triode gun is quite satisfactory. The writer has used in this equipment a pre-war tube with a 2-V heater and a triode gun with very good results. With this type of tube some increase in the values of R_2 and R_3 may be found necessary since the focus-coil current needed is usually greater with the triode gun than with the tetrode. Because of this there is likely to be rather more change of focus with temperature.

As the photographs show, the framework consists of a plywood base carrying a plywood front by two stout brackets. The front has a hole of 6¾in diameter which is bevelled out to 7¼in at the front. A length of rubber draft-excluder is tacked around the edge to form a resilient support for the tube. A notch is cut out of the hole opposite the join in the rubber seating to give clearance to the sealing-off cover on the tube.

A moulded rubber mask is fitted to the tube and is faced by a sheet of ¼-in plate glass 10in by 8¼in, held in place by brass corner supports screwed to wooden stand-off pieces.



Full details are given here of the focus coil. As explained in the text the 24 spacing-bars are used only because of the difficulty of obtaining large diameter steel tubing.

The focus coil and deflector coil assembly are carried by a steel bracket supported in its turn by a block of wood, which carries the various capacitors and a tag strip. A sketch giving

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details for making the mounting bracket will be found on page 284. Two 1-in strips of wood, one of which has cut-outs to clear the brackets, are screwed across the base to carry the units. Hinges on the rear of the Receiver and Frame Time-Base units are screwed directly to the rear strip. The Line Time-Base hinges are screwed to a cross piece joining the ends of the two strips. A metal sheet is erected between the two time-base units to provide inter-unit screening. It is, of course, earthed to – H.T.

Details of the deflector coils have already been given and the assembly is held to the bracket by two screws fixed to the latter. Milled nuts permit the assembly to be slackened easily so that it can be rotated slightly about the neck of the tube, and so bring the picture square with the mask.

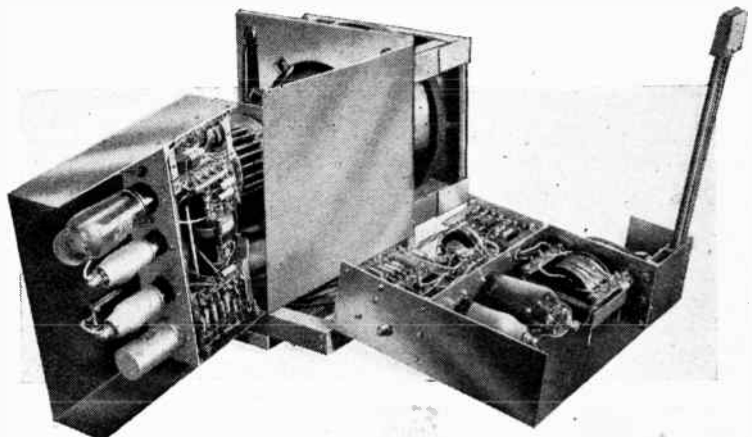
The focus coil is held to the rear of the bracket on three short lengths of 2 B.A. studding. On one of these a short, strong spring is placed between the coil and the bracket with lock-nuts to hold the coil on. On the other two half-nuts are used, one each side of the coil flange. By slacking these nuts the focus coil can be tilted for centring the picture in the mask. The use of a spring for the third avoids the need for access to a rather awkwardly placed nut.

Details of the focus coil itself are given in one of the drawings. It comprises front and back-end plates of mild steel held apart by 24 mild-steel spacers around the outer edges. Inside there is a core tube, which is ⅛in shorter than the spacers so that there is a ⅛-in gap between the end of the core tube and the front-end plate. It is in this gap that the magnetic field for focusing is developed.

The 24 spacers complete the magnetic circuit and are adequate for this purpose. It is more usual to employ a piece of large-diameter tubing of ⅛-in to $\frac{3}{16}$-in wall, in place of them. With such a piece of tubing the construction would be easier since only six fixing screws would be needed at each end instead of twenty-four, so that thirty-six fewer holes would have to be drilled and tapped.

However, steel tubing of the requisite diameter is extremely hard to obtain in short lengths and the construction with separate spacers was adopted as a practicable alternative. Incidentally ordinary 5-in wire nails represent the most easily obtainable material for the spacers! Tubing is necessary for the core piece, but because of its smaller diameter it is not unduly difficult to obtain.

A lathe is almost essential for making the focus coil, since it is necessary for the ends of the core tube to be true. It is advisable, although not essential, to true up the ends of the spacers in a lathe and it is also better to use steel screws than brass for holding the parts together.



A rear view of the assembly showing the frame and line time-base units opened out for access to the interior. The only connection that need be broken is the plug-connector to the "Sync Input" socket on the frame unit.

The winding consists of 10,000 turns of No. 36 enamelled wire. The coil resistance is 1,000 Ω and it requires a current of about 45 mA for focusing. The coil is inserted at a point where the current is about 90 mA, and is shunted by resistance to by-pass 45 mA. The resistor is variable as a focus control and has a 500-Ω fixed resistor in series to limit the range as already explained.

Corrections and Additions

In Part 4, the frame scan output valve was given as type CL33 instead of EL33 in the parts list.

In Part 5, the line scan output valve was incorrectly shown in the circuit and in the list of parts as type EF38. It should, of course, be type EL38, and was correctly referred to in the text.

The rectifiers W_1 and W_2 were also listed as Siemens Type H4/200 instead of Standard Telephones & Cables, Selenium Rectifiers, Type H4/200.

Details of the laminations used in the line-scan output transformer were inadvertently omitted from Part 5. The ones used are Joseph Sankey & Sons, No. 4 or 4A, Richard Thomas & Baldwins' Type C.10 or Magnetic & Electric Alloys No. 4 or 4A, silicon steel and a ½-in. stack is needed. The No. 4 differs from the No. 4A and C.10 in not having clamping holes in the corners and so with it the clamping screws must pass outside the laminations instead of through them.

LIST OF COMPONENTS.

Capacitors		
C_1	0.1 μF, 500 V working	T.C.C. type CP435
C_2	50 μF, 50 V electrolytic	Dubilier Drilitic BR505
C_3, C_4, C_5	8 μF, 500 V working, electrolytic	B.I.
Resistors		
R_1	0.22 MΩ ½ W	Erie
R_2	500 Ω 3 W	Welwyn
R_3	1,000 Ω 5 W variable	Reliance Type TW
R_4	100 kΩ variable	Reliance Type SG
Miscellaneous		
Cathode-ray tube, 9-in		Mullard MW22–7
Cathode-ray tube mask (for Mullard MW22–7 tube)		Long & Hamblin

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Tuned A.F. Filters

2—Designing a Correction Filter for a Crystal Pick-up

By **H. E. STYLES**, B.Sc.

THE frequency response curve of a crystal pickup is well known to depend largely upon the load resistance employed, due to the capacitive nature of the pickup, and control of low-frequency response by variation of load resistance is often advocated. The solid curve of Fig. 1 (*a*) shows an average response curve for a load of 500,000 ohms whilst an ideal pickup response is indicated by curve (*b*). The rise in the bass is, of course, required to compensate for the deliberate recording attenuation of 6 decibels per octave of frequencies below 250 c/s.

It will be seen that the output from the pickup is correct at 50 c/s and at 1,500 c/s, but between these limits the output level is too high.

Reducing the load resistance merely attenuates the lowest frequencies which are in any case only just of adequate intensity.

Table I shows the attenuation required to correct the pickup response at frequencies between 50 and 1000 c/s, and it will be seen that the required attenuation reaches a maximum of 10 db at 250 c/s, falling off in a regular manner on each side of this frequency.

TABLE I

Attenuation Required to Correct Pickup Response

Frequency (c/s)	Attenuation (db)	Frequency (c/s)	Attenuation (db)
50	− 0.7	300	8.9
60	0.7	400	6.9
70	1.7	500	5.1
80	2.9	600	3.9
90	3.6	700	2.8
100	4.4	800	2.0
200	8.5	900	1.5
250	9.8	1000	1.0

It is apparent that at 75 c/s and at 800 c/s the required attenuation falls to the negligible value of 2 db and for these two frequencies the values of $\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$, where $f_0 = 250$, are -3.0 and $+2.9$ respectively. Thus the required attenuation is at least approximately symmetrical about a frequency $f_0 = 250$ on an $\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$ basis, which suggests that the required correction might be obtained by means of a flatly tuned rejector or acceptor filter as described in the previous part of this article.

For reasons given in the article referred to above, an acceptor circuit is preferable for the correction of pickup response, and in any case will require more convenient component values.

From the design data already given* we find that if an effective attenuation of 10 decibels is required at a frequency $f_0 = 250$, the value of $Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$ at which the attenuation falls to 2 db amounts to 3.8. Since $\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$ approximates to 3.0 it follows that the required value of Q must be 1.3.

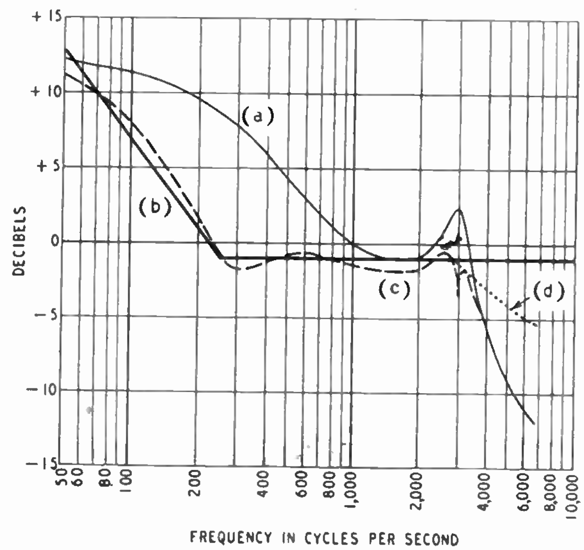

Fig. 1. (a) Response curve of a crystal pickup with 0.5MΩ load. (b) Ideal pickup response. (c) Pickup with filter. (d) Effect of 0.0002μF shunt across resistance S in Fig. 3.

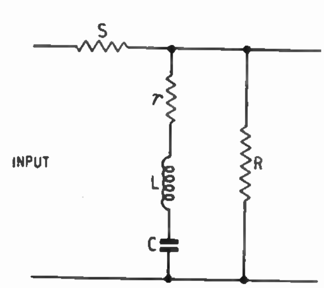

Fig. 2. Basic low-frequency correction circuit.

Thus for the correction filter circuit given in Fig. 2, we have the following design data.

$Q = 1.3$

$f_0 = 250$

$F_0 = 0.32$ (i.e., − 10 db)

$$r = \frac{F_0SR}{(1 - F_0)(R + S)}$$

$$L = \frac{Qr}{2\pi f_0}$$

$$C = \frac{1}{2\pi f_0 Qr}$$

As already stated, the response curve of the pickup varies considerably with variation in load resistance and the data given in Table I are based upon a fixed load of 500,000 ohms.

* Incidentally, the title of Table I in the previous instalment should read "when maximum attenuation at f_0 is as indicated".

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In order, therefore, to ensure reasonable compliance with this requirement it is necessary to limit the variation of the filter input impedance to say 600,000 ohms maximum and 400,000 ohms minimum.

TABLE II

Attenuation Produced by Filter of Fig. 2

Frequency (c/s)	Absolute Attenuation (db)	Effective Attenuation (db)	Frequency (c/s)	Absolute Attenuation (db)	Effective Attenuation (db)
50	8.5	0.9	500	12.2	4.6
70	9.2	1.6	600	11.0	3.4
100	10.9	3.3	700	10.3	2.7
150	13.7	6.1	800	9.7	2.1
200	15.2	7.6	900	9.2	1.6
250	17.6	10.0	1000	9.0	1.4
300	17.2	9.6	1500	8.5	0.9
400	13.7	6.1	—	—	—

Hence R + S = 600,000 and since R will normally be a volume control its value can be made 250,000 ohms, in which case S will have to be made 350,000 ohms, a value which will obviously give a minimum input impedance of about the desired amount.

Thus $r = 68{,}500\,\Omega$, L = 57 H. C = 0.0072 μF. Using these values, the circuit of Fig. 2 will produce a constant attenuation of $\frac{R}{R+S}$ or 7.6 db at frequencies far from resonance, the attenuation at frequencies between 50 and 1500 c/s being as given in Table II.

It will be seen that the effective attenuation produced by the filter corresponds well with the attenuation required to correct the pickup response, curve (*c*) in Fig. 1 showing that the corrected response curve nowhere departs from the ideal curve by more than 2 db between 50 and 2,000 c/s.

The output from the pickup and filter combination will, of course, be 8.6 db below the normal output at 1,000 c/s. And since the latter is usually about 1.6 volts, the mean output from the combination will approximate to 0.6 V.

There remains the peak in the response curve at 3,000 c/s resulting from resonance of the pickup needle and movement, and whilst this is not of very great magnitude it does produce a certain degree of needle scratch due to shock excitation of the movement. The precise frequency and amplitude of the peak may vary somewhat and it is therefore desirable to provide a tunable correction filter with a fairly sharp cut-off. With such a filter a certain degree of over correction will produce no noticeable attenuation, whilst at the same time it will provide a means of ensuring elimination of needle scratch reproduction. It will be observed, that owing to the general fall in response level at high frequencies the resonance peak is sharper on the high-frequency side, and in order to avoid further attenuation of the higher frequencies it is desirable to ensure that the correction filter should produce an attenuation of not more than 2 db at say 3,300 c/s corresponding to a value of $\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$ equal to 0.19.

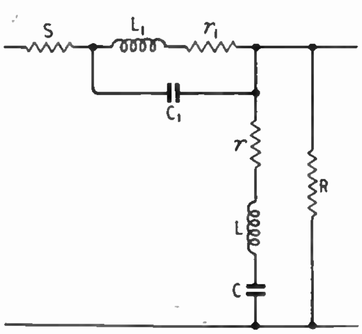

Fig. 3. Circuit with the addition of a rejector for the 3,000 c/s needle resonance.

If the filter is designed to produce a maximum attenuation of 6 db (i.e., $F_0 = 0.5$) at the resonant frequency f_0=3,000 c/s, the value of $Q\left(\frac{f_0}{f} - \frac{f}{f_0}\right)$ corresponding to − 2 decibels will be 2.0 from which it is evident that Q must be 10.

Now at frequencies around 3,000 c/s the pickup output does not vary much with variation in load resistance and it is therefore permissible to introduce a rejector circuit as shown in Fig. 3.

At frequencies around 3,000 c/s the effect of the shunt circuit L, C, r, may be ignored and hence the circuit of Fig. 3 becomes in effect a rejector circuit in which L_1, C_1 and r_1 form the tuned circuit and R + S the total series resistance, the output being in effect tapped down to a fraction $\frac{R}{R+S}$ of the voltage developed across R + S.

Thus we have for this rejector circuit.

$f_0 = 3{,}000$
$F_0 = 0.5$
$Q = 10$
$R = 600{,}000$

Hence $r_1 = \frac{R(1 - F_0)}{Q^2 F_0} = 6{,}000\,\Omega$

$$L_1 = \frac{Qr_1}{2\pi f_0} = 3.2 \text{ H}$$

$$C_1 = \frac{1}{2\pi f_0 Q r_1} = 0.00088\,\mu\text{F}$$

The attenuation produced by this filter is given in Table III.

TABLE III

Attenuation Produced by Rejector Circuit

Frequency (c/s)	Attenuation (db)	Frequency (c/s)	Attenuation (db)
2,600	1.3	3,200	3.2
2,800	3.1	3,400	1.5
3,000	6.0	3,600	0.8

Curve (*c*) in Fig. 1 also includes the correction produced by this filter, which should be carefully tuned to eliminate scratch, and it will be seen that the overall corrected response nowhere differs by more than 2 (db) from the ideal curve between 50 and 3,500 c/s.

Frequencies above 4,000 c/s are considerably attenuated, but for

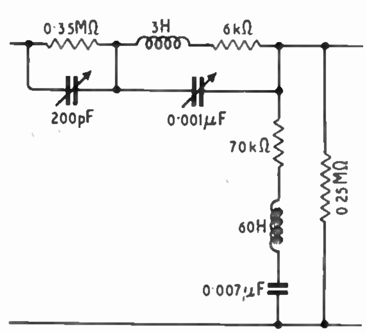

Fig. 4. Final circuit with component values.

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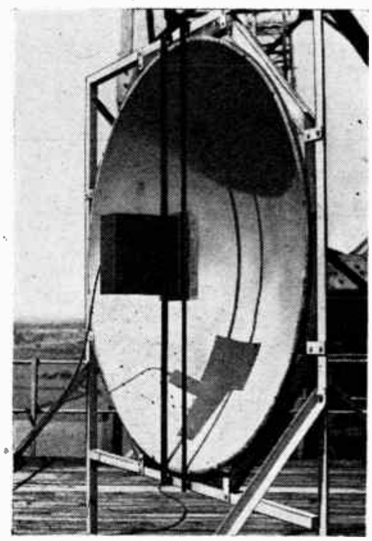
most recordings this is not of any great consequence. Nevertheless, if desired, a certain degree of high-frequency lift can be obtained by shunting resistance S with a variable condenser of about 0.0002 μF capacity, the most suitable value being obtained experimentally. In this manner the response at 6,000 c/s can be lifted by 5–6 db, as indicated by curve (*d*) in Fig. 1, without appreciably affecting the level at frequencies of 3,000 c/s or less.

The final correction circuit is shown in Fig. 4 in which the approximate component values are given.

Marconi Television Link

A DEMONSTRATION was given on June 17 of an experimental television relay link by Marconi's W.T. Co. The Alexandra Palace transmission was received at Danbury, near Chelmsford, and re-transmitted to a receiving site at Great Bromley, close to Colchester, the distance of the relay being about 24 miles.



The receiving paraboloid with the input stages of the receiver.

The vision channel was 510 Mc/s (60 cm) and employed a carrier power of some 5 watts. Frequency modulation was used, largely because of the constancy of the receiver output obtained through the use of limiters. The transmitting aerial took the form of a horn radiator mounted on a mast 40 ft above ground and energized by a probe.

At the receiving end a paraboloid reflector was used and carried at the 200-ft level on a mast. For the sound channel the transmitting aerial was a Yagi with a cylindrical reflector and eight directors. Frequency modulation was used here also and a power of 100 milliwatts.

The programme for the demonstration originated in Ascot, so that as seen at Bromley, it travelled by the B.B.C. outside-broadcast link to Alexandra Palace, from there to Danbury by the normal television transmission, and from Danbury to Bromley by the Marconi link. In spite of its many transformations the received picture was extremely good and appeared to have suffered little, if at all, in the last stage of its journey.

In order to judge the precise effect of the link on picture quality it would be necessary to compare relayed and unrelayed pictures side by side. It is understood that the Marconi Co. hope to carry out such a trial by erecting a further link back from Bromley to Danbury. It will then be possible to have C.R. tubes side by side, one showing the picture received directly from Alexandra Palace and the other a picture relayed to Bromley and then back to Danbury. By comparing the two pictures the effect of a two-step relay will be immediately obvious.

Our cover picture shows the horn aerial used on the vision transmitter together with a second experimental horn and the Yagi aerial of the sound transmitter.

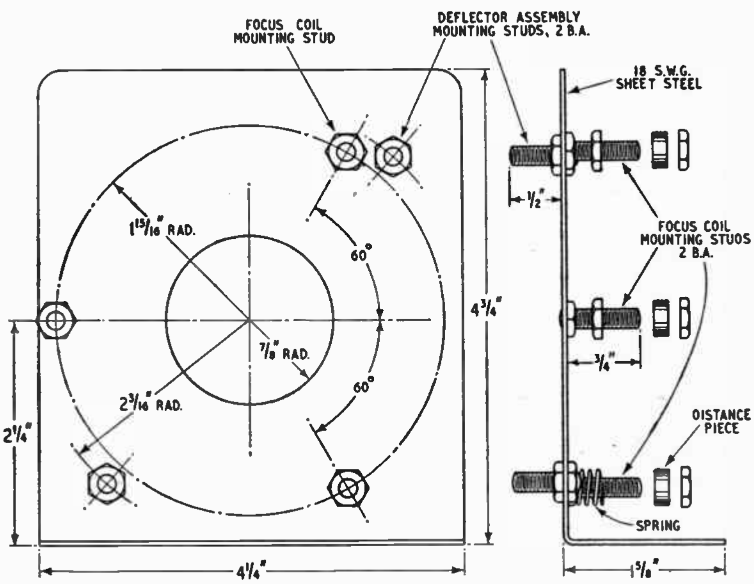
BOOKS RECEIVED

The Cathode-Ray Tube Handbook (Second Edition).—By S. K. Lewer, B.Sc. Other than the sections which have been added to the chapter covering the application of the cathode-ray oscillograph, the material is unchanged. 103 pages with 36 figures. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 6s.

Capacitors—Their Use in Electronic Circuits.—By M. Brotherton, Ph.D. (Bell Telephone Laboratories, Inc.). In this book the author has attempted to bring together in a form suitable for quick reading the material needed by a circuit designer to enable him to evaluate his requirements 107+vii pages with 33 diagrams. D. Van Nostrand Co., Inc., New York. English publishers, Macmillan and Co., St. Martin's Street, London, W.C.2. Price 16s 6d.

Television Receiver Construction

(See page 278-281)



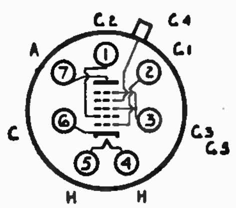
Constructional details for making the steel bracket that carries the focus and deflector coil assemblies.

World Radio History

WHEN 15D1 NEEDS ARISE — KNOWING DEALERS ★ BRIMARIZE

15D1

Types 15D1 and 15D2 are identical except that the heater current of the former is 0.2 amp. whilst that of the latter is only 0.15 amp. In AC/DC receivers where the heaters are wired in series, it will therefore be necessary to wire a resistor in parallel with the 15D2 heater to carry the extra 0.05 amp. This resistor will, of course, not be needed in A.C. receivers where heaters are in parallel.



TYPES 15D1, 15D2

RATED CHARACTERISTICS

	15D1	15D2
Heater Volts	13.0	13.0V
Heater Current	0.2	0.15A
Anode Volts	250V	250V
Anode Current	3.5mA	3.5mA
Screen Volts	100V	100V
Screen Current	2.2mA	2.2mA
Grid Bias	−3V	−3V
Conversion	0.55mA/v	0.55mA/v

TYPE	CHANGE SOCKET FROM	CHANGE SOCKET TO	CHANGE CONNECTIONS FROM OLD SOCKET	CHANGE CONNECTIONS TO NEW SOCKET	OTHER WORK NECESSARY	PERFORMANCE CHANGE
15D2	ENGLISH 7-pin NO CHANGE		NO CHANGE		In AC/DC receivers a 250-ohm resistor must be connected in parallel with the heater (between pins 4 and 5)	NONE

← PUNCH HOLES HERE →

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

5

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London Philharmonic Orchestra
Conductor: Ernest Ansermet — AK 1574-6

Full Symphony Orchestra

March Slav. Op. 31 *(Tchaikovsky)* Parts 1 and 2
National Symphony Orchestra
Conductor: Anatole Fistoulari — K 1282

Choir, Soprano and Contralto soloists, and String Orchestra

Stabat Mater *(Pergolesi)* Parts 1-10
Nottingham Oriana Choir with Joan Taylor *(Soprano)*
Kathleen Ferrier *(Contralto)*
and the Boyd Neel String Orchestra — AK 1517-21

String Orchestra, with flute, oboe, violin and trumpet soloists

Brandenburg Concerto No. 2 in F major *(Bach)*
Parts 1-4
Boyd Neel Orchestra with Arthur Gleghorn *(flute)* Evelyn Rothwell *(oboe)* Frederick Grinke *(violin)* and George Eskdale *(trumpet)* — AK 1550-1

Solo Soprano (boy), male voice Choir, and Organ

Hear my prayer *(Mendelssohn)*
O for the wings of a dove *(Mendelssohn)*
Derek Barsham *(Boy Soprano)* with the High Wycombe Orpheus Male Voice Choir *Conductor* W. Bromage Smith *Organist:* J. B. Harris — K 1111

Violin and piano

Sonata in G minor *(Tartini)* Campoli *(violin)*
with Eric Gritton *(piano)* — K 1531-2

Solo piano

Sonata in E major *(Schubert)*
Kathleen Long *(piano)* — AK 1180-2

Rumba band

Maracas,
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Edmundo Ros and his Rumba Band — F 8777

Swing band

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World Radio History

Moving Iron Pickups

Effect of Inductance on Frequency Response

By E. H. FRANCIS

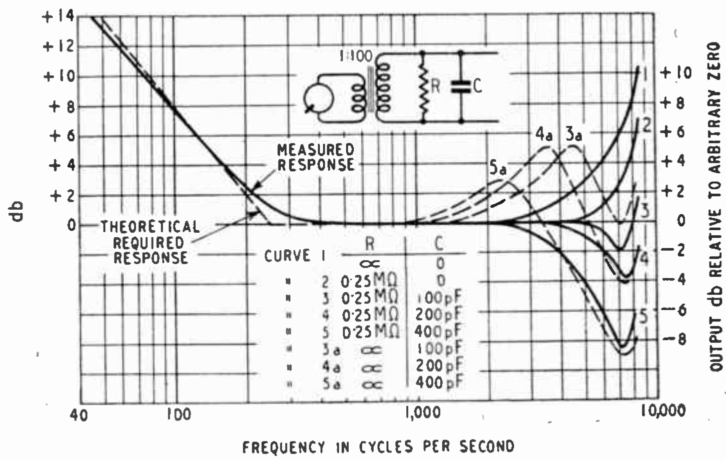

Fig. 1. Frequency response of pickup (including bass compensation) for various loads on secondary of coupling transformer.

IT is the purpose of this article to underline certain features of miniature moving-iron pickups which should be appreciated to obtain most satisfactory results. These important features are: (1) The frequency response of the pickup; (2) the impedance/frequency characteristic in association with the input transformer; (3) the frequency correction necessary for playing ordinary recordings.

Some experiments with the E.M.I. Type 12 ("Hypersensitive") pickup may serve to draw attention to the importance of the inductive reactance of the pickup winding, and the necessity for care in choice of coupling component values.

Dealing first with the H.F. end (i.e., frequencies above 1,000 c/s), curve 1 of Fig. 1 shows the output with the secondary of the step-up transformer (as supplied with the Type 12 pickup; ratio approximately 1:100) connected directly to a medium-slope triode amplifier. The curves of Fig. 1 were taken using H.M.V. test records DB4034 to 4037 and with the transformer feeding into an amplifier whose gain/frequency response was flat between 1,000 and 10,000 c/s. The output of the amplifier was measured with a meter accurately calibrated in decibels. The zero level is an arbitrary one, and small fluctuations of the order of ±1 db have been smoothed out as they were not likely to be due to the pickup.

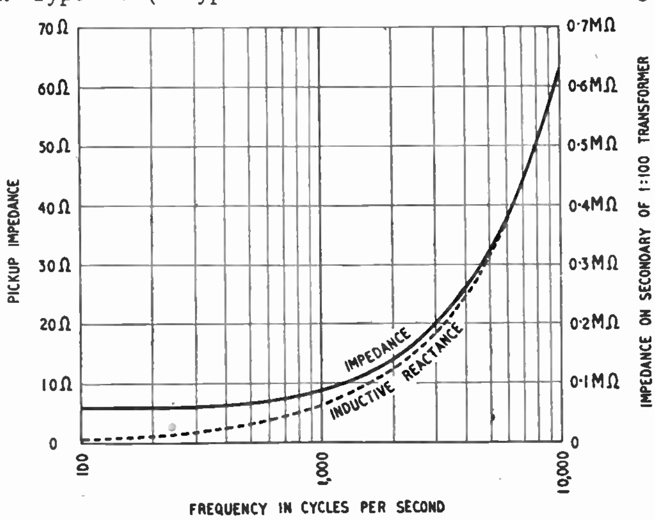

Fig. 2. Impedance and inductive reactance curves above 100 c/s.

The point to note is that the output increases considerably above 4,000 c/s due mainly to the needle resonance which occurs at 9 to 10 kc/s, and due also to some extent to resonance in the transformer secondary circuit. The reason for the transformer resonance will be seen in a moment.

Turning now to the impedance of the pickup; its winding resistance is approximately 6 ohms, but there is also inductance of the order of one millihenry. Fig. 2 shows the impedance, and also the reactive component, over the frequency range at the pickup terminals, and also on the secondary of the 1:100 transformer. Taking 8,000 c/s by way of example, the secondary impedance contains 500,000 ohms (approximately) of inductive reactance, and thus a circuit stray capacitance (i.e., total of winding capacitance and valve input capacitance) of only 40 pF approximately is required to give resonance at this frequency. The equivalent circuit at the transformer secondary is shown in Fig. 3; the increased gain at the resonant frequency is due to the resonant rise in voltage across the

Moving Iron Pickups—
circuit capacity C_s being applied to the valve grid. Curves 3a, 4a and 5a of Fig. 1 show the effect more clearly when the capacity C_s is increased by the addition of 100, 200 and 400 pF condensers respectively.

Top Cut

Allowing for the deficiency of the average speaker above 5 kc/s, the rising response of the pickup aided by the secondary circuit resonance might appear to be an advantage. In practice this is not so, and surface noise and higher frequencies are unduly prominent. It is necessary therefore to take steps to attenuate the higher frequencies, in fact to avoid the distortion which occurs on the louder passages of almost all recordings it is necessary to aim at the sharpest possible cut-off. The makers of the pickup recommend the use of filters to give the following characteristics:—

Frequency (kc/s)		Attenuation (db)
New Records	Old Records	
6	4	6
7	5	15
10	7	30

Only a proper low-pass filter comprising coil and condenser networks (difficult to construct and test for the amateur) could give such a sharp cut-off, but if one assumes some discrimination will be used in rejecting inferior quality or worn recordings, a less sharp cut-off can be allowed with corresponding improvement in reproduction.

Fortunately, for this purpose the resonance referred to above comes in useful, as referring to Fig. 3 it will be seen that the circuit is similar to that of a half-section low-pass filter. Referring again to Fig. 1, curves 2 to 5 show the effect of a 0.25 MΩ shunt resistance and various capacities connected in parallel across the secondary terminals of the transformer. A capacity of 200 pF with 0.25 MΩ shunt in parallel gives a curve which is very satisfactory in practice, but as will be seen from the curve, the output begins to rise again above 7 kc/s. If desired a filter circuit in the amplifier (tuned to 9 kc/s) may be used to ensure further attenuation of frequencies above 7 kc/s. Suitable circuits are described later.

The final circuit of a gramophone pre-amplifier stage used by the author is shown in Fig. 4. Points to note are that the top cut-off condenser C_1 has been made 300 pF variable, further top-cut is given by C_2, a value of 0.002 μF being suitable. A tone control of the variable resistance-capacity type has been included (R_6, C_3). This latter control operates lower in the scale than C_1 and C_2 and forms a useful control of tonal balance, as some recordings, notably American, appear to have pre-emphasis of the higher frequencies. The components R_3, R_4, R_5 and C_5 comprise the main correction circuit for the L.F. recording characteristic giving about 10 db lift at 50 c/s. Additional lift of about 4 db at 50 c/s is given by R_1, R_2 and C_4. R_1 and R_2 also provide the 0.25 MΩ closing resistance for the transformer. The measured L.F. curve including this correction is shown in Fig. 1. This shows more than the calculated lift, due to the effect of the fundamental tone arm mechanical resonance at about 20 c/s.

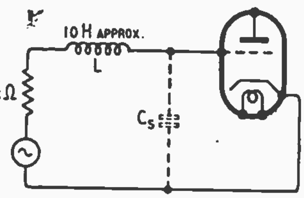

Fig. 3. Equivalent circuit at secondary of coupling transformer (ratio 1 : 100).

V_1 is a triode of about 10,000 Ω impedance. Should a higher impedance triode be used R_3 should be omitted. If higher gain is required from this stage a pentode may be used. In this case R_3 and R_4 should be omitted, and the anode load resistance made 100 kΩ; suitable other components are, cathode resistor and condenser 1,500 Ω and 25 μF, screen resistor and condenser 470 kΩ and 0.5 μF.

One final word on the operation of the control in the pre-amplifier (Fig. 4). On most new English recordings R_6 needs adjustment for maximum top and on good recordings C_1 may be adjusted to allow the full frequency range. On worn records or records with pre-emphasis R_6 is used to reduce surface noise and high frequencies and C_1 will help in these respects and also to eliminate the higher frequency products of distortion. If the bass appears to be too heavy, the components R_1, R_2 and C_4 may be replaced by a 0.25 MΩ resistor connected directly across the transformer, or C_4 may be short-circuited with a switch to form a bass control.

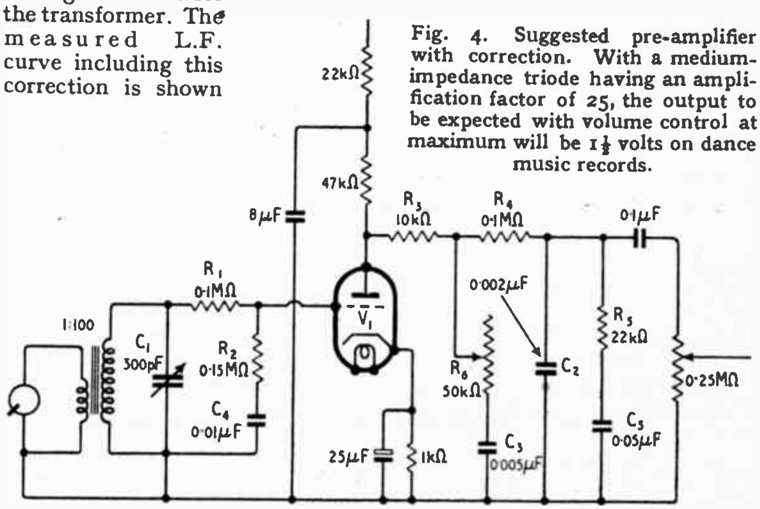

Fig. 4. Suggested pre-amplifier with correction. With a medium-impedance triode having an amplification factor of 25, the output to be expected with volume control at maximum will be 1½ volts on dance music records.

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Radial Time Bases

How They Were Developed for Radar

By G. W. A. DUMMER, M.B.E., M.I.E.E., and E. FRANKLIN, Ph.D.
(*Telecommunications Research Establishment*)

THE first radar P.P.I. (Plan Position Indicator) to be used by the R.A.F. was designed by the authors in 1940, and in view of the use since made of this device it may be of interest to recall early experimental work on radial time bases.

The possibility of the desirable P.P.I. presentation of radar echoes had been realized by the pioneers in the early days of radar. It was not, however, until 1939/40 that the two developments of a radar station using a sufficiently narrow beam and the cathode ray screen with bright and lasting afterglow led to the development of a satisfactory P.P.I.

In 1939/40 work was proceeding on the design of a "radio lighthouse" on a wavelength of 50 cm. It was envisaged that with the narrow beams then obtained on this wavelength it should be possible to rotate a time base in synchronism with the aerial rotation to give a radar "map" of all surrounding aircraft. It was decided that the time base should take one of two forms:—

1. An inductive or capacitive voltage split of X and Y vectors and recombination on an electrostatically deflected tube.
2. A mechanically rotated current time base on a magnetically deflected tube.

At that time 12-inch electrostatic tubes were in use on CH and CHL sets and magnetic afterglow tubes were not fully developed; it was therefore decided to adopt the first scheme. A schematic diagram of the arrangement is given in Fig. 1. A resistance-capacity phase shift oscillator (600/800 c/s) was used as a master sine wave generator (see circuit diagram Fig. 2). The output was squared and then integrated by an R-C combination and the resultant triangular wave was amplified and fed to the search coil of an inductive type of phase splitter wound to an accuracy of half a degree. By using a triangular wave, all unwanted inductive effects due to flybacks were eliminated.

As the induced voltage on the stators was proportional to the rate of change of rotor current, the voltage on the stators was the differential of the triangular wave and a small square wave was induced in each of the stators. The amplitude of these waves rose and fell according to the position of the rotor coil.

Two similar amplifiers "X" and "Y" were provided. Taking one amplifier, the incoming square wave was amplified and integrated to a triangular waveform and then mixed with a square wave to give a sawtooth waveform which was equal in positive and negative directions. One of these halves was blacked out on the CR tube so that a single time base trace was left commencing at the centre of the tube. The mixing of triangular and square waves was effected simply by inserting a resistance in series with the integrating condenser. The square-topped current wave produced a triangular voltage wave across the condenser and also produced a square voltage wave across the resistance. As both were inserted into the grid circuit of a valve the required mix was obtained.

The resultant waveform was then amplified and passed to two paraphase valves to feed the X and Y deflector plates of the tube. The signals from the receiver were D.C.-restored before feeding to the tube cathode and a diode limiter was also used to prevent defocusing of the tube by large signals. It is interesting to recall that the first model of the rotating time base with tube, time base, power packs, etc., filled the whole of a 6ft Post Office Rack.

By the time the radial time base was completed (May, 1940) the remainder of the 50-cm "Radio Lighthouse" was not ready, and it was therefore decided to try out the system on the C.H.L. receiver. The C.H.L. set operated on $1\frac{1}{2}$ metres and was provided with two display tubes, one for range and one with a "split" device which provided accurate azimuth. It was necessary to stop and "inch" the aerial system to take an accurate azimuth reading on one aircraft and other aircraft on different azimuths might be missed. A radial time base would provide constant 360° cover if a tube with a long afterglow was used. Accordingly, the whole

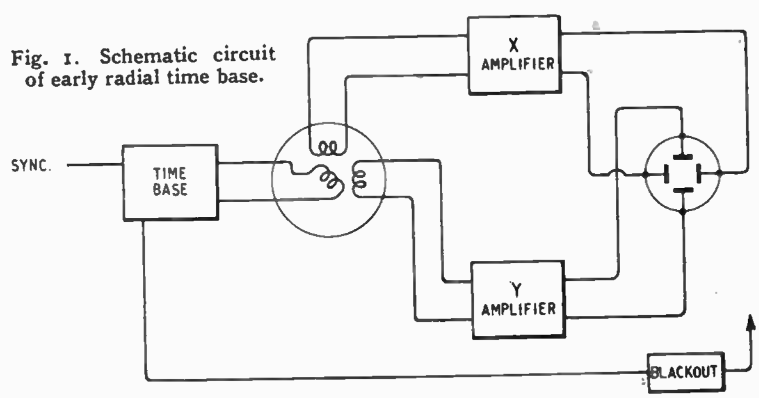

Fig. 1. Schematic circuit of early radial time base.

Radial Time Bases—
equipment was fitted to a standard C.H.L. receiver at Worth Matravers, Dorset, and after initial teething troubles and one or two false "invasion" alarms the equipment operated satisfactorily. A map of the Dorset coast was drawn on the tube face with a chinagraph pencil by the authors, and the first demonstration of the equipment was given to A. M. Sir Phillip Joubert. It was remarkable that during his visit a convoy was sailing down the Channel and twelve Spitfires were flying overhead making an excellent "picture" on the C.R.T. face.

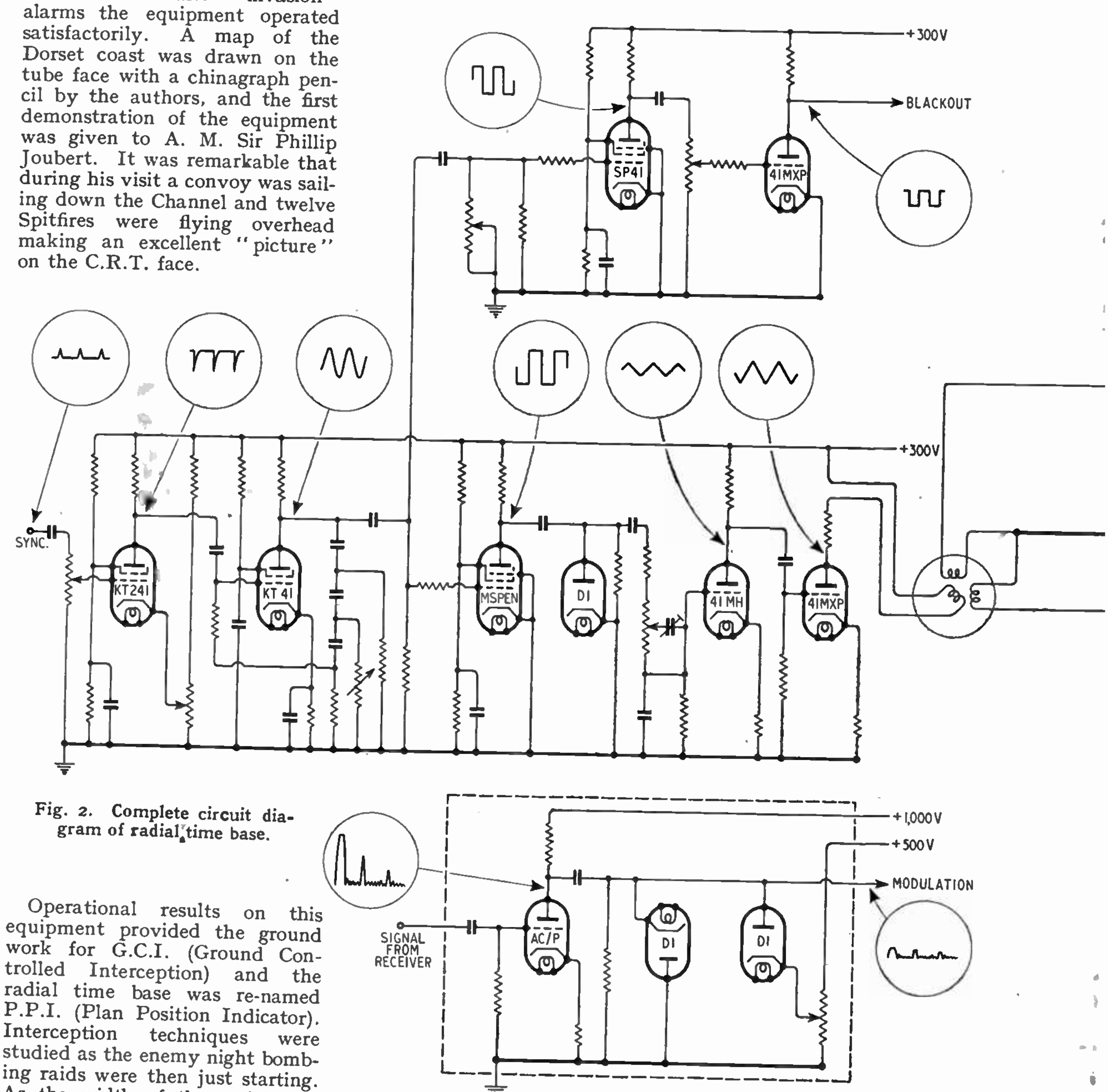

Fig. 2. Complete circuit diagram of radial time base.

Operational results on this equipment provided the ground work for G.C.I. (Ground Controlled Interception) and the radial time base was re-named P.P.I. (Plan Position Indicator). Interception techniques were studied as the enemy night bombing raids were then just starting. As the width of the aerial lobe was approximately 15°, the echoes were seen as arcs, the aircraft position being the centre of the inner edge.

At this period magnetic tubes with increased beam currents were becoming available and it was decided that, for full production, mechanically rotated time base coils would be simpler to produce, and a P.P.I. of this type was, therefore, designed. A triangular waveform was again used to reduce flyback effects and to simplify scanning transformer design. P.P.I.s of this type were modified for production by the manufacturers.

This type had one main drawback; it was not automatically self-centring. In order that the time base should rotate about its one end, it was obviously necessary for there to be zero current in the deflector coils at that point. But, as the triangular waveform was fed to the coils through a transformer, the zero current point occurred in the middle of the sweep, and the time base rotated around its mid-point.

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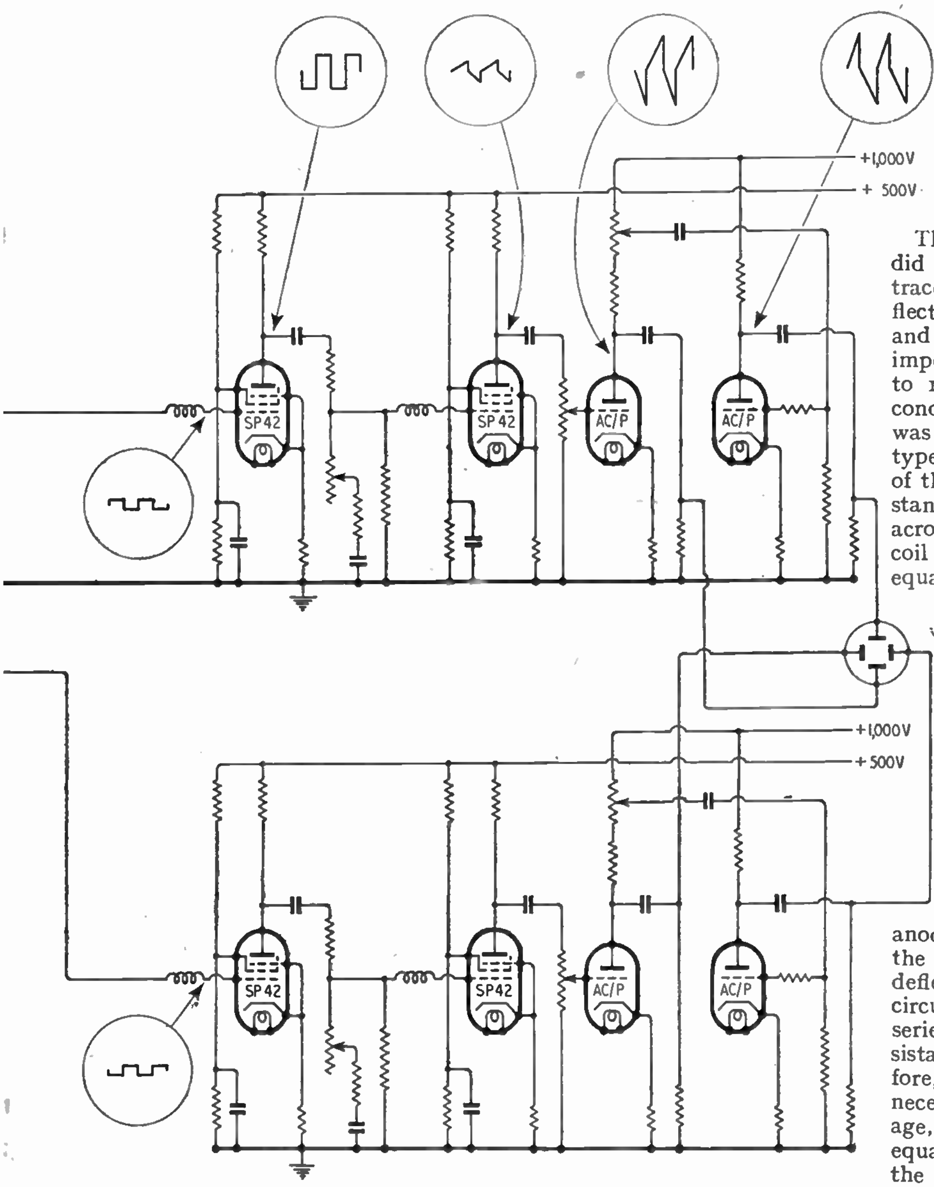
To make it rotate around one end, a "shift" current had to be passed through the coils equal in value to the peak alternating current. This involved a large D.C. power supply and high-wattage potentiometers for adjusting the shift current; also, it was found that fairly frequent readjustment of shift current was necessary, due to power supply voltage variations, etc. The automatically self-centring circuit of Fig. 3(a) was therefore developed, and was used in the highly mobile Light Warning Equipment and in several ground equipments.

A square wave was applied to the grid of the valve V_1, which had the deflector coils in its cathode circuit. During the negative half-wave the valve was cut off, therefore no current flowed through the coils and the cathode beam took up its no-current position in the middle of the tube face. During the positive half-wave the valve took current, and, acting as a cathode follower, maintained constant voltage across the coils. Constant voltage across an inductance required constant rate of change of current through the inductance, therefore the cathode beam traced out a linear time base starting from the no-current point on the tube.

The valve was cut off during the periods between time base, and therefore the mean current was very much less than that of the previous circuit.

The simple circuit of Fig. 3(a) did not give a perfectly linear trace, due to the fact that the deflector coils had resistance R_L, and the valve had a finite output impedance. The latter was equal to $1/g$ where g was the mutual conductance of the valve, and this was about 150 to 200 ohms for the type of valve used. The effect of this impedance was, at any instant, to decrease the voltage across the inductive part of the coil impedance by an amount equal to the current at that instant multiplied by the resistance $(R_L + 1/g)$, this reduced the rate of rise of current in the coil by an equivalent amount.

In order to overcome this effect it was necessary to raise the grid voltage by an equal amount, and this was done automatically in the circuit of Fig. 3(b). A square wave was applied to V_1 grid and this appeared inverted on the anode of V_1, and finally on the grid of V_2, which had the deflector coils in its cathode circuit. These coils had in series with them a total resistance $(R_L + R_3 + 1/g)$. Therefore, for a linear time base, it was necessary to add to V_2 grid voltage, at any instant, a voltage equal to the current, i, through the coil multiplied by $(R_L + R_3 + 1/g)$. This was done by feeding back the voltage iR_3 which appeared across R_3 into the cathode circuit of V_1 and choosing the values of R_2, R_1, and R_4, R_5 so that total gain round the circuit from the junction of R_2 and R_3, through V_1 to the junction of R_1 and R_5 was equal to $(R_2 + R_3 + 1/g)/R_3$. To a high degree of ap-



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proximation, this occurred when $R_1R_5/R_2(R_4+R_5) = (R_L+R_3+1/g)R_3$.

This improvement in the circuit came too late to be adopted in the production models of Mark VA or Mark VI G.C.I. or C.H.L. or in the Light Warning Set, and was, therefore, never used in the field.

Experimental work was also carried out on "strobing" a portion of the time base shown in Fig. 1, amplifying it and feeding it to another tube. By this means an enlarged P.P.I. was developed. A dim "square" (approximately) 1in side on a 12in tube) was produced on the first tube by partial blackout to identify the area which was being enlarged and this area appeared as full size on the other tube. Owing to the 15° beamwidth of the polar diagram the system was not used, but it is interesting to record that a system of this type was operating in this country in 1941.

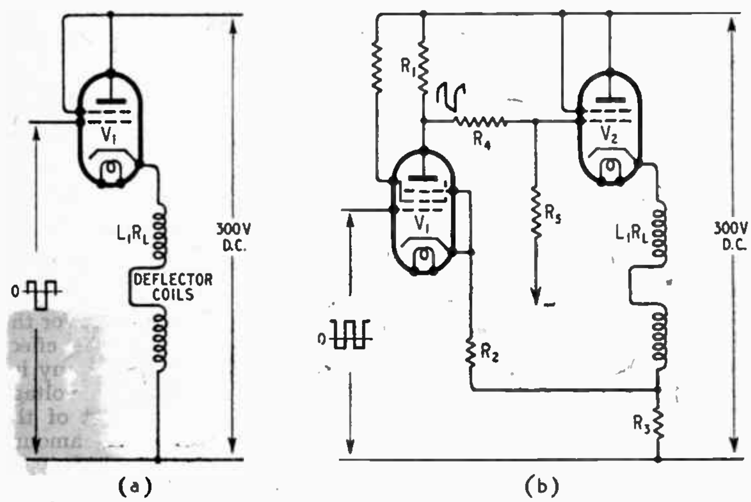


Fig. 3. (a) Automatic self-centring circuit, (b) modified circuit to correct non-linearity in the trace.

The P.P.I. was next adapted for use in the first centimetre A1 equipment and afterwards for H_2S and ASV. It has become one of the most widely used presentation systems for radar both in this country and U.S.A. and it seems a far cry from the original 6ft rack to the compact, efficient airborne P.P.I.'s in use today.

Superhet Foundation Kit

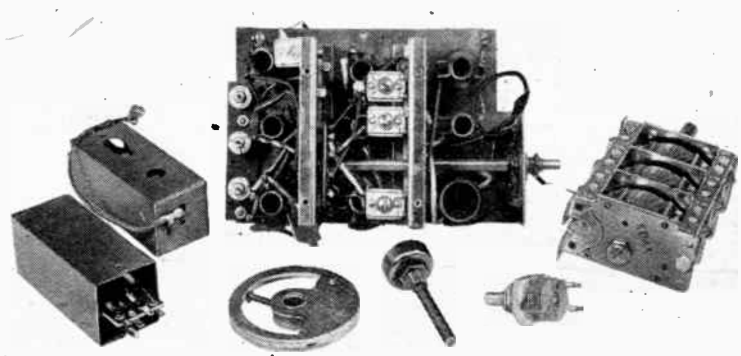
THIS is a selection of parts for the construction of a superheterodyne receiver and consists of a three-band coil unit, complete with switching, padding and trimming condensers; a three-gang tuning condenser; two 465-kc/s permeability tuned I.F. transformers; an air-dielectric trimmer for the oscillator circuit and slow motion drive mechanism and engraved scales. It provides the essential items for either a domestic-type broadcast set or a small communication receiver, the R.F. stage providing that additional sensitivity so desirable in a set of the last-mentioned kind.

The three wavebands provide for reception on the short and the medium waves, their respective coverages being 23 to 7 Mc/s, 7 to 2.3 Mc/s and 190 to 560 metres. These three scales are actually engraved on the transparent dial plate, which also has markings for the wavechange switch and a two-position tone switch.

The coil-unit is well finished and contains high grade parts, air-dielectric trimmers being used where desirable for the short-wave ranges. Adequate screening of the three coil sections is provided, the oscillator section being almost completely enclosed.

Accompanying each kit is a circuit diagram giving all component values for a superhet receiver, but constructors can always modify it to incorporate any preferred feature.

This foundation kit is obtainable from Premier Radio Co., Jubilee Works, 167, Lower Clapton Road, London, E.5, and the price is £3 17s 6d.



The various items, with the exception of the transparent dial plate, that comprise the Premier three-band superhet kit.

Soldering Technique

A PARTICULARLY informative and well illustrated booklet, "The Evolution of Activated Rosin Cored Solder," has been produced by H. J. Enthoven and Sons (230, Thornton Road, West Croydon, Surrey) who are the makers of "Superspeed" cored solder. Much useful technical information on the properties of solders and fluxes is given, and an especially interesting section is that explaining the transition from the solid to the liquid state of solder. In some kinds of work it is desirable to avoid the intermediate plastic or "pasty" stage in order to prevent waste of time in waiting for the joint to set. This can be done by choosing solder alloy of the right composition.

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Design Data (15)

Link Coupling

WHEN it is necessary to use a coupled pair of resonance circuits it is not always convenient to couple them together in any of the conventional ways. It is sometimes mechanically desirable to have the two circuits some considerable distance apart. In a rack-built transmitter, for instance, one circuit may fit best on one deck and the other on a different one; again, in a superheterodyne receiver it is sometimes convenient to build the frequency-changer and I.F. amplifiers as separate units. One circuit of the first I.F. coupling then fits best with the frequency changer and the other with the I.F. amplifier.

In such cases it is customary to use link coupling between the tuned circuits as shown in Fig. 1 (a). The two tuned circuits are L_1C_1 and L_2C_2 and they are coupled by the link circuit which comprises L_3 coupled to L_1 by the mutual inductance M_1 and L_4 coupled to L_2 by the mutual inductance M_2. The two link coils are connected by some form of screened cable, such as a length of coaxial feeder.

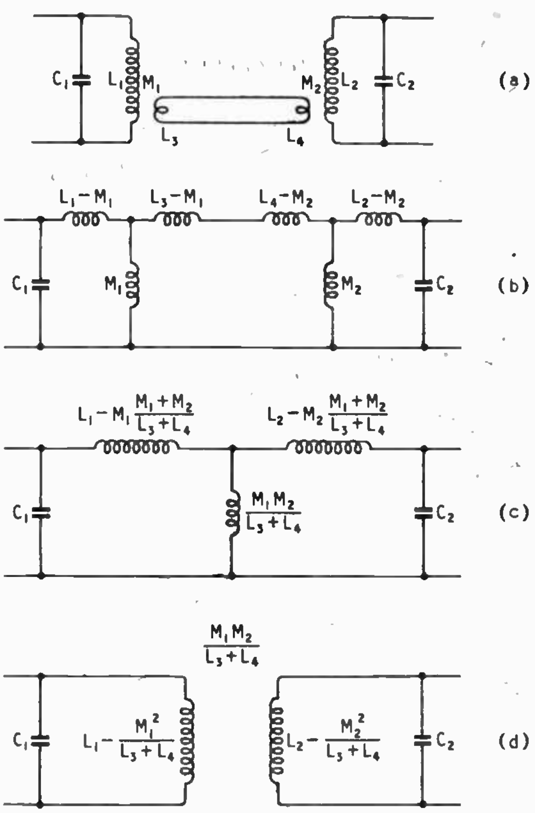

Fig. 1.

If the length of this connecting cable is short compared with a quarter-wavelength the effect of the cable is mainly that of its capacitance. This can usually be made negligible by using sufficiently great step-down and step-up ratios in the transformers at each end.

In most practical applications of link coupling the connecting cable does not exceed a yard in length and is often no more than a foot. Intermediate frequencies do not usually exceed 15 Mc/s or 20 metres, so that the cable is nearly always very short compared with a wavelength.

The case where the cable is comparable in length with a wavelength is comparatively rare. It is usually only met with in a transmitter. It might, for instance, be desired to couple two stages with a link circuit at a frequency of 60 Mc/s or 5 metres. More than a very short cable is likely to approach or exceed a quarter-wavelength, especially as the electrical length of cable is near one-half its physical length.

In such usage it is necessary to exercise very great care in design and the matter will not be dealt with here. In this note only the case of a cable very short compared with a wavelength will be considered, and the effect of the cable will be taken as negligible.

By various well-known transformation theorems, the circuit of Fig. 1 (a) can be reduced to the exact equivalent (d) through the intermediate steps (b) and (c). All the circuits of Fig. 1 are equivalent, and so it can be seen that the link-coupled circuit is no different in its performance from a pair of tuned circuits coupled by mutual inductance between the coils themselves.

When working out the coupling required between two circuits it is usually more convenient to think in terms of the coupling coefficient k than in mutual inductance. If the two circuits have Q-values Q_1 and Q_2 optimum coupling is obtained when

$$k = 1/\sqrt{Q_1Q_2} \quad \ldots \quad (1)$$

In the circuit of Fig. 1 (d) the coupling is

$$k = \frac{\dfrac{M_1M_2}{L_3 + L_4}}{\sqrt{\left[\left(L_1 - \dfrac{M_1^2}{L_3 + L_4}\right)\left(L_2 - \dfrac{M_2^2}{L_3 + L_4}\right)\right]}} \quad \ldots \quad (2)$$

In Fig. 1 (a) there are two coupling coefficients for the two halves of the circuit,

$$k_1 = \frac{M_1}{\sqrt{L_1L_3}} \text{ and } k_2 = \frac{M_2}{\sqrt{L_2L_4}} \quad \ldots \quad (3)$$

Rewriting (2) in terms of k_1 and k_2 we have

$$k = \frac{1}{\sqrt{\left[\left(\dfrac{L_3 + L_4}{k_1^2L_3} - 1\right)\left(\dfrac{L_3 + L_4}{k_2^2L_4} - 1\right)\right]}} \quad \ldots \quad (4)$$

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Design Data (15)—

When $L_3 = L_4$, as it will do in many practical applications, (4) reduces to

$$k = \frac{1}{\sqrt{\left[\left(\frac{2}{k_1^2} - 1\right)\left(\frac{2}{k_2^2} - 1\right)\right]}} \quad \ldots \quad (5)$$

and when $k_1 = k_2$ it becomes

$$k = \frac{1}{2/k_1^2 - 1} \quad \ldots \quad (6)$$

It is important to note that, when the individual couplings are loose so that $2/k_1^2 \gg 1$, $k \approx k_1^2/2$. Consequently, the overall coupling is much smaller than the individual couplings; thus, if $k_1 = 0.01$, $k \approx 0.00005$.

It is to be noted also that the performance is dependent on k, which is dependent in the symmetrical case, only on k_1 and k_2. The actual magnitudes of L_3 and L_4 are thus unimportant.

In practice, one commonly finds that attempts are made to adjust the coupling by altering the number of turns on L_3 and L_4. The equations show that such attempts will not be successful. Varying the number of turns on these coupling coils simultaneously alters their inductance and their mutual inductance with the tuned coils, so that the coupling coefficients stay unchanged. Of course, in practice, there is usually some change of coupling coefficients as well as inductances because the physical sizes of the coupling coils are altered. Nevertheless, it is true that altering the turns has only a minor effect on the coupling coefficient.

The correct way of adjusting the coupling is by altering the physical separation of L_1 and L_3 on the one hand and of L_2 and L_4 on the other. It is not essential that the two coupling coils should be identical nor that the two couplings should be alike. As L_1 and L_2 are usually approximately the same it is generally convenient to make L_3 and L_4 alike and, in the first instance, to couple them to the same degrees to L_1 and L_2. Subsequent alterations to achieve optimum coupling need be made only to one circuit, however.

For design purposes, it is desirable to rewrite Equations (5) and (6) to give the value of k_1 needed. We get, when $k_1 = k_2$,

$$k_1 = \sqrt{\frac{2}{1 + 1/k}} \quad \ldots \quad (7)$$

and when $k_1 \neq k_2$

$$k_1 = \sqrt{\frac{2}{1 + \frac{1/k^2}{2/k_2^2 - 1}}} \quad \ldots \quad (8)$$

As an example, suppose that it is required to couple two circuits of $Q_1 = Q_2 = 100$ with optimum coupling. From (1), $k = 0.01$ and from (7) $k_1 = k_2 = \sqrt{\frac{2}{101}} = 0.141$. If it turns out when the circuit is put into practical form that the couplings are too large, say $k_1 = k_2 = 0.2$, it is not necessary to reduce both. One, say k_1, can be reduced to the value given by (8); that is, to

$$k_1 = \sqrt{\left[\frac{2}{1 + \frac{10^4}{\frac{2}{0.04} - 1}}\right]} = 0.099$$

The design of the coils themselves is outside the scope of this note, and the turns needed on the coupling coils and their physical relation to the tuned coils will depend on the turns and shape of the latter. With air-core single-layer coils having a length/diameter ratio of more than unity one will not be far wrong if L_3 and L_4 consist of about one-tenth the number of turns of L_1 and L_2 overwound on the earthy ends. Provision should be made for one of the coils to slide over the main winding as a coupling adjustment.

In the case of wideband amplifiers some difficulty may be found in obtaining sufficient coupling. In such a case Q may be 2.5 only, so that k must be 0.4 and k_1 and k_2 become 0.755. Such tight coupling may not be easy to secure with air-core coils, but should not be unduly difficult if iron-dust cores are employed.

Practical Training

A REPORT of some importance to both the radio industry and to the would-be radio engineer has just been issued. Entitled "The Practical Training of Professional Electrical Engineers," it is produced by a committee on which the Radio Industry Council is strongly represented.

Two types of apprenticeships are recommended for giving practical training as a supplement to academic instruction. Graduate Apprenticeships (lasting two years) are for those who obtain their technical education by full-time university courses, and Student Apprenticeships (four years) for those attending part-time courses at technical colleges.

Some stress is laid on the recommendation that those intending to take university courses should serve the first year of their apprenticeship before entering the university. By doing so the student would be in a better position to profit from formal instruction and, perhaps equally important, would be able to decide if he has a real inclination towards an engineering career.

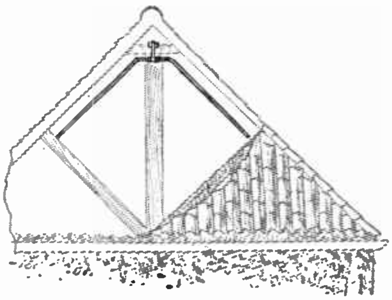
The success of this scheme naturally depends on the support given by industry. A number of large firms have already entered but more are wanted to participate. From many students' point of view it is important that the Ministry of Labour have decided to grant deferment of military service for those taking this training.

The report is obtainable from the Institution of Electrical Engineers, Savoy Place, London, W.C.2; price 1s.

World Radio History

BELLING-LEE QUIZ (No. 14)

Answers to questions we are often asked by letter and telephone



*1 Shows the Belling-Lee inverted "V" television aerial mounted in the attic.

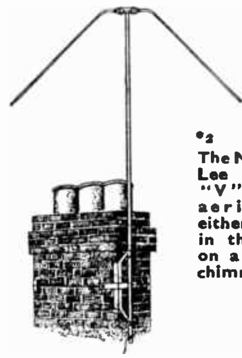
Question 43. *(Requested many times.) Can we have further technical information regarding your inverted "V" Television Aerial.*

Answer 43. This inverted "V" aerial was designed, in the first place, for indoor use in vicinities where the field strength was sufficiently intense to dispense with outdoor aerials. Apart from the symmetrical manner in which this aerial fits in with the roof shape, the bending of each element to an angle of 45° introduces a valuable technical feature, namely the independence of the aerial upon the angle of polarisation of the incident signal wave.

Although the signal wave is vertically polarised in the first place, the presence of metallic conductors such as conduit, water pipings, etc., can by re-radiation, cause a major change in the polarisation of the signal wave at the receiving aerial. These changes are looked after, automatically, by the inverted "V" construction of our aerial.

There is naturally some loss of signal, the terminal voltage at the mid-point being 6 db less than that from a single vertical half wave dipole. Since the aerial is only intended for use under conditions of high field strength this loss is quite unimportant.

In addition to this non-polarising feature, the aerial is directional, possessing sharp minima at right angles to its plane. This property is of very great use in removing a "ghost" due to the multipath transmission, or for eliminating interference from electronic heating or diathermy apparatus.



*2 The New Belling-Lee inverted "V" television aerial may either be fitted in the attic or on a convenient chimney.

As regards the limits of distance (from the transmitter) at which the inverted "V" aerial can be expected to work satisfactorily, a great deal obviously depends upon the amount of local screening.

Experience indicates that, in suburban districts, a distance up to five miles can usually be relied upon.

If the aerial is mounted out of doors at a height of about 40ft. the above distance can be doubled.

The aerial is designed to be connected to a twin balanced feeder of 75 ohms nominal characteristic impedance (our L.336)*3 but co-axial feeder (our L.600)*4 may be used with negligible difference in results.

Due to the partial folding of the elements, the bandwidth of the aerial is somewhat greater than that of the conventional dipole using elements of the same diameters, and is more than adequate for both the sound and vision channels as at present transmitted.

As a matter of interest the relative polar diagrams of our three aerial systems are depicted in the May issue of the "Wireless World."

Inverted "V" TV Aerial.
Patent applied for

*1 L.605 For Attic Mounting **£2/7/6.**

*2 L.606 For Chimney Mounting **£4/10/-.**

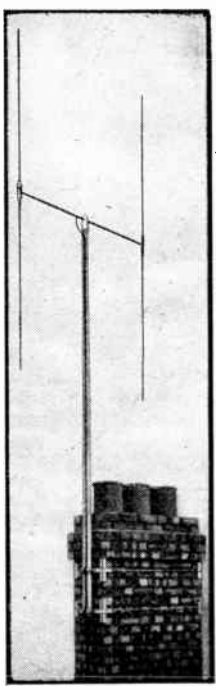
*3 L.336 Balanced twin feeder, per yard, **7½d.**

*4 L.600 Co-axial feeder, per yard, **1/3d.**

UNIQUE FEATURES OF THE BELLING-LEE

"VIEWROD" REGD. TRADE MARK

TELEVISION AERIAL



The Belling-Lee Television dipole is neat and easy to erect. It was the first mass produced dipole of improved technical design and embodies many features.

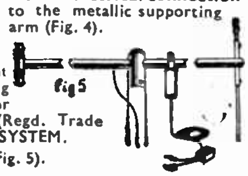
Some of these features are shown below together with various Registered Design and Patent numbers which protect their design and construction.

Regd. Design No. 836593. This registers the design of the moulded dipole insulator (Fig. 1).

U.K. PATENT No. 526587. This Patent is concerned with the cap shaped mast head fixing (Fig. 3).

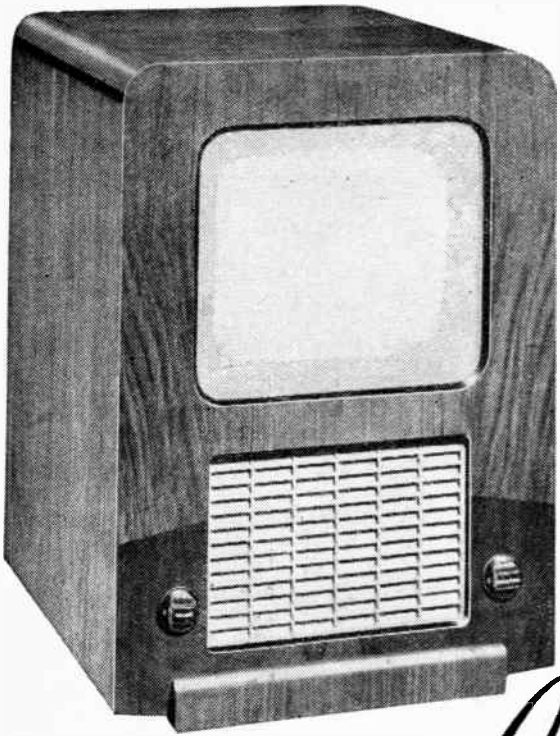
Regd. Design No. 836591. This registers the design of the arm and mast cap which support the dipole and reflector elements (Fig. 2).

U.K. Patent No. 519883. This patent covers the attachment of the reflector by **direct electrical connection** to the metallic supporting arm (Fig. 4).



U.K. Patent No. 520628. This patent covers the use of a combined supporting arm and reflector as a capacity aerial for attachment to the "ELIMINOISE" (Regd. Trade Mark) ANTI-INTERFERENCE AERIAL SYSTEM.
U.K. PATENTS 477218, 479118 (Fig. 5).

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX



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POST-WAR TELEVISION

★ *This magic selling feature—the signature of Radio's greatest genius is on every set.*

THE NEW MARCONIPHONE TELEVISION V.T. 50A

This is a sound and vision Table Grand Receiver, for A.C. mains, using a 10" Emiscope giving a picture $6\frac{3}{8}$" x $8\frac{5}{8}$" with a brilliance permitting enjoyable viewing even with the lights on! The cabinet is of typical Marconiphone quality finished in dark and light walnut panels with the popular Marconi bronze metal speaker grille.

PRICE 59 GNS. (Plus £14 . 1 . 11 Purchase Tax)

MARCONIPHONE

THE *Real* THING IN RADIO

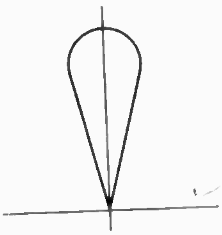
M.3

Television Aerials

Close-Spaced Arrays

By N. M. BEST
and R. D. BEEBE,
B.Sc. (Eng.), A.C.G.I.
(Antiference Ltd.)

IN considering the design of a television aerial array for domestic receivers a number of conflicting factors arise. The electrical requirements are maximum discrimination against interference, good forward gain, and wide bandwidth acceptance. Mechanically, the aerial needs to be of light and rigid construction and as compact as possible. In view of the fact that the spacings and reflector lengths giving maximum forward gain are not the same as those giving maximum discrimination, and that in general the high-gain arrays have considerably narrower bandwidths, a compromise has to be arrived at in designing an aerial for universal use.



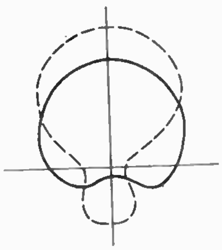


Fig. 1 (left). Ideal directional pattern obtainable only with multi-element array. Fig. 2 (right). Specimen patterns obtainable with single reflector.

In most practical cases these requirements are met by using a dipole and parasitic reflector, and it has been common practice to use a reflector element spaced at approximately a quarter-wavelength from the dipole. Experience showed, however, that closer-spaced reflectors appeared to give equal results, and in view of the mechanical advantage obtained it was decided to investigate the performance of this type of array over the bandwidth required for television reception, and to ascertain the optimum spacing and element lengths.

To overcome interference the aerial needs a directional reception pattern so that by rotating the aerial to a suitable position the direction of minimum reception may correspond with that of the interference. As this interference usually comes from a distributed source, such as motor vehicles passing along the road, rather than from a single point, an array having a sharply defined minimum reception position is not as generally useful as one which has reduced signal pick-up over a wide angle. Good forward gain also helps in improving the signal-to-noise ratio. These considerations do not apply, of course, in cases where both the interference and signal are coming from the same direction, for advantage cannot then be taken of the directional properties of an aerial.

An ideal polar diagram is shown in Fig. 1, but such patterns are only obtainable with multi-element arrays which are not practicable for domestic installation. The patterns usually obtained with a single reflector approximate to the general shapes shown in Fig. 2. It is difficult to express the performance of an aerial in terms of its polar diagram, and it is usually more convenient to specify the ratio of the signal received from the front to that received from the rear. This front-to-back ratio, while not giving a complete picture, is a fair guide to the discriminating efficiency of the aerial.

Fig. 3 shows the gain of a reflector array over that of a simple dipole plotted against reflector spacing when the reflector lengths are adjusted in each case for optimum front-to-back ratio.[1] It will be seen that the maximum gain is obtained at a spacing of 0.175 wavelength, but the overall variation in gain for spacings between ⅛ wavelength and ¼ wavelength is less than 0.5 db, which may be considered negligible for all practical purposes. In view of the necessity for maintaining the front-to-back ratio as high as possible for maximum interference discrimination, it would appear that spacings of less than ⅛ wavelength are not desirable owing to the steep drop in forward gain.

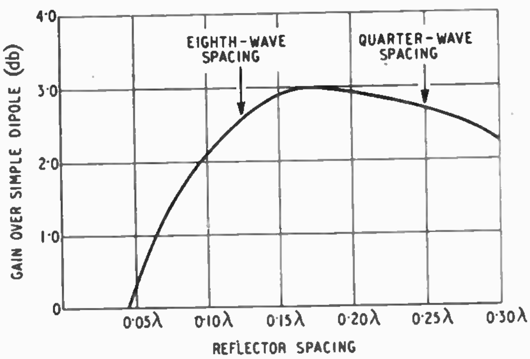


Fig. 3. Variation of gain of dipole and reflector over dipole alone with reflector spacing when the reflector length is adjusted for the optimum front-to-back ratio.

The effect on the front-to-back ratio of varying the reflector length is shown in Fig. 4 for ¼-wavelength and ⅛-wavelength spacing. Reflector spacings between these two values give curves lying between the two shown. It will be seen that for reflector lengths of between 0.49 wavelength and 0.57 wavelength the front-to-back ratio is greater for the eighth-wave array than the quarter-wave. Below 0.49 wavelength the ratio falls away very sharply, but the slope is more gradual for increasing reflector lengths. It would appear,

[1] "Some experiments on linear aerials." McPetrie and Saxton, *Wireless Engineer*, April 1946.

Television Aerials—

therefore, that for good signal-to-noise ratio using the closer spacing the reflector length should be at least 0.49 wavelength at the lowest frequency to be received. The bandwidth required for television reception is from 41.5 to 48 Mc/s, and if advantage is to be taken of the higher front-to-back ratio possible with ⅛-wavelength spacing, the reflector length should be at least 0.49 wavelength at 41.5 Mc/s. This length is equivalent to 0.57 wavelength at 48 Mc/s, giving a front-to-back ratio over the band of from 9 db at 41.5 to 6.8 db at 48 Mc/s. It has been common practice to make the reflector length about 0.51 wavelength at the vision frequency of 45 Mc/s. This corresponds to a length of 0.47 wavelength at 41.5 Mc/s, and should result in a considerable drop in signal-to-noise ratio on the sound frequency. Table I shows the approximate front-to-back ratios corresponding to these lengths and spacings. Comparing the arrays, the ⅛ wavelength spaced aerial appears to give a maximum front-to-back ratio between 41.5 and 45 Mc/s, which falls slightly at 48 Mc/s. The ¼-wavelength array has its maximum at about 44-45 Mc/s, falling away at each end of the band.

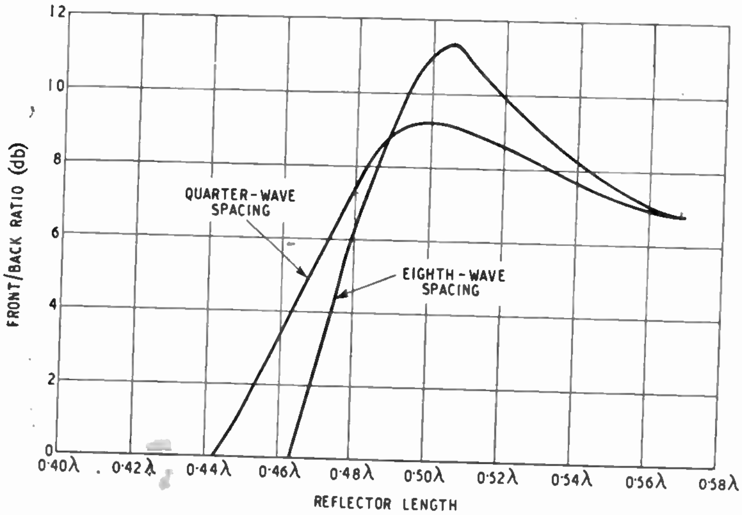


Fig. 4. The effect of the reflector length on the front-to-back ratio is shown here for reflector-aerial spacings of λ/8 and λ/4.

TABLE I

Array	Freq. (Mc/s)	Length	Spacing	Front/Back (db) (Approx.)
Typical commercial quarter-wave with 133-inch reflector.	41.5	0.47λ	0.23λ	5.4
	45.0	0.51λ	0.25λ	9.0
	48.0	0.54λ	0.27λ	7.6
Eighth - wave with 139-inch reflector ...	41.5	0.49λ	0.115λ	9.0
	45.0	0.53λ	0.125λ	9.0
	48.0	0.57λ	0.133λ	6.8

To verify the above conclusions an experimental confirmation was planned. A low-power oscillator was connected to a vertical half-wave dipole erected at a height greater than 1.25 wavelength at the lowest frequency to be used. The dipole elements were constructed of ⅜-in diameter aluminium tubing. One hundred yards of coaxial cable of 75-ohm impedance joined the oscillator to the dipole, enabling the operator to stand well outside the field of the dipole. About three wavelengths away at the lowest frequency used, a similar dipole was erected connected by a similar cable to a field strength meter calibrated directly in db with a reference level of 1 millivolt. The calibration was checked against a high-grade signal generator through an equal length of cable to that used in the tests and found to be accurate within plus or minus 0.5 db, enabling direct readings to be taken. The frequency of the oscillator was varied in 0.5 Mc/s steps from 41.5 Mc/s to 48 Mc/s, the aerial current being kept constant. The field-strength meter was tuned to the oscillator frequency at each step, the db readings being recorded against frequency. The resulting curve showed slight cyclical variations over the band, but a mean curve could be drawn with a fair degree of accuracy.

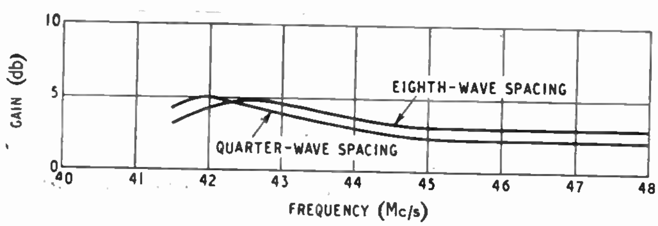


Fig. 5. Measured forward-gain curves of λ/8 and λ/4 spaced reflectors.

A quarter-wave spaced reflector of 0.51 wavelength was then added to the receiving dipole and a similar set of readings obtained, and this was repeated for various element spacings and reflector lengths. At spot frequencies of 41.5, 43.5, 45, 46.5 and 48 Mc/s, polar diagrams were taken by rotating the receiving array in angular steps of 30°. For each array a mean curve of signal against frequency was drawn, and by subtracting from these the mean curve obtained with the dipole alone the forward gains for each array were calculated. The front-to-back ratios were obtained from the polar diagrams.

The forward-gain curves obtained by this method for $\frac{1}{8}$-wavelength and $\frac{1}{4}$-wavelength spaced arrays are shown in Fig. 5. It was found that spacings between these values gave curves in Fig. 7, from which it would appear that there is little to choose between the two arrays on the score of discrimination. The familiar cardioid pattern only appears in Fig. 7 (c), and the asym-

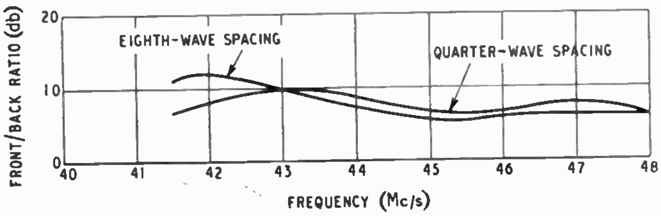


Fig. 6. Measured front-to-back ratios for $\lambda/8$ and $\lambda/4$ spaced reflectors.

lying approximately between those shown and that no greater overall gain was obtained. The optimum length of reflector for the $\frac{1}{8}$-wavelength spaced array was 0.49 wavelength at the lowest frequency; shorter lengths giving considerable loss at 41.5 Mc/s. The reflector length for the $\frac{1}{4}$-wavelength spaced array was less critical, and a value of 0.51 wavelength at 45 Mc/s appeared a good compromise. The curves of Fig. 5 appear very satisfactory, and, assuming that the dipole alone gives a symmetrical bandwidth, the $\frac{1}{8}$-wavelength spaced array gives a response curve flat within approximately 1 db over the television band.

Fig. 6 shows the front-to-back ratios of the same arrays. These agree with the figures expected except that the maxima for both curves occur at rather lower frequencies. The polar diagrams for 41.5, 45 and 48 Mc/s are plotted metrical shape of this is probably due to the use of coaxial-feeder cable.[2] Arrays having spacing between $\frac{1}{4}$ wavelength and $\frac{1}{8}$ wavelength gave similar diagrams when the reflector lengths were suitably adjusted.

No adverse effects were produced in practice through the lack of an impedance-matching device between the cable and aerial when using the close-spaced arrays. The figures given include any losses due to mismatch at this point. Eighth-wave spaced arrays have given satisfactory reception with all types of commercial television receivers, and the test results have been confirmed in a large number of practical installations, including many on the fringes of, and beyond, the generally recognized television service area. No cases of ghost images due to reflections up and down the feeder cable have been encountered, and tests made by introducing a large mismatch at the connection of aerial to cable show no adverse visual effects.

In general, it can be concluded that the advantages of the more sturdy and lighter construction of the close spaced array may be utilized for television-receiving aerials with the additional benefit, in so far as the $\frac{1}{8}$-wavelength spacing is concerned, of more even gain over the bandwidth, and better signal-to-noise ratio on the sound channel.

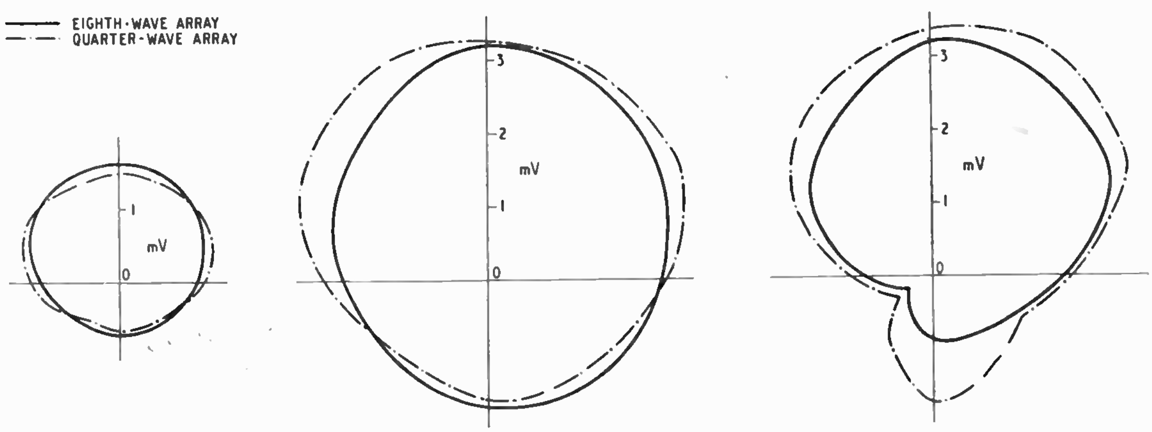
[2] "Dipole with unbalanced feeder." D. A. Bell. *Wireless Engineer*, January 1947.

BOOKS RECEIVED

(*see also p.* 284)

Communication Through the Ages.—By Alfred Still. The first of this book's eleven chapters is headed "The Writer's Aim," in which the author states that his intention is not merely to tell the story of how men, through the ages, have conveyed information over distances but to consider what it is that the mind of one man communicates to the mind of another. 201 pages. Murray Hill Books, Inc., 232, Madison Avenue, New York, 16, U.S.A. Price $2.75.

Radio Operating Questions and Answers (Eighth Edition).—By Arthur R. Nilson and J. L. Hornung. As its title implies, this American book uses the question and answer principle to instruct prospective radio operators in preparation for the U.S. Government's licence examinations for commercial operators. The publication of this edition marks the twenty-fifth year since the book was first issued. A new feature of this edition is the appendix giving the American Standards Association's graphical symbols. 434+xi pages. McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 17s 6d.



(a) (b) (c)

Fig. 7. Polar diagrams of $\lambda/8$ and $\lambda/4$ spaced reflector systems at 48 Mc/s (a), 45 Mc/s (b) and 41.5 Mc/s (c).

World Radio History

World of Wireless

SERVICE-MEN'S REGISTER

A REGISTER of radio service technicians is to be compiled jointly by the Guild of Radio Service Engineers and the Radio and Television Retailers' Association in the interests of a higher standard of servicing.

The general requirements upon which applications to be included on the Register will be considered are as follows:—

That the applicant is over 21 years of age, and has either

(a) completed an approved apprenticeship or

(b) has secured the R.T.E.B. Certificate or other approved certificate, or

(c) has been in approved employment as a radio service technician for five consecutive years.

Applicants who have served in the Forces on work comparable, in the opinion of the Joint Committee, with service work, and were in the trade prior to being called up will be eligible for registration. Only one-third of their time in the Services will be counted as civilian employment in the case of men who were in the trade prior to their call-up and were not engaged on radio work in the Forces.

CAR RADIO

CONSIDERABLE confusion has existed regarding the liability of car radio sets to purchase tax. Although manufacturers have been charging purchase tax on these sets for some time the Treasury has announced that the existing law does not provide for purchase tax to be charged on receivers specially designed for use in cars and unsuitable for use otherwise. Manufacturers have, therefore, made arrangements to refund the tax collected on sets recently sold.

The present position is, however, unlikely to last for long as the Board of Trade states that it proposes to make an order charging with purchase tax car-radio sets.

F.M. OUSTS S.W.?

ACCORDING to a survey undertaken by our New York contemporary, *Electronics*, most of the new broadcast receivers now being designed will not include coverage of the short-wave bands.

The reasons given are:—

(1) F.M. is a better selling feature;

(2) Foreign reception is of lasting interest to very few customers;

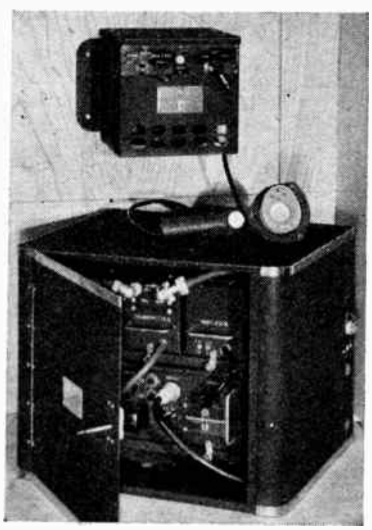
(3) The cost of its inclusion ($2-$6) "bulks large at a time when consumer resistance to higher list prices is feared."

The fact that short-wave reception is essential for certain regions has not been overlooked, and it is suggested that this demand could be met by the production by each manufacturer of one model with short-wave coverage.

RADIO TELEPHONY FOR TUGS

DIFFICULTIES of controlling tugs when operating at a distance from their base have been overcome by the installation of radio-telephones on board the France Fenwick's Anchor Tugs operating in the Tyne and Wear.

The Pye system installed consists of four control stations—two on the Tyne and two on the Wear—twenty-five transmitter-receivers on tugs and two portable control stations. The latter are for use in liners being towed, thereby keeping the ship in constant touch with the tugs.



MARINE VERSION of the Pye radio-telephone equipment, described in our November, 1946, issue.

The installations work on two fixed frequencies in the 80-100 Mc/s band, one being used for Tyne traffic and one for Wear traffic. The coverage of the stations is such that tugs based on one river can be controlled when operating in the other river or well out at sea.

18,850 TELEVIEWERS

ALL the old 10s licences for both sound and vision reception have now expired, and so it is at last possible to ascertain the number of television viewers from the licence figures. Post Office returns from May 31st show that holders of the new £2 combined sound-and-vision licences number 18,850. Broadcast licence figures are given in "In Brief."

INTERNATIONAL STANDARDIZATION

THE national standards organizations of eleven countries were represented on the council of the International Organization for Standardization (known as the I.S.O.) at its first meeting since the ratification of its constitution drafted last October. The countries represented at the Zurich meeting were Australia, Belgium, Brazil, China, France, India, Norway, Switzerland, U.K., U.S.A. and U.S.S.R. The office of the I.S.O. is in Geneva.

As a result of a joint meeting of the I.S.O. and the International Electrotechnical Commission, which was formed over 40 years ago, it has been recommended that the I.E.C. should affiliate with the I.S.O.

RAILWAY RADIO

REPLYING to a question in the House of Commons, the Postmaster-General announced that wavelengths had been allocated to the railway companies "to cover their immediate radio-communication needs."

It is understood from the Railway Signals and Engineers' Committee, which is the co-ordinating body in this matter for the four main-line railways, that the work to be undertaken is entirely experimental and will, in the first instance, be confined mainly to communication between signal boxes and shunting engines in marshalling yards.

NO ALL-INDIA RADIO?

WITH the partition of India the title All-India Radio will presumably no longer be used by the broadcasting organization of either India or Pakistan.

Broadcasting is one of the many "assets" being considered by special committees for division between the two States.

In 1927 the Indian Broadcasting Co. opened its first station—a 1.5 kW M.W. transmitter in Bombay. In 1930 broadcasting was placed under the direct control of

World Radio History

the Government of India and was called the Indian State Broadcasting Service. The service, which by 1936 was provided by three transmitters, was reorganized in accordance with a report presented by H. L. Kirke (B.B.C.) and renamed All-India Radio. At the end of 1939 fourteen transmitters—9 M.W. and 5 S.W.—were in use in Dacca, Delhi, Bombay, Calcutta, Lahore, Lucknow, Madras, Peshawar and Trichinopoly. During the war additional S.W. transmitters were installed at Delhi for the overseas service.

F.M. ALLOCATIONS

NEW frequency allocations for America's F.M. stations were adopted by the F.C.C. in June. Nearly 650 stations, including 35 non-commercial educational stations, are included in the allocations. This list covers all stations for which operating licences have been granted although they are not all operating at the moment. The change-over to the new frequencies in the 89-108 Mc/s band will take place by October 1st.

For allocation purposes the band is divided into 200-kc/s channels, arbitrarily numbered 208-300. A minimum separation of four channels between stations operating in the same city is employed.

A complete list of stations is given in the June 23rd issue of our Washington contemporary, *Broadcasting*.

E.M.I. INSTITUTES

AMONG the postal courses provided by E.M.I. Institutes, which is controlled by Electric and Musical Industries, is one covering the syllabus of the P.M.G.'s Amateur Radio Licence Examination. There are fifteen lessons in the course which provides an elementary knowledge of the principles of design and operation of simple transmitters and receivers. There are also postal courses in basic radio, mathematics and physics and basic television.

An intensive three-week laboratory/workshop course designed primarily as a follow-up to the postal television and radio courses is also provided. There are also full-time courses.

Details are available from the Principal, Prof. H. F. Trewman, 43, Grove Park Road, London, W.4.

PERSONALITIES

H.M. Queen Mary has consented to be Patron of the National Radio Exhibition, Olympia (October 1st to 11th).

Sir Edward Appleton, F.R.S., has been elected an honorary life member of the Australian Institution of Radio Engineers.

Sir Clifford Paterson, F.R.S., has been elected chairman of the general council of the British Standards Institution in succession to Sir William Larke.

Sir Stanley Angwin, who is leading the British delegation to the Atlantic City telecommunications conference, has been appointed chairman of the all-important frequency allocations committee.

Charles R. Denny, chairman of the U.S. Federal Communications Commission, is chairman of the Atlantic City conference.

IN BRIEF

Receiving Licences.—A decrease of 28,550 in the number of broadcast receiving licences in force in Great Britain and Northern Ireland was recorded at the end of May. The total was 10,782,000 compared with 10,810,550 in April. The March figure was 10,780,400. The May figure includes 18,850 television licences. During May 525 set owners were prosecuted for operating unlicensed receivers.

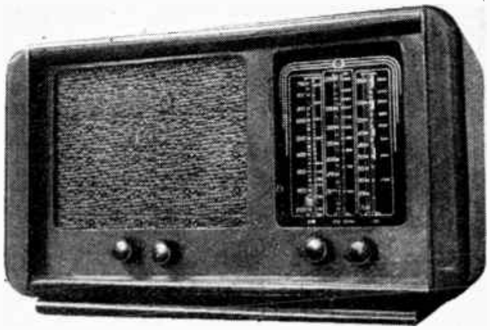
Marconi Memorial.—The monument erected by the Canadian Marconi Company on Signal Hill, Newfoundland, to mark the site where Marconi received the first transatlantic signal on December 12th, 1901, was unveiled by the Governor of Newfoundland on July 16th. Its erection was started in 1939, but was not completed owing to the war.

New Laboratories of the British Scientific Instrument Research Association were recently opened at "Sira," Southill, Elmstead Woods, Chislehurst, Kent. (Tel.: Imperial 2237.)

A **Three-day Visit** to the various Mullard factories was recently arranged by the War Office as part of a telecommunications course for officers of the Royal Corps of Signals.

Radio Officers.—Owing to "an acute shortage of experienced 1st and 2nd Class certificated radio officers," provision has been made for officers who left the Merchant Navy to return, subject to their being able to satisfy the operating company's requirements in respect of qualifications, medical fitness, etc.

SOVIET RECEIVERS. This set, the fifty-thousandth, produced in the Elektrosila factory in Voronezh, covers the 25-75, 200-550 and 750-2,000 metre bands. Production of receivers in the U.S.S.R. is considerably in advance of the pre-war output.



Canadian Licences.—During the past year (1946-47) 1,807,824 broadcast receiving licences were issued in Canada compared with 1,754,351 in 1945-46. Licensed car-radio receivers totalled 53,479 compared with 51,162 the previous year. The Province with the largest number of licence holders is Ontario with 628,075.

Ship's Newspapers.—With the sailing of the *Queen Mary* on July 31st *Ocean Times* will be published daily at sea on board three Cunard-White Star transatlantic liners. *The Empress News* recommences daily publication at sea when the C.P.S. *Empress of Canada* makes her first transatlantic run after refitting. These ocean newspapers, which are published by our associates Wireless Press, Ltd., rely on the news service "Shipress" transmitted from the G.P.O. Rugby station.

American Books.—We understand from Wireless Supplies Unlimited, of 264, Old Christchurch Road, Bournemouth, Hants, that they have a stock of the A.R.R.L. "Radio Amateur's Handbook, 1947," which we learn is now out of print in the U.S. They cost 13s 3d, including postage. A small supply of the A.R.R.L. "Antenna Book" will shortly be available also. They will cost about 5s.

Radiotelephone Services.—The opening of the London-Malta radiotelephone service last month is part of a big scheme being developed by Cable and Wireless and the Post Office to interlink many parts of the Empire by telephone. Plans provide for the linking (via London) of Kenya and Bermuda with Australia and India, and Bermuda and Ceylon with South Africa.

Polish Industry.—In the State radio factory in Dzierzoniow, Lower Silesia, where some 3,000 ex-German receivers have recently been overhauled and repaired, production of 15,000 new sets was begun in July. At the moment about 70 per cent of the components are Swedish, but by 1949 it is hoped to be assembling the receivers entirely from Polish components.

Scientific Instruments.—An exhibition designed to show the importance of scientific instruments in everyday life was recently opened by the Minister of Supply at Charing Cross Underground Station. It was planned by the Ministry of Supply with the co-operation of the Scientific Instrument Manufacturers' Association.

Instrument Finishes.—Amateur constructors desiring a professional finish to their equipment are offered a service

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World of Wireless—

of plating, painting and engraving by Labgear, Willow Place, Fair Street, Cambridge, who have set aside a section of their works for the purpose. All classes of plating, with the exception of chromium, can be undertaken and grey, smooth black and crackle paint finishes are available.

"Electronic Engineering" has been acquired from Hulton Press, Ltd., by Morgan Brothers (Publishers), Ltd., proprietors of *The Engineer, The Ironmonger* and *The Chemist and Druggist*. Geoffrey Parr is continuing as editor. The editorial and publishing offices are at 28, Essex Street, Strand, London, W.C.2.

B.S.R.A.—The secretary of the British Sound Recording Association, R. W. Lowden, has changed his address to Wayford, Napoleon Avenue, Farnborough, Hants.

I.E.E. London Students' Section.—Officers of the section elected for the 1947-48 Session are E. M. Hickin, chairman; A. Mason, B.Sc. (Eng.), vice-chairman; and P. W. Castle, secretary. The membership of the Section is 3,353 (2,420 students and 933 graduates).

An **appeal** to stop the destruction of salvageable paper has been made by the Waste Paper Recovery Association—a non-profit-making organization operating in collaboration with the Board of Trade. It is pointed out that in many industries the shortage of containers is becoming acute. Whilst the radio industry is well down the list of users of containers, the need is just as important, especially in the export field. "There is no such thing as waste paper; if it is recovered it can be used over and over again."

INDUSTRIAL NEWS

G.E.C. has installed a frequency-modulated E.H.F. communication system for the St. John Ambulance Brigade in Guernsey, Channel Islands. Simplex operation on 76.2 Mc/s is provided between the four ambulances and the headquarters' 10-watt control station which employs an end-fed dipole mounted on a ninety-foot mast. Complete coverage of the island is provided.

Cossor Radar Co. installed the shore radar station at Noordwijk, Holland (midway between Amsterdam and The Hague), which was opened by the Dutch Minister of Transport on July 7th. The P.P.I. of Holland's first radar station shows the whole of the six-mile channel between Amsterdam and Rotterdam.

B.V.A. Officers.—The new chairman and vice-chairman of the British Radio Valve Manufacturers' Association for the year commencing July 1st are G. A. Marriott and Frank Jones, respectively.

R.C.A.—The Radio Corporation of America has appointed Vice-Admiral W. A. Glassford, U.S.N. (Retd.) as European Manager. His headquarters will be at 43, Berkeley Square, London, W.1.

Marconi Jubilee.—A commemorative brochure has been issued by Marconi's to mark the fiftieth anniversary of the establishment of the company. In its 58 pp, which are well illustrated, the history of the company, originally the Wireless Telegraph and Signal Company, is briefly reviewed.

Mullard Wireless Service Co. has formed an Electro-Acoustic Division to market amplifiers for public address work. A range of three amplifiers (for export only, for the time being) has been produced comprising 25-, 50- and 100-watt types with three-channel inputs.

Marconi International.—In addition to the latest types of Marconi marine transmitting and receiving gear, the Canadian Pacific liner, *Empress of Canada*, is being fitted with an elaborate P.A. system in readiness for her first post-war voyage on the Canadian passenger service. Two sound-reproducing systems are being fitted. One is for entertainment and employs 32 loudspeakers, and the other is an "order" system providing two-way communication between the bridge and ten points on deck.

Ultra.—As a result of the recent visit of E. E. Rosen, managing director of Ultra Electric, Ultra sets will be manufactured in the Argentine. The recent embargo of the Argentine Government on the import of completed sets was made just before his arrival in the country so that his plans for marketing British-made sets had to be radically changed.

Marconi.—Two 100-kW short-wave broadcasting transmitters have been ordered from Marconi's by the Swedish Telegraph Administration for erection at Hörby. They will cost over £110,000. One transmitter will be equipped with an omni-directional aerial and will supplement the country's existing medium-wave service, whilst the other will employ directional aerials.

Watson-Watt.—We were misinformed regarding the address of Sir Robert Watson-Watt and Partners, Ltd., the recently formed company of scientific advisers. It is 7, Gayfere Street, London, S.W.1, (Tel.: Abbey 2956-7), and not as given in last month's issue.

G.E.C.—After tests with a number of receivers the G.E.C. Overseas 7 has been chosen by the Malayan broadcasting authorities for use in schools in Malaya.

Philco.—The recently held Radio Distributors' Convention at Atlantic City was attended by J. V. Holman, D. S. Spink and A. F. D. Knight, of Philco Radio and Television Corp.

Electrical Sound and Television Patents, Ltd., of 12, Pembroke Street, London, N.1, will be closed from August 1st-11th for the annual holiday.

TRADE ENQUIRIES

Belgium.—La Transmission Electrique, of 63, rue Dr. Van Bockxstaele, Ghent, Belgium, wish to get into touch with British manufacturers of transformer core stampings.

Siam.—A firm in Siam requires a number of simple two-valve sets to specification. Details from William Jacks & Co., Winchester House, Old Broad Street, London, E.C.2.

CLUBS

Birkenhead.—The Wirral Amateur Radio Society is meeting only once in August, on the 27th, at the Y.M.C.A., Whetstone Lane, Birkenhead. It is hoped to resume the two meetings a month in September. Sec.: B. O'Brien, G2AMV, 26, Coombe Road, Irby, Heswall, Cheshire.

Birmingham.—The second of a series of D.F. tests will be conducted by Slade Radio on August 31st. These tests are in addition to the fortnightly meetings held on Fridays at 8.0 at the Parochial Hall, Broomfield Road, Erdington, Birmingham, 23. August meetings will be held on the 8th and 22nd. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Clapham.—A radio club has been formed by the 56th (London) Armoured Divisional Signal Regiment, T.A.—one of the oldest signal units in the Territorial Army—as part of its wireless training scheme. It will have its own transmitter at the regimental H.Q. at 20, Atkins Road, Clapham, London, S.W.12, from where details of the club and conditions of service in the T.A. are obtainable.

Harrogate.—A talk on "Recent Developments in Radio Valves and Cathode-Ray Tubes" will be given by C. A. Norman, of the G.E.C., to members of the Harrogate and District Short-Wave Radio Society on August 6th at 7.30 at the Y.M.C.A., Victoria Avenue, Harrogate. Sec.: K. B. Moore, 2a, Wayside Crescent, Harrogate, Yorks.

Harrow.—Entries for the recently held constructional competition organized by the Radio Society of Harrow were exhibited in a local radio shop as part of a drive to create interest in the activities of the club. The winning entry was a flat-dweller's transmitter. Meetings are held on alternate Tuesdays at Northwick Café, Kenton Road, Kenton, at 7.30. Next meeting on July 29th. Sec.: J. F. A. Lavender, G2KA, 29, Crofts Road, Harrow, Middx.

Hounslow.—Meetings of the Hounslow and District Radio Society are held on alternate Wednesdays at the Grove Road Schools, Hounslow. The next meeting will be on August 6th. Sec.: A. H. Pottle, 11, Abinger Gardens, Isleworth, Middx.

Kingston.—Members of the Kingston and District Amateur Radio Society are meeting each Thursday at 8.0 in the Kingston Hotel, opposite the Southern Railway Station, until a more permanent meeting place can be found. Sec.: L. Knight, G2LP, 132, Elgar Avenue, Tolworth, Surrey.

Worthing.—The second annual general meeting of the Worthing Group of the R.S.G.B. will be held at the Thomas-a-Becket Hotel at 7.30 on September 4th. The group is now issuing a monthly duplicated news sheet. Sec.: G. W. Morton, 42, Southfarm Road, Worthing.

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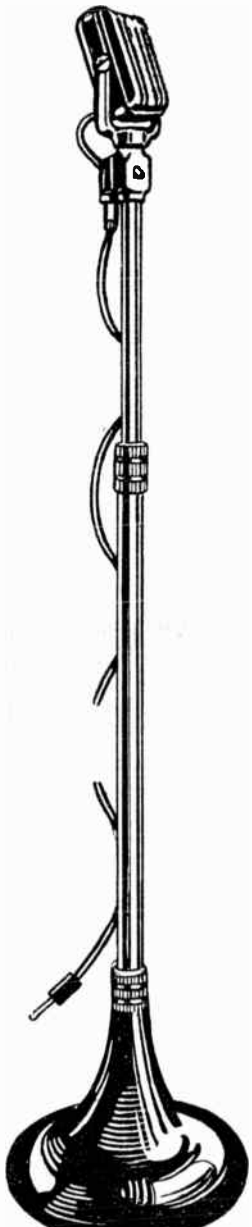

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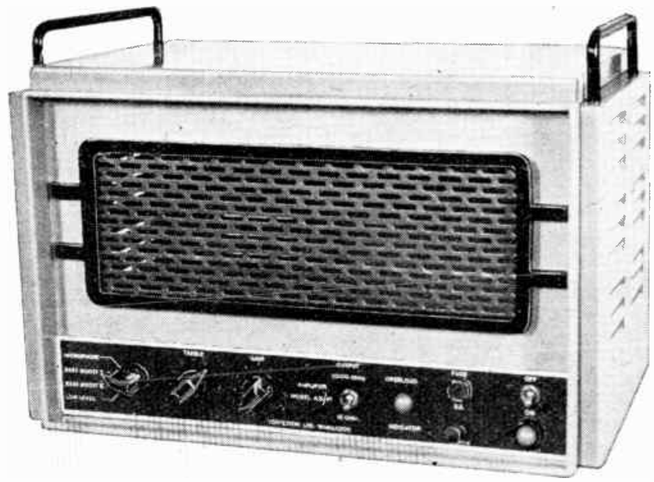

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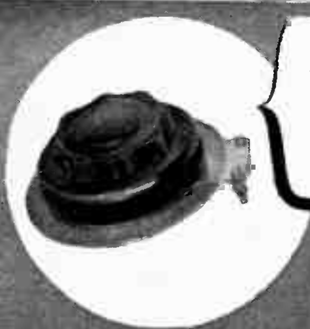

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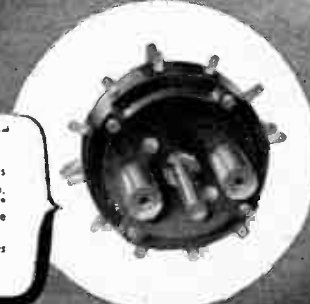

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Unbiased

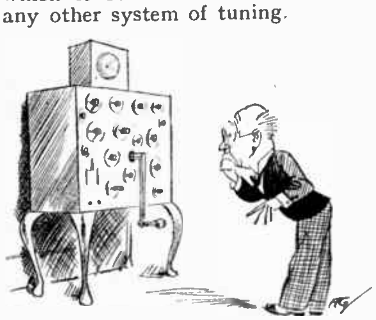
By FREE GRID

Plugging P-B.T.

PUSH-BUTTONS seem to be coming into favour once again after their wartime setback and I sincerely hope that the sets which are to be exhibited at Olympia in October will have push-buttons only. I am well aware that a very large number of my readers will be against me on this point, mainly on the grounds that they consider the use of such a device to be lazy, effeminate and symptomatic of the abrogation on the part of its users of any claim to take, what the Editor called in the July issue, "an intelligent interest in the technical means whereby broadcasting is brought to them".

So far from this being the case I maintain that a desire for push-button tuning indicates exactly the opposite; namely, that the listener has outgrown the "horseless carriage" era of wireless and has come to realize that simplicity and ease of control are no more symptomatic of such things in the case of a wireless set than they are in that of a car or any other instance of applied science.

If push-button tuning possessed no other advantages than simplicity and convenience it might not be worthy of serious consideration but so far from this being the case it has technical merits of the highest order. No designer who desires to produce a set which is equally efficient in every respect over the whole of the frequency band or bands which it covers can afford to use any other system of tuning.



Multi-knob P-B Equivalent.

I should add that I am, of course, referring to that system of push-button tuning which employs pre-set circuits. It is fairly obvious that with this system of tuning one can arrange to have optimum conditions for receiving any particular station, for by merely adding an extra cam on the push rod for the operation of another switch we can bring into circuit the most suitable degree of anything, ranging from aerial coupling to tone correction to suit the particular frequency upon which we wish to receive.

In fact we can have the equivalent of a multi-knob super-communication receiver for every station covered by the number of buttons available without the necessity of a skilled operator to tune it for us. The ordinary unskilled listener—even a woman—is put on an equal footing with the most practised knob twister.

There is, of course, nothing original in this idea. I believe, in fact, that it was the Editor who first advocated it, but it is high time that it was given greater publicity. As for those who still want to use the old system of tuning, let them at least be logical and use halfpenny dips in place of electric lighting in their homes. They will probably be compelled to do it next winter in any case—that is, of course, if they are able to buy the halfpenny dips.

Ariel Subdues Caliban

CREDULITY is a human weakness usually associated with marines, just as superstition seems inseparable from sailors. Having mixed a good deal with both these sections of the community I must place on record the fact that while they are certainly not free from these traits of character, it ill behoves the rest of us to cast aspersions on them. Only the other day an amazing instance of credulity among the non-nautical classes came my way when I was prodding and elbowing my way through the motley throng that surrounds the stalls of a London street market lying almost in the shadow of the Old Bailey.

The thing which attracted my attention was a Caliban-like cacophony coming from a wireless receiver which sounded as though it were overloaded in every component. This was not surprising as it was being operated without any vestige of an aerial and consequently was working "all-out" to make itself heard above the noises of the crowd. Man-made interference from all the unsuppressed electrical apparatus in the neighbourhood was adding to the truly appalling racket coming from the overburdened set.

I had just elbowed my way forward to remonstrate and offer the ribs of my umbrella as a makeshift aerial when suddenly the stallholder picked up a pretty little tubular device to each end of which was connected a short length of wire with gaily coloured insulation. He attached one wire to the aerial terminal of the set and the other to the canvas top of the stall so that the little condenser—for such

Signs of disapproval.

it obviously was—was suspended daintily in mid-air where it danced and pirouetted on the breeze like Prospero's "Dainty Ariel."

As if by magic the Caliban noises ceased and were succeeded by the calm beauty—relatively speaking—of a B.B.C. gale warning mingled with adenoidal noises from the stallholder who was endeavouring with considerable success to sell what he called his magic noise-eliminating aerial to the gaping crowd. Hastily mounting an adjacent soap box I delivered an impromptu lecture on the morality of the salesman, pointing out that precisely the same result could be had for very much less than 5s, the price charged for the "eliminator."

To my astonishment my advice to my fellow citizens to save their money and invest it instead in a few feet of copper wire led to nothing but a volley of abuse and other signs of disapproval, not only from the stallholder from whom I might have expected it but from the people whose interests I was endeavouring to serve. I might, in fact, have been a politician for all the thanks I got for my efforts, and to crown all, I was compelled to suffer the indignity of being moved on by a policeman.

World Radio History

Permanent Magnets

How They Fit Into the "Magnetic Ohm's Law"

By "CATHODE RAY"

ALTHOUGH electrically-energized magnetic circuits are discussed at length in most books on basic electrical engineering, permanent magnets are usually dismissed in a few descriptive paragraphs, leaving no very definite clues. Considering the scale on which permanent magnets are used in telecommunications, for loud speakers, gramophone pick-ups, microphones, telephone receivers, measuring instruments, and so forth, this seems strange.

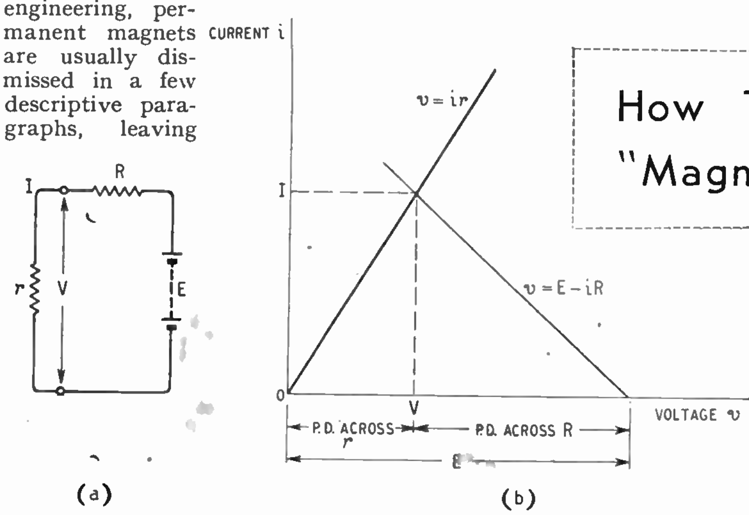


Fig. 1. Graphical method, based on Ohm's Law, of finding the current and voltage in a circuit with two resistances. When the resistances are linear, as here, it is quicker to do it mentally or by algebra, but in Fig. 2. . .

The usual approach to magnetic circuits in general is by way of analogy from electrical circuits. Corresponding to electromotive force in the electrical circuit is magnetomotive force, expressed in ampere-turns. When one considers a permanent magnet circuit, however, where there are no ampere-turns (except for hypothetical ones in the molecular structure of the material), this concept does not get one very far. Yet the analogue of current—magnetic flux—is present; and one wants to be able to calculate how much of it one can get from a given magnet, or how much magnet and what shape will best give a required flux.

A second troublesome feature, which is common to all iron-cored magnetic circuits, permanent or energized, is the non-linear relationship between magnetomotive force and flux.

Now it happens that there is an electrical circuit which combines both of these features—non-linearity, and current without E.M.F. (apart from a rather nebulous electronic one). And as it is a simple and familiar circuit, it seems to be just the analogy that was wanted. The circuit in question is shown in Fig. 3a, and the graphical method of calculating the voltage and current in Fig. 3b.

So that the relationship between energized and permanent magnetic circuits may be clear, let us approach Fig. 3 via the still simpler case of Fig. 1. Consider the left-hand side only, consisting of *r*. If this is an ohmic resistance, any potential difference across it is related to the current through it by Ohm's Law:

$v = ir$ .. .. .. (1)

(The small letters v and i denote *any* values of voltage or current). Taking the right-hand side by itself, the voltage across the terminals is given by:

$v = E - iR$ .. .. (2)

Here v and i are not necessarily the same as in (1). But when the

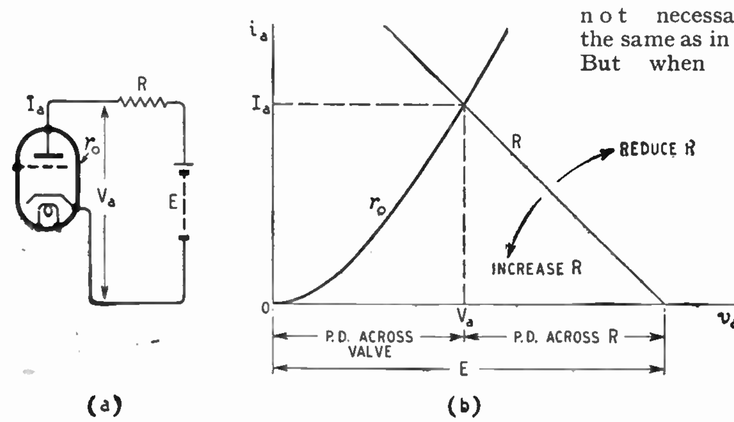


Fig. 2. The D.C. "resistance" of the valve, r_o, is known only as a graph, so the method of Fig. 1 must be used. This case is analogous to the simple magnetic circuit of Fig. 4. The effect on output, current and voltage of varying the load resistance can be seen by varying the slope of the load line.

World Radio History

two halves are put together, v and i must be the same in both. Call the particular values of v and i, which are the solutions of the above two simultaneous equations, V and I. Solving these equations:

$$V = \frac{Er}{R + r} \quad \ldots \quad \ldots \quad (3)$$

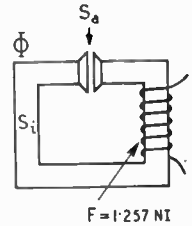
$$I = \frac{E}{R + r} \quad \ldots \quad \ldots \quad (4)$$

In case the solving of these equations is too great a strain on one's algebra, there is the alternative method of drawing the graphs representing the equations, as in Fig. 1b. The solution is given by their intersection, and as they are linear equations there is only one intersection.

Well, of course, that legendary creature "Any Schoolboy" could give the answers without setting pencil to paper in either method, because with ohmic or linear resistances it is so easy. If one or both of the resistances were expressible only by more involved equations, then some algebra might be necessary; while in the more likely event of their being known only as graphical curves, the second method would have to be used. For example, r might be r_o, the D.C. resistance of the anode-to-cathode path in a valve, and R its load resistance (Fig. 2a). The two graphs are then generally called the i_a/v_a characteristic of the valve and its load line respectively, and are very familiar in these guises (Fig. 2b). For brevity I have labelled them simply r_o and R, but, of course, the line "R" is really the graph of the linear equation $v_a = E - i_aR$. Incidentally, this graphical method would be even more necessary if r, too, were a non-linear resistance, such as a lamp. Note also that a single scale serves for both potential difference and E.M.F., because both are reckoned in volts.

Lastly, in Fig. 3, we have a case where r and E.M.F. are individually rather vague, but collectively can be expressed as an i_g/v_g curve. The actual voltage on the grid for any particular value of R can easily be found by the same general procedure as before (Fig. 3b). The externally-applied E.M.F., E, being zero, the load line starts from O; but, as the valve characteristic starts from a slightly negative v_g, some current flows notwithstanding.

Fig. 4. Analysis of energized magnetic circuit for comparison with Fig. 2.



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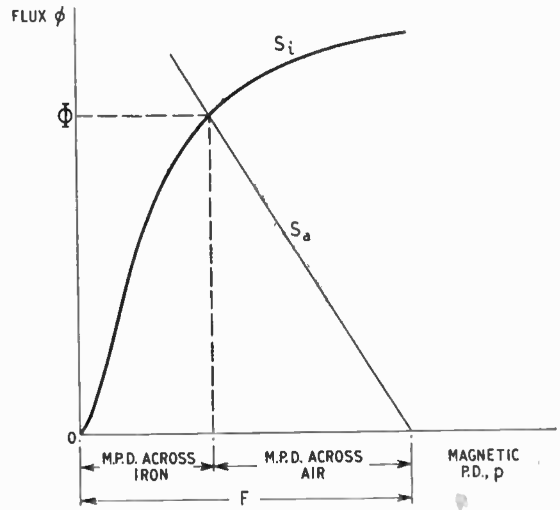

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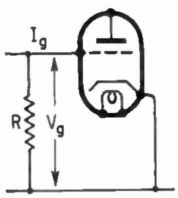
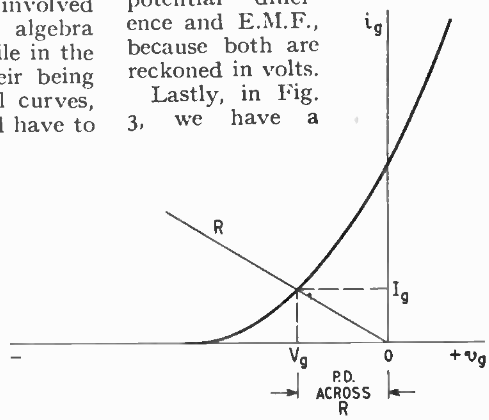


(a)



(b)

Fig. 3. This is similar in principle to Fig. 2, except that the source of E.M.F. is absent. It is analogous to a permanent magnet circuit; compare Fig. 7.

Fig. 2 is the analogue of a magnetic circuit consisting partly of air (linear) and partly of iron (non-linear), energized by the magnetomotive force of a current-carrying coil; and Fig. 3 a similar circuit but with a permanent magnet and zero externally-applied M.M.F. ("Iron" herein means any magnetic metal). Corresponding to current is flux Φ measured in lines (= maxwells); and corresponding to E.M.F. is M.M.F., F, which for practical convenience in the energized case is often reckoned in ampere-turns.

Supposing, then, one has an electromagnet operating in series with an air gap (Fig. 4*a*), it corresponds with the electrical circuit of Fig. 2*a* and can be calculated in the same way, merely changing the units (Fig. 4*b*). The "load line" is marked S_a, which stands for the reluctance of the air gap, and (in accordance with the magnetic "Ohm's Law") is equal to the magnetic difference of potential across it divided by Φ. So, corresponding exactly to (2), the equation of the line is:

$$p = F - \phi S_a \quad \ldots \quad (5)$$

And S_i is just the flux/magnetic-potential characteristic of the iron core.

I admit that this is not exactly the usual way in which the matter is put, and may be quite novel to some readers. But the analogy between the electric and magnetic circuits is sometimes confused

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Permanent Magnets—
because the two are not compared, as they are here, in their corresponding forms. There are very good practical reasons, which we shall come to in a minute, for dealing differently with magnetic circuits; but to get a good theoretical grasp of the matter beforehand it is advisable to compare Figs. 2 and 4 for a while. For instance, just as the E.M.F. developed by the battery in Fig. 2 is divided between the two resistive elements in the circuit, so the M.M.F. developed by the coil in Fig. 4 is divided between the two reluctances. If as a short-circuited load would be in the electrical case.

Although the Fig. 4 form of diagram for the magnetic circuit is the most helpful for getting a clear picture of the theory by pondering on the similarities between it and the familiar valve loading diagrams, it is not the best for practical purposes. An i_a/v_a characteristic curve is useful only for the particular resistor or valve for which it has been drawn. With a valve, that is unfortunately unavoidable, because its "resistance" depends in a very complicated way on a large number of different variable

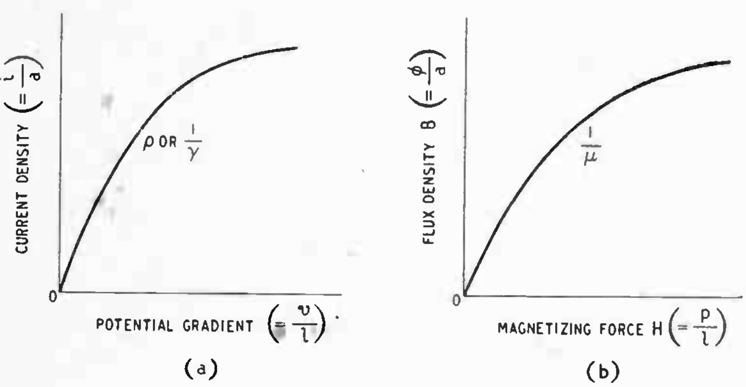

Fig. 5. When the non-linearity of a resistor is a peculiarity of the material of which it is made, it is more helpful to have a graph of the material, rather than of any particularly-sized piece of it, as would be shown in a Fig. 2*b* type of graph. This is done by altering the co-ordinate scales, as at *a*. The same argument applies to magnetic materials, which accounts for their graphs usually being plotted as at *b* (compare *a*) instead of as Fig. 4*b*.

the M.M.F. available for the load be increased, by raising its reluctance (decreasing the slope of the S_a line) it is at the expense of flux. It is generally the aim to get as much flux as possible in the air gap; and for this purpose it is fortunate that the characteristic curves of most irons rise steeply at first, like that of a pentode. But in order to get a slight increase on the flux indicated in Fig. 4*b* it would be necessary to steepen the air-gap line considerably; that is to say, make its reluctance much less. The increase is only moderate even if one goes so far as to draw the line vertical, representing zero reluctance, obtainable only by closing the gap completely and thereby making it as useless such as the potentials of the various electrodes as well as all their dimensions. But the resistance of homogeneous solid materials is much simpler, being proportional to the length (l) and inversely as the cross-section area (a). The only other factor is the one that distinguishes materials from one another as regards resistiveness—the resistivity, ρ, which is the resistance of 1 cm. cube. So

$$r = \rho\frac{l}{a} \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

For non-linear materials, a curve of current against voltage ($v = ir$) refers only to one particular size and shape of resistor. But by plotting current *density* (amps per sq. cm.) against voltage *gradient* (volts per cm.), the dimensions are incorporated into the co-ordinate scales, and we get a graph of ρ instead of r, one that applies to that material in general, irrespective of size. Thus, instead of plotting, as in Fig. 1b,

$$v = ir \left(= i\frac{l}{a}\rho\right)$$

we rearrange this to bring the l to the left-hand side:

$$\frac{v}{l} = \frac{i}{a}\rho \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

So the graph takes the form shown in Fig. 5*a*.

There is every reason for adopting the same policy for magnetic materials, because, unlike resistive materials, they are all very non-linear; but, like resistance, reluctance varies in the same way with l and a. The magnetic quantity corresponding to ρ, called reluctivity, is not commonly used. But $\rho = \frac{1}{\gamma}$, γ being called the conductivity, and the magnetic equivalent of that is well known under the name of permeability, μ. So corresponding to (6) (modified by substituting $\frac{1}{\gamma}$ for ρ) is

$$S = \frac{1}{\mu}\frac{l}{a} \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

B/H Curves

The permeability of all magnetic materials varies in a way that can only be recorded as a graph; and nobody wants to draw a separate graph like Fig. 4*b* for every possible size and shape of piece, when one plotted as in Fig. 5*b* gives the essential information from which the reluctance of any size can quickly be calculated. That is why the scale of flux (ϕ) becomes one of flux per unit cross-section area, or flux density, B; and the horizontal scale is in magnetomotive force (or magnetic potential difference) per unit length, which is rather confusingly called the magnetizing force, H. In other words, instead of plotting, as in the Fig. 4*b* type of curve:

$$p = \phi S \left(= \frac{l}{a}\frac{1}{\mu}\right)$$

the core dimensions are trans-

World Radio History

ferred from the curve to the co-ordinates:

$$\frac{p}{l} = \frac{\phi}{a}\frac{1}{\mu}$$

$$\text{or } H = B\frac{1}{\mu}$$

$$\text{or } B = \mu H \qquad \ldots \qquad (9)$$

The information about any magnetic material, then, is usually given in the form of a B/H curve (as in Fig. 5*b*). Given the dimensions of any particular piece of it, the relationship ϕ/p is obtained by multiplying B by *a* and H by *l*. If a core consists of several sections in series, each with a different constant cross-section area, the magnetic potential drops for each (p_1, p_2, etc.) are calculated and added together to give the M.M.F. (ampere-turns) required to maintain the desired flux throughout the circuit.

For the sake of making the permeability of vacuum (and, for all practical purposes, air and other non-magnetic materials) = 1 and to avoid having to talk about ampere-turns when permanent magnets are in question, there is the alternative and slightly smaller unit of M.M.F. called (with no humorous intent) the gilbert. To convert a number of ampere-turns to gilberts, multiply by 1.257 (= 0.4π). If H is in gilberts per cm, then B for air = H.

Since all this is very thoroughly

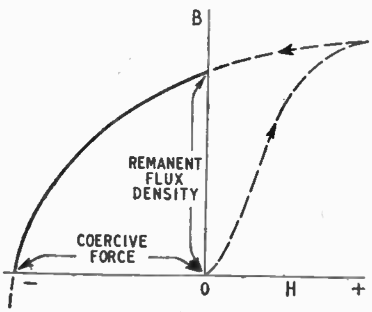

Fig. 6. Materials suitable for permanent magnets have a large part of their characteristic curve in the negative H quarter. (Compare Fig. 3*b*).

explained in textbooks we hurry on to the final goal—the permanent magnet circuit. Permanent magnets depend on the fact that when the magnetizing force applied to magnetic material is reduced, the characteristic curve doesn't follow the same path downward as it did upward. Materials most suitable for permanent magnets are those in which the departure is particularly large, as in Fig. 6, where the flux density is still near its maximum even when the magnetizing force has been completely removed; and to reduce it to zero necessitates a considerable negative magnetizing force. It is the section of curve in between these two points that gives us what we want, corresponding (except for the generalized type of scales) to Fig. 3*b*.

If Fig. 6 is converted to the ϕ/p co-ordinates of a particular magnet, by multiplying the B scale by *a* and the H scale by *l*, we get Fig. 7, which corresponds

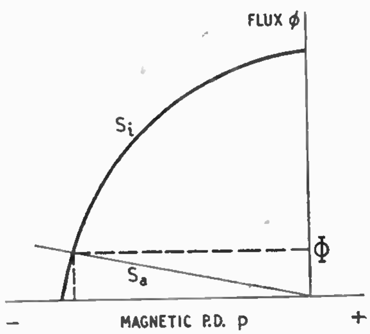

Fig. 7. This is the exact analogue of Fig. 3*b*, so the air-gap line, S_a, can be drawn in. But in practice the S_i line is not usually known, so the S_a line has to be transferred to a graph of the Fig. 6 type by multiplying the size factors, as in Fig. 8.

exactly to Fig. 3*b*, and can be used to investigate the magnet when in series with an air-gap, by drawing the S_a line, corresponding to the R line in Fig. 3*b*.

Neglecting magnetic leakage, the flux in iron and gap is the same, and is represented in Fig. 7 by the intersection of the two graphs, at value Φ. This diagram therefore shows the flux in the air gap when dimensions of gap and magnet are given. If these dimensions had been picked out of a hat or otherwise chosen at random, the chances would be that gap and magnet wouldn't match one another particularly well, any more than a valve

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M.T.3 stands for "Midget Telesonic 3-stage". The 3-stage amplifier consists of a space charge double tetrode, i.e., 2 valves in one bottle, and an output pentode, used as a pentode when a magnetic miniature earpiece or Bone Conductor is plugged in, or as a triode when a crystal earpiece is plugged in. The alteration is effected automatically by the difference in the wiring in the 3-socket earpiece plug. The crystal microphone used is not soldered in but plugged into a minute holder, similar to that used for the valves.

Volume Control is obtained by novel means—a specially made type of differential condenser used in a negative reaction circuit. The whole mechanism, combined with the on/off switch, is very flat; it is placed under the crystal microphone. With an inductive load in the output the effect of the control is differential with respect to frequency, tending to reduce the high note response of the instrument and with it the background noise.

The size of this instrument is 3¼" long x 1-11/16" at its widest and 1-5/16" at its narrowest end; depth varying from ¾" to 11/16". Weight 2¾ ozs.

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World Radio History

Permanent Magnets—

picked at random would drive a particular loudspeaker with maximum efficiency. In Fig. 7, for example, the reluctance of the air gap is so large for the magnet that comparatively little flux is available in it. This is like a loudspeaker of excessively high impedance for the valve. Steepening the S_a line to represent a gap of lower reluctance, it is seen that the flux increases; until maximum flux is obtained by closing the gap completely—a magnetic short-circuit.

Generally one has an air gap of a particular size, and B/H curves of available magnet alloys, and one wants to know the dimensions of magnet that will give the required flux, or flux density; preferably using the smallest possible magnet. The dimensions of the magnet not being known, it is impossible to start by converting Fig. 6 (which one has) into Fig. 7.

There is a way, which for the sake of those sufficiently interested I will point out at the end, of getting over this by transferring the air-gap line to the B/H diagram; but in the meantime we can use Fig. 7 merely as an aid to grasping the basic principles. These are two in number, and both very simple. The first we have already assumed, that the flux is constant throughout the circuit. That is absolutely true, just as for current in an electric circuit. Neither current nor flux can quietly vanish anywhere around a circuit. But it can leak off so that not all of the total flux goes through a particular localized air gap. If the circuit is well designed, this leakage flux is relatively small, and we shall neglect it. (In practical engineering, it is taken care of by a factor based on experience of similar magnet systems).

So $\Phi = B_i a_i = B_a a_a$ .. (10)

$\therefore \; a_i = a_a \dfrac{B_a}{B_i}$ .. .. (11)

You are quite right if you guess that the subscripts *i* and *a* indicate iron and air respectively. And as we presumably know the air-gap area, a_a, and its flux density, B_a, all we need to get the magnet cross-section area is its flux density, B_i.

The second principle is that the total M.M.F. (F) in a magnetic circuit is equal to the sum of all the magnetic potential drops. (Compare the corresponding Kirchhof's Law for an electric circuit.) Applying it to our permanent magnet circuit; where there is zero F:

$0 = p_i + p_a = H_i l_i + H_a l_a$ .. .. (12)

$\therefore \; l_i = l_a \dfrac{H_a}{-H_i}$ .. .. (13)

We know that H_a is equal to B_a (because, if the right units are chosen, μ for air = 1), and the length of the gap, l_a, is given, so here we have the length of the magnet, l_i, in terms of H_i. (In practice, another factor is used to cover the fact that the effective length of the gap tends to increase near its edges.)

The B/H curve for the magnet metal gives H_i in terms of B_i, or vice versa; but how do we choose a particular combination of the two? Fig. 7 shows what seems to be a rather bad combination. The best, presumably, is that which requires the smallest magnet.

Combining (11) and (13).

Volume of iron $= l_i a_i$

$= \dfrac{B_a^2 \, l_a \, a_a}{-H_i \, B_i}$ .. .. (14)

Therefore, for given air-gap dimensions and flux density, the smallest volume of iron is needed when $-H_iB_i$ is a maximum. And, as you see, the volume of iron goes up in the same proportion as the volume of air gap, and as the square of the gap flux density.

The thing to do, then, is to plot $-H_iB_i$ against B (a convenient place is in the empty space to the right of the B scale as in Fig. 8), and connect a horizontal line from the peak of that curve to intersect the B/H curve, thus showing the most economical B_i and H_i—the last remaining data needed for finding the magnet dimensions. Instead of bothering to plot the H_iB_i curve, a short cut that is near enough with most magnet curves is to complete the rectangle as shown dotted in Fig. 8, and use the B_i and H_i values given by the intersection of its diagonal with the B/H curve.

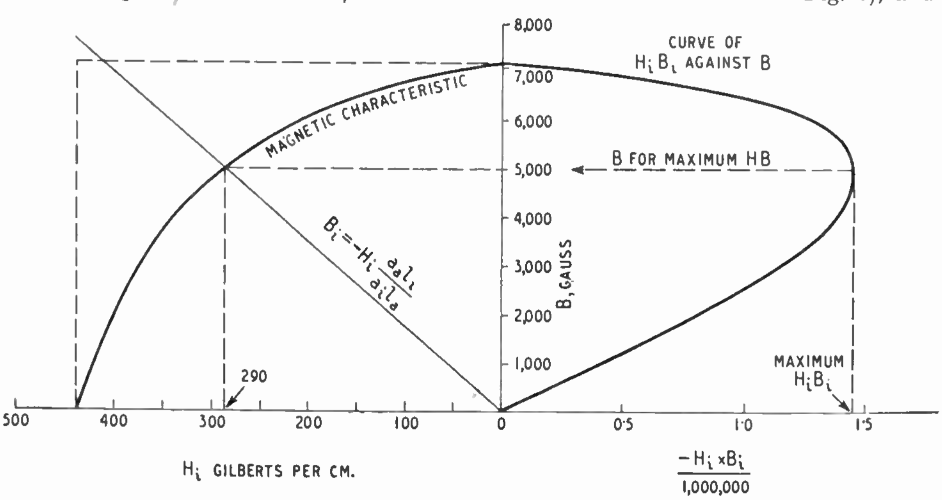

Fig. 8. Example of use of permanent-magnet B/H curve to find the smallest size of magnet necessary to excite a given gap.

Suppose an air gap 0.25 cm long by 2 cm square (after using the factors that allow for flux "fringing") is to be given a flux density of 8,000 lines per sq. cm. (= 8,000 gauss), by means of a magnet made from alloy having the characteristics shown in Fig. 8. The most economical B_i is seen to be 5,000, corresponding to H =

World Radio History

-290. Then, applying (11) and (13), $a_i = \frac{B_a a_a}{B_i} = \frac{8{,}000 \times 4}{5{,}000}$

$= 6.4$ sq. cm., and $l_i = \frac{B_a l_a}{-H_i}$

$= \frac{8{,}000 \times 0.25}{290} = 6.9$ cm.

A magnet of these stubby dimensions may have to be connected to the given air gap by means of low-reluctance pole pieces; but that is as obvious as saying that a generator should be connected to its load by low-resistance leads. And in practice there are sometimes reasons for choosing magnet dimensions other than the most economical in material.

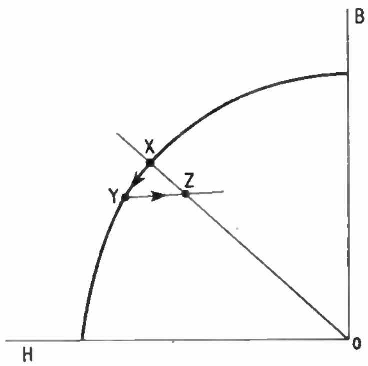

Fig. 9. If a magnetic circuit originally working at point X is demagnetized somewhat, say to Y; removing the demagnetizing influence causes it to return, not to X but to Z. To avoid the loss XZ taking place during service, magnets are previously brought by "aging" on to a flat curve like YZ.

To solve problems like the example above it is clear that no graph drawing is necessary so long as the best B of the magnet metal is given, and its corresponding H; only two easy formulæ.

There are cases, however, where it might at least be instructive to use the "load-line" technique of Fig. 7, if some means could be found of applying it to the B/H curve, instead of to a type of curve that cannot be drawn until we have the information we are trying to find. The S_a line of Fig. 7 mustn't be used in Fig. 6 (or Fig. 8) as it is, because the scales are wrong. To convert Fig. 6 to Fig. 7 we multiplied the B scale by a_i (giving ϕ), and the H scale by l_i (giving p). We could have done the same thing (less conveniently) by leaving the scale *numbering* alone—just changing the symbols—and fitting the curve to it by *dividing* its co-ordinates by the same factors. To convert a graph (to wit, the S_a line in Fig. 7) back to the original Fig. 6 scales of B and H, it is necessary to perform the reverse operation, viz., *multiply* the S_a line co-ordinates, so that what was a graph of

$$\phi = \frac{-p}{S_a} = \frac{-p a_a}{l_a}$$

becomes $Ba_i = \frac{-H a_a l_i}{l_a}$

$$\text{or } B = \frac{-H\, a_a\, l_i}{a_i\, l_a} \quad .. \quad .. \quad (15)$$

Given a B/H curve for the magnetic metal, then, a transferred air-gap line can be drawn, as in Fig. 8. Either the slope of the line is given by already-known iron and gap dimensions, in which case the resulting flux-density is shown; or one can draw the line to suit the B/H curve, and then calculate the unknown dimensions from the slope. (Incidentally, $\frac{a_a l_i}{a_i l_a}$, which is the ratio B/-H, is called the unit permeance).

It should be fairly obvious how to apply the foregoing principles to more complicated situations. For example, if there were some M.M.F. coming from a coil, assisting or opposing the magnet, the starting point of the air-gap line in Fig. 7 would have to be to the right or left respectively of zero, by an amount equal to the M.M.F.

In these calculations it has been assumed that the whole of the permanent magnet is working at the same point on its B/H curve. In actual fact it would not be, but the difference is not enough to justify the appalling difficulties one would get into by departing from this simplifying assumption.

This article is only a framework of theory, which serves as a first approximation in design. In practice there are other considerations for which there is no room here.

There is one very important thing, however. Suppose a permanent magnet in service, say in a moving coil meter, comes under

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The new 42REH has advantages of complete weather-proofness, smaller overall length, better weight distribution and consequently greater ease in handling, which make this one of the most popular of the new F.I. loud-speakers. The horn is designed for use with the standard F.I. L.S.7 Unit and allows for this unit to be driven to 12 watts input. A spun aluminium cover over the unit has room for housing a suitable matching transformer.

The construction has been designed so that the whole unit is assembled and held together with ONE LARGE NUT only. This construction enables a number of units to be packed for export in a space which is a fraction of that normally required; assembly is a matter of a few minutes unskilled labour.

This unique feature will recommend itself to all export buyers particularly.

The 42REH is not of the "loud-hailer" type of speaker, but is designed to cover a range of frequencies considerably greater than those needed for purely "announcing" purposes: i.e., it is suitable for all normal requirements of high power reproduction of music as well as speech.

Dimensions assembled ...	22in. dia. x 24in.
Bell diameter	22in.
Cut-off frequency	175
Effective Air Column	42in.
Weight Horn only	8 lbs.
Shipping space ...	One—23in. x 23in. x 18in.
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Permanent Magnets—
the influence of an external magnetic field that opposes its own field, so that the working point moves downwards, say from X to Y in Fig. 9. When this disturbing influence is removed, the *status quo* is not restored. Instead, the working point goes to some such place as Z, the flux being very little more than at Y, and decidedly lower than at X. The accuracy of the meter is permanently ruined. To avoid this, magnets are "aged" by demagnetizing them in advance to a greater extent than they are likely to experience after calibration. So variations take place along a nearly flat curve such as YZ.

This also shows the reason for warnings about it being a bad idea to take permanent magnet circuits to pieces. If the pole pieces are removed, the reluctance is increased, the "load line" moves anti-clockwise to some such position as in Fig. 7, and when put together again the system has lost a large part of its magnetism. One should also keep screwdrivers well away, because the horrid smack when such an implement is drawn against the magnet is also liable to de-gauss it appreciably.

Talking about gauss; magnetic units are a frequent source of confusion, which I shall try to dispel in a sequel. This inevitably brings in electric units as well, leading to consideration of the M.K.S. system of electro-magnetic units.

V.H.F. Aircraft Equipment

Transmitter-Receiver with Simplified Wave-changing

MANY ingenious systems have been evolved for remote control of the wave-changing mechanism in V.H.F. communication equipment in aircraft, but few appear to rival that employed in the Standard Telephones STR12 transmitter-receiver.

In this equipment the change from channel to channel is effected merely by selecting an appropriate pair of crystals, one for the transmitter and one for the receiver. By this means provision is made for the immediate operation on any one of twelve spot frequencies between 118 and 128 Mc/s.

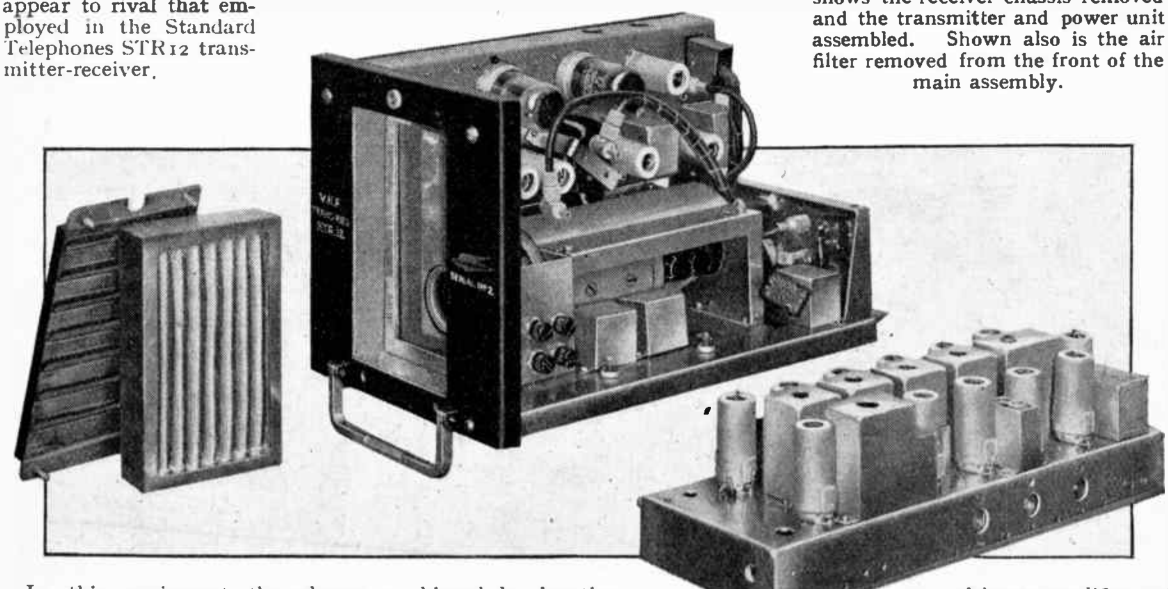
This simplicity of operation is achieved by locating the crystal oscillator stage of the transmitter and the local oscillator of the receiver in the remote control unit and using wide-band circuits as inter-stage couplings throughout the transmitter and for certain stages of the receiver.

These two oscillators are both crystal controlled; they are similar in design and both operate as frequency doublers. As the crystal frequencies are necessarily low, eight stages in all of frequency doubling have to be employed in order to raise the frequency to the working value. The extra doublers are located on the transmitter and receiver chassis in the main assembly, which can be located in any convenient part of the aircraft. Coaxial cables terminating in band-pass filters convey the outputs of the two oscillators in the remote control unit to their respective frequency multipliers in the main assembly.

The transmitter chassis has two doubler stages followed by a driver amplifier and a pair of grounded-grid triodes connected in parallel and delivering approximately 3.5 watts of R.F. to the aerial.

The bandwidths of the interstage couplings are graded throughout the transmitter, being 2.5 Mc/s at the input and 10 Mc/s at the output. Thus the even harmonics up to the eighth of all crystal frequencies between 14.75 and 16 Mc/s are passed without the need for retuning.

A.F. modulation is applied simultaneously to the screen of the penultimate amplifier and to the anodes of the output valves and either telephony or M.C.W. can be employed. A detector for monitoring the trans-



This view of the STR12 equipment shows the receiver chassis removed and the transmitter and power unit assembled. Shown also is the air filter removed from the front of the main assembly.

World Radio History

mission through a side-tone valve on the receiver is also included in the transmitter.

One R.F. stage, a crystal-controlled local oscillator as already mentioned, four I.F. amplifiers at 20 Mc/s and with a bandwidth of ±40 kc/s, A.G.C., noise limiter and muting circuit to suppress receiver noise in the absence of a signal are used in the receiver. Before the local oscillations are fed to the diode frequency changer they pass through two stages of frequency doublers coupled by wide-band circuits of the same kind used in the transmitter. In this case the final frequency lies between 98 and 108 Mc/s.

Power for the transmitter and the receiver is provided by a rotary transformer, which together with the smoothing circuits, is housed in the base of the main assembly. It produces 265 volts D.C. and supplies the transmitter and the receiver as required. L.T. for the valve heaters is obtained from a regulated supply of 19 volts derived from the aircraft batteries.

The rotary transformer drives also a cooling and ventilating fan, the air drawn in being first passed through a filter located on the front face of the main assembly.

Miniature and tropicalized components are used extensively in the STR12 set and it has thus been possible to bring the overall size of the main assembly down to 7.9in × 12.5in × 7.8in. The control unit, which contains the two master oscillators, provision for 24 plug-in crystals and selector switch, on-off switch, volume control, microphone and telephone jacks, requires only 5.9in × 2.5in × 3.9in to accommodate it.

Miniaturization is extended even to the quartz crystal units themselves. These have been developed especially for aircraft use and measure only $\frac{3}{4}$in × $1\frac{3}{16}$in × $\frac{1}{4}$in. The equipment is made by Standard Telephones and Cables, Ltd., New Southgate, London, N.11.

National Physical Laboratory

Annual Exhibition of Work

THE second demonstration of the N.P.L.'s scientific work and apparatus since the war was given this year from June 18th to 20th and included many items of interest to readers of this journal.

In the Radio Division methods of investigating site errors in direction finding at V.H.F. were demonstrated, using a scale model with rotating obstacle, synchronized with a cathode ray display. The trace showed general agreement with the calculated azimuthal error diagram. The technique of field strength measurement on centimetre wavelengths using a bolometer bridge in association with an aerial of known gain in relation to a half-wave dipole was shown; the same aerial radiating a known power provides a means of establishing a standard field strength.

The low-power klystron 1 cm transmitter and receiver with directional horn radiators, shown at last year's demonstration, were again seen in operation, this time in a demonstration of refraction through a Perspex prism. A parallel beam of red light passing through the same prism showed the same angle of refraction—a rather unexpected result in view of the ratio of 80 million in the wavelengths.

In the Electricity Division a method of measuring the velocity of electromagnetic waves was shown, based on resonance in hollow conductors. Using a copper cylinder 8 cm in diameter and 8 cm long measured to less than 10^{-5} cm, and determining the resonant frequency to a few parts in a million, the velocity obtained is 17 km/s greater than the accepted value derived by other methods of measurement. The work is being continued with electrical resonators of different shapes.

Apparatus for making overall measurements on hearing aids, including earpieces of all types in current use, was shown in the Physics Division. The acoustic measurement equipment is in course of extension and a new acoustically "dead" room with wedge cavity absorbent lining is under construction. An "infinite" duct, also making use of absorbent wedge termination is proving of great value in the absolute calibration of microphones at low frequencies. For the rapid and accurate determination of any given frequency from, say, a beat-frequency oscillator, an electronic decimal counter has been installed. This shows on a series of dials the number of cycles registered in the interval between standard second pulses received by line from the Metrology Division, and has proved a most convenient tool in routine acoustic measurements.

LETTERS TO THE EDITOR

What is a Filter? ✦ Distortion and the "Average Receiver" ✦ Choice of Communication Frequencies ✦ Disc Records or ....?

Tuned A.F. Filters

"A wave filter is a device for separating waves characterized by a difference in frequency."[1]

THIS definition should be amplified in order to distinguish the highly specialized networks, usually called wave filters, from such systems as a continuous telephone line or a parallel tuned circuit, which do possess some frequency discrimination. We may say that "a wave filter is a network, whose ideal form has an attenuation which is zero in a band or bands of frequencies and is not zero outside these bands."[2]

Mr. Styles, in the July issue of *Wireless World* is most definitely not describing filter circuits, nor is it possible to envisage an untuned filter.

A somewhat more symmetrical treatment of the two circuits may be obtained by taking the resistive component of the series arm in the parallel tuned rejector in shunt with the coil. This is particularly useful when resistance-cancellation is employed to sharpen the response of a system of low Q.[3]

THOMAS RODDAM.

1. G. A. Campbell, "Physical Theory of the Wave Filter," *Bell System Technical Journal*, p. 2, November 1922.
2. A. T. Starr, "Electric Circuits and Wave Filters," p. 201, (2nd Edition, 1928) Pitman.
3. Thomas Roddam, "Wavetraps with Infinite Q," *Wireless World*, April, 1945.

B.B.C. Quality

I WAS very interested in the recent correspondence on the subject of the quality of the B.B.C.'s transmissions, but I refrained from making any immediate comment in order to give myself time to make more extensive observations.

Unlike Mr. Hartley, I am not in a position to make quantitative analyses of the distortion, but I have been able to make frequent qualitative tests on six different receivers. Two of these are commercial superhets of average quality, both ten years old; one of the others is an R.A.F. R1155 with 6V6 output and an eight-inch loud speaker. Of the remaining three receivers, one is a T.R.F. "quality" receiver, another a domestic T.R.F. set with triode output and an eight-inch loudspeaker, and the third is a T.R.F. midget with 3½-inch loudspeaker.

On all the receivers except the midget, distortion is present to a marked degree on certain transmissions. On the "quality" receiver about 10 per cent of all transmissions are above complaint. The R1155 and one of the commercial superhets give reasonable reproduction on about fifty per cent of broadcasts, while the two remaining receivers are satisfactory on about twenty per cent of transmissions. These figures seem to refute the contention that the distortion is not noticeable on the average receiver; the R1155 is certainly below average in this respect.

With regard to the incidence of distortion among the various programmes, the Home Service appears to be more free from this evil than the other two services. The Third Programme frequently regales us with a succession of the B.B.C.'s "muddy" recordings, and the Light Programme appears to be suffering from over-modulation most of the time. This fault is by no means confined to the Light Programme: one of the consistent offenders is "Music in the Morning" on the Home Service. This programme is frequently transmitted at a level more than twice that of the previous night's transmissions, accompanied by all the evils of harmonic distortion, intermodulation and sideband splash. In accordance with Mr. Bishop's suggestion (March issue) I have notified the B.B.C. of this complaint.

While most listeners will appreciate the Corporation's difficulties regarding equipment, etc., one cannot help feeling that much of the trouble is due, not to aged apparatus, but to careless monitoring of the transmissions.

GERALD R. W. LEWIS.
Beckenham, Kent.

V.H.F. for Trunk Communications

IN his article "Wire or Wireless" in your July issue, Thomas Roddam appears to imply that the radio engineer has no propagation worries at V.H.F. and higher frequencies. But frequencies of the order of 42 to 50 Mc/s (which he quotes as being used in British Columbia, with the relatively high power, for a semi-optical service, of 250 watts) are capable of propagation beyond the horizon; and because channel space is precious at these lower frequencies, they should be reserved for longer-than-optical links. Anyone who thinks that such links are all plain sailing should study the arguments which arose in U.S.A. over the transfer of the F.M. service from 40-50 Mc/s to around 100 Mc/s. Admittedly there were commercial interests involved, but there were plenty of genuine technical points in the Norton *versus* Dellinger arguments. (See, for example, "V.H.F. and U.H.F. Signal Ranges as Limited by Noise and Co-Channel Interference," E. J. Allen, *Proc. I.R.E.*, Feb. 1947, p. 128, and the discussion on this paper.)

At centimetre wavelengths we are practically limited to genuinely optical paths, but the tendency is for the beam to become so narrow that atmospheric refraction can divert it off the receiving aerial. In fact, it has even been proposed to use diversity reception in order to overcome fading at a frequency of some thousands of megacycles.

It is perhaps unfortunate that we are rather slow in publishing reports in this country, but one of the papers read to the I.E.E. Radiocommunications Convention this year, entitled "Resumé of V.H.F. Point-to-Point Communication," gave an account of a number of V.H.F. multi-channel telephone circuits which are already in use in the Post Office telephone service. When this paper is printed, we shall not need to cross the Atlantic for examples of radio trunk lines, and incidentally the Post Office radio circuits are 12- and 24-channel links compared with the 1- and 6-channel examples from British Columbia.

D. A. BELL.
British Telecommunications Research, Ltd.,
Taplow, Berks.

"Degrees for ex-Servicemen"

WITH reference to recent correspondence in this column, I have received a total to date of ninety-three completed questionnaires. Of these fifty-one are from the London area, including Dartford and South-West Essex, and ten from Stoke-on-Trent. The numbers in each of the other localities are unfortunately too small to make it possible to ask the Ministry of Education to take action, but it is hoped that in London and Stoke it may be possible to bring about the desired results.

I am communicating with the Ministry of Education, to whom the questionnaires and an analysis of the results is being sent.

I should like very much to thank those who have completed question-

World Radio History

naires and to request that those to whom they have been sent and who have not yet returned them would do so immediately, especially if they wish to take courses in the London area or in Stoke.

O. S. PUCKLE,
R.F. Equipment, Ltd.,
Langley Park, Nr Slough, Bucks.

"Squegger"

DURING the first World War, while serving with the Royal Air Force in Egypt (in 1918), I read a report on a "Squegger."

The instrument was intended for testing grid leaks, and consisted of an oscillating valve with excessive retroaction, the grid leak being selected by operating a two-way switch.

The leak under test was compared with a standard leak by comparing the pitch of the two squeaks heard with the switch in alternative positions, a high squeak indicating a low resistance.

The description stated that the instrument, by *squ*eaking, acted as a substitute for the (almost unobtainable) M*egger*, and was therefore called a "squegger."

In view of Mr. Round's explanation in your issue for July, 1947, this explanation appears to be untrue. Possibly it gained currency owing to its very plausible reason for the derivation of the last part of the word.

L. BAINBRIDGE-BELL.
Witley, Surrey.

Domestic Recordings: Disc v. Wrapped-up Systems

IN past years much space in your publication has been devoted to the hoary problem of disc *v.* tape or film recording, and there is no need to cover old ground.

However, I agree with the conclusion of Mr. A. J. Little in his letter (July issue) that the disc system will remain for domestic recordings of short popular items, and that a "wrapped up" system (probably magnetic) will in due course be introduced commercially to cater for enthusiasts requiring high-quality long-playing musical or operatic recordings. Apart from the simplicity of the disc system for the average user, any competing system must have a technique of cheap, simple and quick multiple duplication of the master recording. These systems should, in my opinion, be regarded as complementary.

As a matter of interest, Mr. Little, and other readers, might like to know that R.C.A. in America have recently marketed a wire recorder, in which no threading or wire handling is necessary. A recording cartridge, providing 15 or 30 minutes' running time, with a simple mechanism that drives two wires, is merely slipped into the unit.

Finally, it ought to be made clear that rather more than a suitable sound-head is required to convert a disc reproducer into a magnetic strip record reproducer, as Mr. Little suggests, but one novel method of solving the wire transport requirement, which is already incorporated in an American design, is to utilize the rim of the turntable, on which ordinary discs can be played, as a capstan around which the wire is wrapped.

DONALD W. ALDOUS.
Torquay, Devon.

Television Deflector Coils

I HAVE followed the articles on television construction and have made a good job of the deflector coil assembly. It took me longer to make the coil formers than to do the winding and assembly, and I am writing to say that I am willing to lend my formers to any reader who is making the coils.*

W. J. DAWSON.
Burnham-on-Crouch, Essex.

* *We shall be pleased to forward letters from any readers wishing to avail themselves of Mr. Dawson's kind offer.*—ED.

"Loudspeaker Damping"

IN your April issue D. T. N. Williamson refers to electromagnetic damping of a baffle-loaded loudspeaker, through low output resistance of the amplifier, as being important. I used to think so myself, and was the first to use the word "damping factor" but my belief was much shaken by the following argument.

If a loudspeaker can be represented by an equivalent circuit consisting of a resistance in series with an "ideal" loudspeaker of 100 per cent efficiency, then the damping must be applied across the input terminals. In this case, even if the amplifier output resistance is zero, the damping is limited by the series resistance which, for 5 per cent efficiency, would be twenty times the resistance of the ideal loudspeaker. This extreme simplification, of course, leaves out the reactive components of the speaker impedance, but the argument still holds qualitatively.

Can any reader of *Wireless World* point out any error in this argument? If it is true, there is very little gained by attempting to achieve excessively low output resistances.

F. LANGFORD-SMITH.
Sydney, Australia.

182

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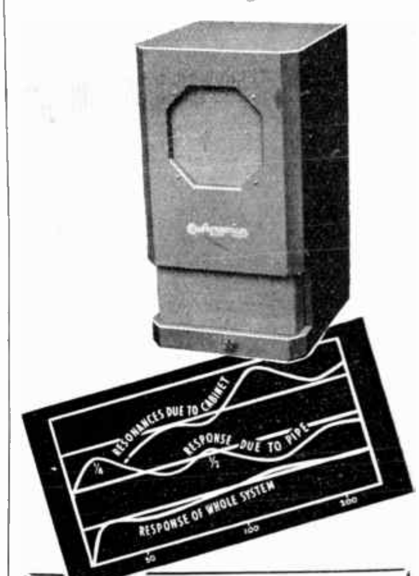

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RANDOM RADIATIONS

By "DIALLIST"

An Occasion

THE I.E.E. Conversazione, held this time in the Science Museum instead of the Natural History Museum, was a most successful affair. After all these years of drabness and austerity a full-dress evening function, with its masculine white ties and its polychromatic feminine confections, was indeed a sight for sore eyes. And what a company was there! I heard many guesses made at the numbers, some pretty near, others wildly too big or too small; the official figure was, I understand, 2,500. I like the rather Victorian term "conversazione" for two reasons. First of all, it has been in use ever since these gatherings were started and suggests the respectable length of the Institution's history; secondly, it is descriptive, for the primary object of most of those who attend is to chat with friends old and new. You renew relations with people whom you hadn't seen for years and make all sorts of interesting fresh contacts. Recalling that so many of us had been away at the wars since 1939 and had laid up our evening togs, not in lavender, but in naphthalene and what not, I had warned Mrs. Diallist to prepare for the most formidable concentration of moth-ball perfume in the history of mankind. My fears, however, proved groundless, no doubt because the preceding spell of fine, sunny weather had provided heaven-sent opportunities for the preliminary airing of festive garments.

□ □ □

Summertime Nuisances

THOUGH the B.B.C. suggests politely from time to time that in the season of warm evenings and open windows listeners should remember that a blaring loudspeaker can cause a great deal of annoyance to neighbours some distance away, there are always some who either won't believe it or don't care the now historic tinker's cuss. I'm lucky (says I, touching wood) in having neighbours who behave with due consideration for others. But a few evenings before this was written I found my ears assailed by a bellowing and horribly distorted rendering of the light programme. A reconnoitring stroll tracked down the source of the din to a house 200 yards away, into which newcomers had recently moved. The blinds were up, the lights were on and there, right against the open window, was the *back* of the wireless receiver. What to do, as the French say? Luckily, the owner emerged just at that moment to take his dog for its bedtime saunter and I joined him, bidding him welcome to the neighbourhood. We had to shout to make ourselves heard and so found some difficulty in the exchange of names. "I say," he said, "that can't be my wireless that's making the uproar; it couldn't be, for my loudspeaker's pointing into the room and it's the back of the set that's near the window." I suggested that quite a lot of noise could come from the back of a set and, having convinced him that his was the culprit, got him to walk up the road, counting his paces as he went, to see just how far such unintentional broadcasting could carry with nuisance value. When he'd counted up to 300 paces he turned round and went back almost at the double! There has been no further trouble and (fingers crossed) I don't fancy there will be.

□ □ □

Worth Trying

A TEST that every listener should make, particularly in summertime, is this. Turn on the set and adjust the volume to your liking. Then go outside the house and see at what sort of distance the sound is likely to disturb other people. So long as it is confined to your own boundaries, well and good. But remember that, however much you may pride yourself on the quality of its reproduction, your receiver is not as a rule giving your neighbours a treat if they must perforce listen to it. It is *not* funny to have the third programme as something more than a background when you are trying to listen to Itma—or *vice versa*. It is still less funny to have incomprehensible speech or a travesty of music, consisting largely or resonance peaks, hurled at you when you are trying to read or work.

□ □ □

Can You Beat It?

BEFORE now I've commented on the fine free disregard shown in American technical books and periodicals for the internationally accepted symbols and abbreviations of electricity in general and wireless in particular. The other day I added to my collection a specimen which seems to me to put all previous finds quite in the shade, particularly as it occurred in the advertisement of an important manufacturing firm. Capacitors of certain types are announced "with values up to 500 Mmfd." What they apparently mean is 500 micro-microfarads, picofarads or "puffs." But the only meaning that 500 Mmfd can have, according to the internationally agreed symbols, is 500 mega-millifarads = $500 \times 10^6 \times 10^{-3}$F = 500,000F! I'd rather like to see a capacitor of that size, though I can't think off-hand of any useful application for it in the wireless receiver. A pity that this sort of thing should happen. The main purpose of the international system of symbols and abbreviations is to facilitate the understanding of text books, articles and so on written in languages foreign to the reader. Letters or signs should have fixed and unalterable meanings.

□ □ □

English As She Is Translated

A FRENCH reader kindly sends me some comments on the alleged French version of the catalogue of this year's Components Exhibition. When an exhibition is staged largely with the purpose of attracting foreign buyers of our goods, in order to help the export drive, it is plainly good policy to print the catalogue not only in English, but in those other international languages, French and Spanish. But—and it is a big but—it is just as well to ensure that the French is French and the Spanish, Spanish. Something went wrong when French- and Spanish-speaking visitors (all potential buyers in the export markets that we are striving to expand) are reduced to helplessness by paroxysms of laughter on comparing the exhibits with their catalogue descriptions. To give but two examples: the "racks" of a radio assembly are not the kind of racks that are associated with pinions, though that's how they were translated for the benefit (?) of the foreign visitor; you can, in English, describe a refurbished component or piece of apparatus as "rehabilitated." But you can't call it *réhabilité* in French; that would mean that its reputation or its civil rights, lost as the result of some fall from grace, had been restored. Such bloomers are on a par with that of the schoolboy who was at first stumped by a "chest of drawers" in the French prose which was part of his evening's homework. Failing to find in the dictionary any equivalent for the whole expression, he looked up "chest" and found *poitrine* (=thorax); for "drawers" the dictionary suggested *caleçon* (=pants).

World Radio History

He therefore wrote *une poitrine de caleçons*.

□ □ □

No Prizes Offered

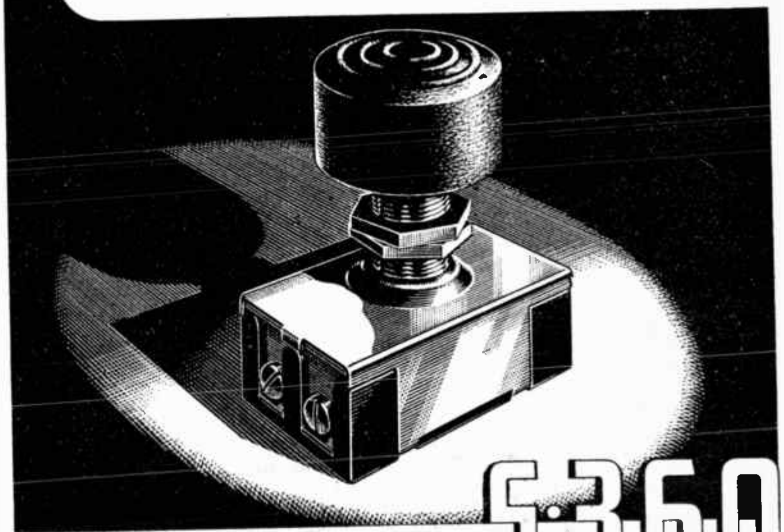
HERE'S one of those little problems which, though they're absurdly easy, often puzzle for a bit those at whom they are fired suddenly. You have two small steel bars of identical size and appearance. One is magnetized; the other is not. No instruments or appliances of any kind are available—no compass; not even a piece of string with which to suspend them; no other piece of metal. How can you discover in a moment which is which? Got that one? Try this. Time allowed 15 seconds. As you look at the screen of a television C.R.T. current flows through the line-scan deflector coil so as to make the direction of the deflecting magetic field upwards. Does the spot move towards your right hand, or towards your left? Test books not infrequently evade that issue either by stating merely that the spot is moved to the right or to the left according to the direction of the deflecting field, or by offering an illustration in which the field is shown by vertical straight lines with arrowheads at either end and the movements of the spot by a horizontal straight line, also arrowheaded at both ends. It's easy enough to work out; but don't forget that 15-second time limit!

□ □ □

Electronics

MY sympathies are with L. Wafer, who expressed in last month's *W.W.* his dislike of the overworked and misused term "electronics." If we accept the definition adopted by the American I.E.E., the term becomes of absurdly wide application, as "Cathode-Ray" has pointed out. Is the sparking-plug, for instance, an electronic device? I suppose it must be, for its action depends on "the conduction of electricity through gases." One hardly thinks of either the sparking plug or the spark transmitter as electronic appliances, probably because they don't belong to "Cathode-Ray's" "glassware department of electricity." The definition would, I think, be better if it read: ". . . the conduction of electric current between cathode and anode sealed into an evacuated or gas-filled envelope." Even so, if we are to retain the term, I feel that it should be far less generally applied than it is at present. Before now I have been moved to mirth by a shop front with large and gaudy lettering which proclaimed some not over-bright electrician as an "Electrical, Radio and Electronic Engineer."

a new foot-operated switch



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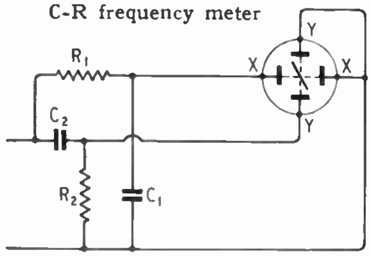
FREQUENCY MEASUREMENT

THE frequency of a variable signal is measured by passing it through two parallel circuits, one or both of which produce corresponding phase or amplitude variations, which are then

C-R frequency meter



applied to the deflecting plates of a cathode ray tube.

In the simple arrangement shown, the input comprises two resistance-capacity branches C_1, R_1 and C_2, R_2, the reactance of C_1 being small compared with R_1, and that of C_2 large compared with R_2. The first branch produces a voltage lead, and the second a voltage lag of 90 deg. so that when applied across the deflecting plates X, Y, they give a straight-line trace on the screen. In addition, one branch-circuit progressively lessens the amplitude of the higher frequencies, whilst the second branch has the reverse effect, thus causing the trace to rotate through an angle of 90 deg. over the whole frequency range. By the use of more elaborate delay and attenuating networks, the response can be increased to one or more complete rotations. The invention is applicable to radar and altimeter devices, particularly those using a variable-frequency exploring wave.

Standard Telephones and Cables, Ltd., and C. W. Earp. Application date April 21st, 1942. No. 581201.

WAVEGUIDE OSCILLATOR

STANDING waves are set up in a waveguide and are radiated from its open end, the other end being closed by a sliding piston. The system is energized by projecting a stream of electrons from a cathode gun across the guide at a voltage loop and in a direction parallel with the field created in the resonating space bounded by the closed end of the guide. A reflector, arranged near the opposite wall of the guide, returns the electrons towards the gun, so that the stream is velocity-modulated on the forward journey, and "bunched" on the return, thus feeding energy to the oscillating field. A perforated diaphragm near the open end of the guide serves to prevent any excessive radiation damping of the resonating space.

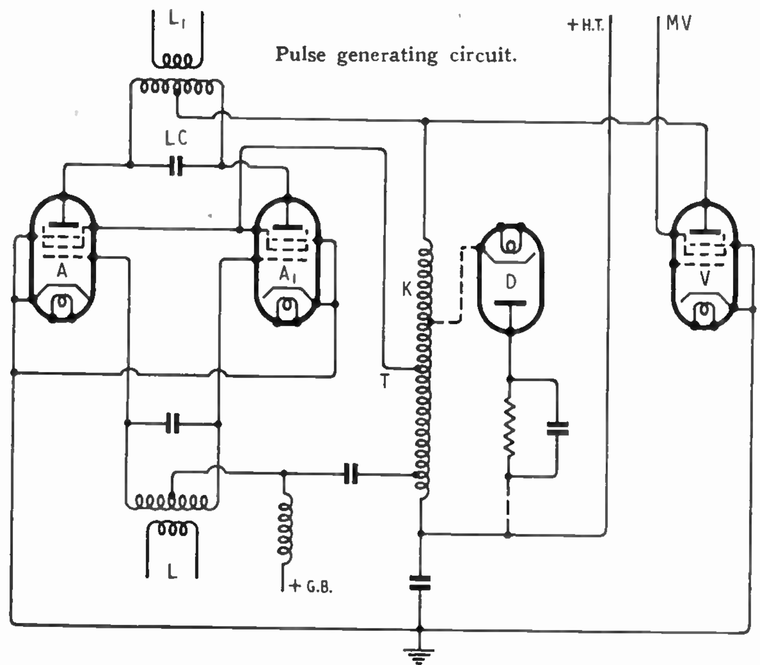
In reception, signals are first rectified on a bend of the characteristic curve of the device, and are then mixed with an autodyne frequency. A flared horn may be attached to the open end of the guide.

Standard Telephones and Cables, Ltd., and S. G. Tomlin. Application date August 29th, 1941. No. 581481.

The British Abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

PULSE GENERATORS

INTENSE voltage surges, suitable for shaping or modulating the pulsed exploring signals used in radiolocation, are developed by suddenly interrupting the current passing



Pulse generating circuit.

through a valve that is coupled to a highly inductive load.

Two R.F. amplifiers A, A1 are fed in push-pull by the output coil L from an oscillator, and are coupled through a coil L1 to the transmitting aerial. A valve V, which is normally non-conducting, is periodically triggered at MV by square-shaped waves from a multivibrator (not shown). This causes current first to build-up in the load inductance K, and then to be rapidly cut-off. The resulting voltage "kick" is injected into the tuned anode circuit LC of the R.F. amplifiers, whilst a fraction of it is also applied to the screen grids, through a tapping T, causing a sharp pulse of radiation from the aerial.

With 1,000 volts H.T. on the anode of the valve V, the back-E.M.F. across K may reach a peak value of 7,000 volts, or more than enough to overload the valve were its duration not so short. A diode D helps to damp the inductance after each excitation. The inductance shown may be replaced by a time-delay network, which serves to shape the modulation voltage.

A. D. Blumlein and E. L. C. White. Application date January 27th, 1940. No. 579725.

TUNING DEVICES

RELATES to the tuning of a hollow resonator, such as is used for generating oscillations by velocity modulation.

The resonator is approximately toroidal in shape, and may consist of a flat cylinder fitted with apertured end discs of suitable curvature. A curved strip of springy metal is fitted inside a selected part of the relatively rigid wall of the cylinder, and is flexed to-and-fro by an external control screw, so as to vary the effective size, and, therefore, the tuning, of the resonant cavity. The strip is bent to a radius which is larger than that of the cylinder, so that its ends always keep in electrical contact with the wall. Or it may be permanently connected to the inner surface of the wall through corrugated end pieces of sufficient flexibility.

A. F. Pearce. Application date February 13th, 1942. No. 579317.

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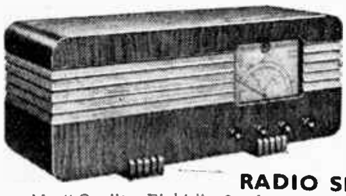

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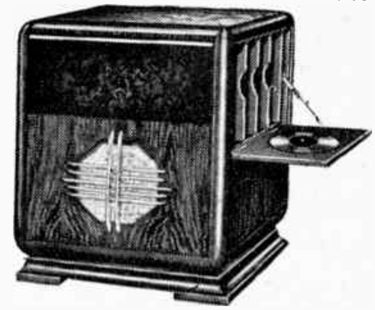

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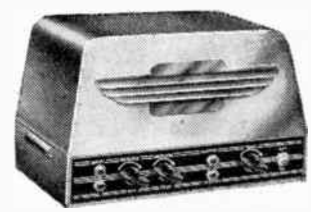

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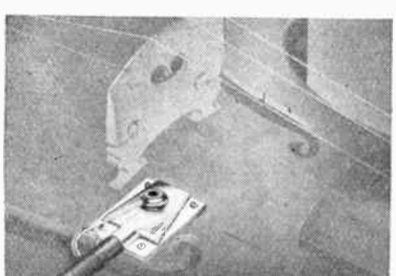

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1817

The Problem

The directional response characteristic of single unit loudspeakers is very pronounced at the higher audio frequencies which are audible only in a comparatively narrow channel directly in front of the reproducer with a corresponding lack of intelligibility and brilliance elsewhere.

This feature is particularly troublesome when high quality sound reproduction is required in public halls, theatres and small cinemas where the size and expense of a large dual channel loudspeaker system is often not justified.

The Solution

It is for such installations that the Vitavox Bitone Reproducer has been designed. High frequency reproduction in this instrument is handled by a small multicellular horn and moving coil pressure unit, this assembly providing adequate coverage and at the same time because of its high efficiency, a rising high note characteristic which is an advantage in auditorium reproduction. A 12" moving coil cone type loudspeaker operating in a vented enclosure reproduces low frequencies and a cross-over filter network is fitted to divide the frequency spectrum correctly between the two units. The whole assembly is mounted in a polished Walnut finished cabinet as standard, Oak and Mahogany veneered models being available to special order, and can be relied upon for applications where quality of performance rather than first cost is the main consideration.

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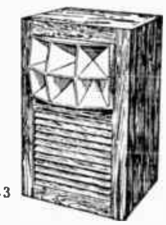

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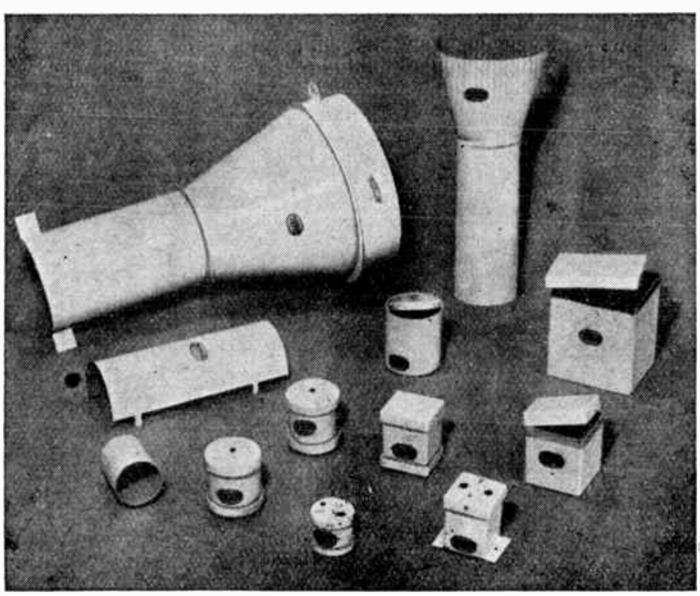

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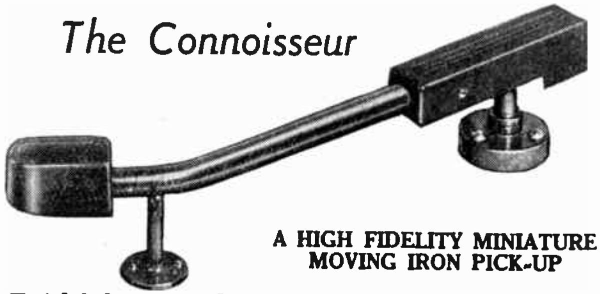

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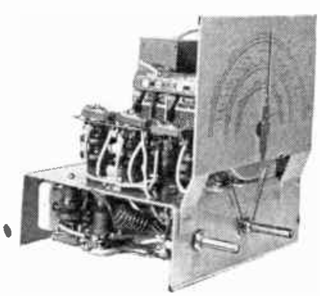

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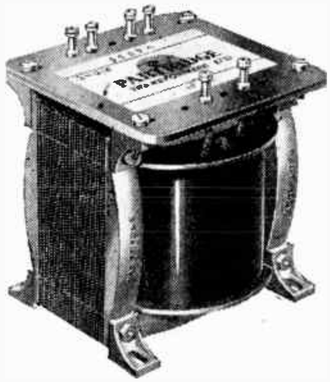

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TAYLOR model 120a, 21-range, ac-dc testers; £7/10 post free.—World Radio & Electric Co., 78, Radford Boulevard, Nottingham.

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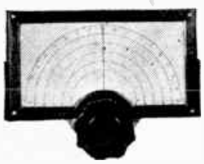

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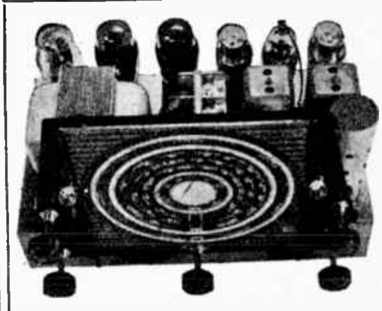

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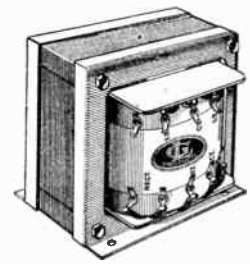

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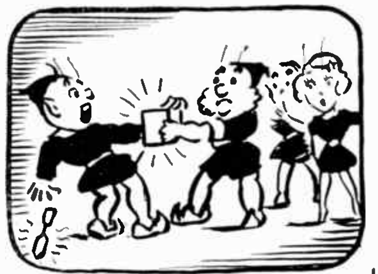

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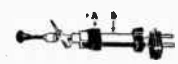

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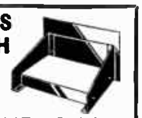

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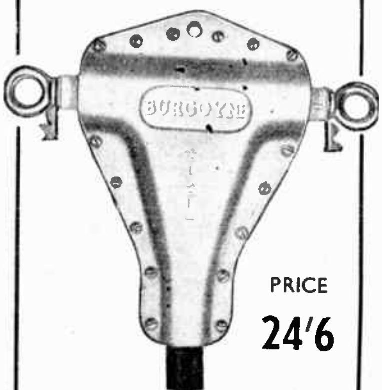

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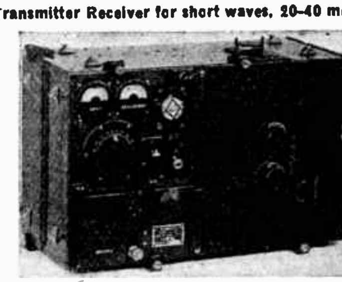

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THE Governing Body invite immediate applications for appointment as full-time lecturer in radio engineering to prepare students for the City and Guilds of London Institute Final Certificate in telecommunications engineering; salary scale £300×£15×£525, plus £36-£48 London allowance, together with other allowances in accordance with the Burnham award. Forms of application, together with full particulars, will be forwarded on receipt of a stamped addressed foolscap envelope.
R. H. CURRELL, Clerk. [7891

SALES engineer with experience of estimating and technical correspondence on sound amplifying equipment; West Middlesex locality.—Reply, stating age, salary required, and experience, to Box 1186. [7972

RADIO service engineers required, permanent situation for all-round practical men; vacancies in various parts of the country; good rates for first class work.—Write, giving full particulars, to Box 949. [7893

CHIEF engineer required with great exp. in commercial receivers and television; first-class references necessary; excellent position offered in a known London radio factory; salary approximately £1,000 p.a.—Box 333.

WELL-KNOWN loudspeaker manufacturers require senior and junior acoustic engineers for development work in research laboratory.—Write, stating age, qualctns., salary rec. and remuneration now req. to Box 1183.

MURPHY dealer requires skilled service engineer with television experience, sole charge of separate workshop; good wages and conditions.—Write or 'phone Wright, 3, Beeches Av., Carshalton, Surrey. Wallington 2119.

DEVELOPMENT and research engineer required by radio manufacturers, S.E. London district, with commercial, radio and television experience.—Apply in strict confidence, stating age, qualifications and experience, to Box 1396. [8029

ENGINEER required for design development and testing of power and audio transformers and test equipment.—Apply Personnel Manager, R.F. Equipment, Ltd., Langley Park, Slough, Bucks, giving details of qualification, experience and salary required. [7936

WELL-KNOWN firm require draughtsmen with experience in laying out and detailing of designs for broadcast and television receivers and communication equipment; stable posts for suitable applicants.—State experience and salary required to Box 951. [7896

LARGE organisation in West Middlesex requires field service engineers with good television and radio technical knowledge; smart appearance, car an advantage but not essential.—Reply, stating details of past experience, age and salary required, to Box 1319. [8003

MANUFACTURERS of high class radio components invite applications from suitably qualified persons to act as representatives; only those with first class wholesale radio trade connections need apply.—State qualifications and terms to Box 1182. [7965

THERE are vacancies for men capable of maintaining and repairing television receivers.—Application should be made to London Rediffusion, 67, Sloane Av., S.W.3, giving full particulars of qualifications and experience. Training facilities will, if necessary, be provided. [7954

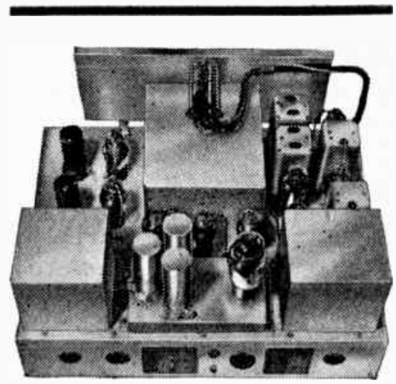
ASSISTANT foreman for large manufacturers, S.E. London area; knowledge of component part and line assembly, also coil wave winding machine setting; accustomed to control and training of female labour; good prospects and permanency for right man.—Apply Box 1320. [8004

SALES engineer to specialise in automobile radio equipment; experience in comparable field and adequate training essential; technical qualifications desirable; age 25-30; employment with leading London manufacturers; excellent prospects; salary according to experience.—Box 1321. [8006

WANTED, experienced engineer to take charge of loudspeaker and transformer service, must have had experience in this class of work, able to control staff and be good correspondent and handle customers' queries; good pay and prospects; well established company in Kingston area.—Box 944. [7869

ELECTRONIC engineer required by progressive firm on East Coast for construction, development and maintenance of process test equipment, must be really practical man, 5-day week; please state full details education, training, experience, age; all applications will be treated with confidence.—Box 947. [7887

UNIVERSITY COLLEGE, Southampton, invites applications for the post of lecturer in the Technical Department, University College, Southampton, for City and Guilds telecommunications up to Grade 5; salary Burnham scale.—Further particulars may be obtained from the Technical Officer, with whom applications should be lodged by 6th September, 1947. [7938



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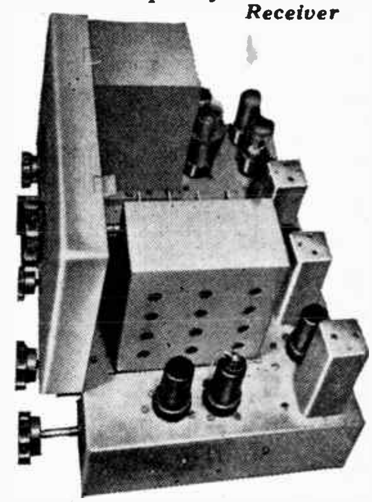

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ENGINEER - REPRESENTATIVE required by British radio component manufacturers for investigation work in India.—Write, giving detailed information re qualifications, experience, age and salary required, to Box 948.

MECHANICAL designers with experience in the design of small mechanisms are invited to apply for progressive posts with a leading firm manufacturing radio communication, civil aviation (airborne and ground), and radar equipment.—Applicants should give full details of experience and quote salary required, to Box 950. [7895

RADIO and television service engineer required. resident in Chelmsford, to cover Essex; good theoretical and practical knowledge and clean driving licence essential; own car an advantage; payment by salary, bonus. allowances and expenses. — Apply Service Manager, Sobell Industries, Ltd., Langley Park, Slough. Bucks. [7935

BRITISH EUROPEAN AIRWAYS are requiring radio mechanics conversant with ex-R.A.F. Transport Command, Bomber Command, signals and radar equipment, for servicing airborne equipment at Northolt Airport; basic pay 2/7 per hour.—Applications should be made to Personnel Officer, Northolt Airport, Ruislip, Middx. [7882

PHYSICIST required by Marconi's Wireless Telegraph Co., Ltd., at their Gt. Baddow Research Laboratories, having specialised knowledge of crystallographic work, with particular reference to Piezo-Electric phenomena; some industrial experience of small-scale crystallisation processes and methods an advantage.—Apply Box 1184. [7967

IMPORTANT radio manufacturing company in London requires first-class sales technical man with previous managerial experience if possible; must be good correspondent.—Full particulars of age, experience, academic qualifications if any, and salary required, to X.Y., Box O/5110, A.K. Advg., 212a, Shaftesbury Av., London, W.C.2. [7756

WOLVERHAMPTON and Staffordshire Technical College.—Assistant (mechanical) and senior assistant (electrical) required in the Engineering Department of the above. Salaries on the appropriate Burnham Technical Scale. —Particulars, etc., on application to F. Lonsdale Mills, Clerk to the Governors, Education Offices, North St., Wolverhampton. [7940

RADIO engineering company in South London requires engineer to take charge of test department specializing in radio navigational equipment; applicants must be able to prove they have first class technical qualifications combined with considerable experience in similar work; position offers good opportunities to the right man.—Write full details to Box 7429. [7202

REQUIRED in Slough district, development and design engineers experienced in the following categories of radio work: (1) H.F. high power transmitters; (2) V.H.F. low power multiple-channel F.M. transmitters; (3) V.H.F. receivers for (2); (4) Portable single-channel transmitter/receiver sets. Salary according to experience.—Write Box 590, Dorlands, 18 20. Regent St., London, S.W.1. [7731

APPLICATIONS are invited by leading manufacturer of broadcast radio and television receivers in the Midland area for vacancies in their development laboratories for design engineers; candidates should be of degree status and have had experience of broadcast and/or television receiver design and development.—Apply, stating age, experience and salary required, to Box 953. [7898

REDIFFUSION, Ltd., have a vacancy in their development laboratory for a senior radio engineer capable of taking full responsibility development and design of transmitters varying powers and frequencies; only live men with practical experience need apply to Manager, Rediffusion, Ltd., Broomhill Rd., Wandsworth, S.W.18, giving details of technical qualifications, salary expected, and when available.

BRITISH OVERSEAS AIRWAYS CORPORATION have vacancies for ground radio operators, medically fit and willing to serve on a world-wide basis overseas. The upper age limit is 40 and preference will be given to single men. Basic rate of pay £5/15 to £6/10 a week, plus allowances overseas graded according to the local standard and cost of living. The initial tour of duty is three years, and successful candidates will be required to serve in any part of the world at the discretion of the Corporation. Essential qualifications: Postmaster-General's First or Second-class Certificate or equivalent service experience. Candidates not holding certificates will be given proficiency tests on ground radio operating.—Applications in writing to Staff Appointments Superintendent, Stratton House, Piccadilly, W.1, stating age, certificates held and giving brief details of radio operating experience. Replies will be sent only to candidates called for interview. Mark envelopes "Ground Radio Operator." [7960

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AIRCRAFT radio installation engineer required capable of dealing with all matters relating to prototype installations in commercial aircraft.—Apply, giving full particulars of qualifications and experience and stating salary required, to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City, Herts.

RADIO.—Energetic young man wanted to assist in the preparation of students for the final grouped technological certificate of the City and Guilds of London; previous teaching experience not essential, but applicants must be keenly interested in radio and youth activities.—Write, giving full particulars of certificates held, salary expected, etc., to the Principal, Wireless College, Colwyn Bay. [7975

A FIRM which manufactures a very wide range of telecommunications equipment requires engineers to develop radio communications equipment in its rapidly expanding V.H.F. and centimetre fields, excellent opportunities exist for suitable applicants, the equivalent of a degree and preferably some experience is required.—Apply, stating age, experience and salary required, to Box 952. [7897

NEW Zealand.—Engineer-salesman for cinema equipment company allied to leading circuit; first-class technical training and thorough experience on installation and servicing of sound film equipment essential; commercial experience, energy, initiative and organising ability will enhance prospects; applications (in strict confidence) should give full details, including experience, qualifications, age, whether married, and present salary.—Write Box 1444.

WELL-KNOWN radio component manufacturer requires electrical inspector for their Wiltshire factory; applicants should have a sound electrical knowledge and preferably some experience of mechanical inspection, experience of mass production inspection is essential; the position offers excellent prospects to an inspector having initiative and the ability to control all inspection in a small radio factory.—Box 962. [7914

EXCEPTIONAL opportunities for draughtsmen are afforded by an expansion of the Marconi drawing offices, Chelmsford, for the design of radio equipment; radio experience desirable but not essential, although drawing office experience of electrical and/or mechanical apparatus definitely required; much of the work is in close collaboration with the research and development engineers.—Apply English Electric Co., Ltd., Queen Hse., Kingsway, W.C.2.

E.M.I. RESEARCH LABORATORIES, Ltd., have vacancies for qualified research engineers with experience in the design and development of: (a) High frequency transmitters; (b) transmitting aerial systems; (c) radar equipment; (d) electric-acoustic equipment. Applications, giving full particulars of qualifications and experience, together with salary expected, should be addressed to Personnel Manager, Gramophone Co., Ltd., Hayes, Middlesex.

MECHANICAL designers, age 30-40, capable of completing mechanical design of fixed or mobile transmitters to electrical information supplied, supervising detail drawings, preparation of stock lists and purchasing specifications; location South-West London.—Write, stating age, experience, salary required and when free to commence, to Group Staff Officer (31), Philips Lamps, Ltd., Century House, Shaftesbury Av., London, W.C.2.

EXPERIENCED wireless mechanics capable of carrying out complete overhauls and repairs to various types of Army and trade pattern wireless transmitters and receivers; wages 104/6 per week, plus up to 20/- per week ability pay according to technical qualifications and skill.—Applications should contain full personal particulars of applicant and experience and should be forwarded in writing to Civilian Establishment Officer, Kinnegar Workshops R.E.M.E., Holywood, Co. Down.

TECHNICAL assistants required for research and development department of large light electrical engineering factory in Ealing area of London; should have graduated in electrical engineering (or equivalent qualifications) with some previous practical engineering experience, required to work on electrical and mechanical testing of equipment and materials; commencing salary from £320 to £450 per annum, according to age; excellent prospects.—Please write, giving full details of age, qualifications and experience, to Box 954. [7903

UNIVERSITY College, London, has a vacancy in the Department of Civil Engineering for a technician with the following qualifications: Skilled or semi-skilled mechanist or fitter with experience in laboratory and instrument cleaning, ability to follow and make up electric wiring from diagrams dealing with thermionic valves and their uses as rectifiers, detectors, oscillators and amplifiers; minimum wage £6 per week and above, according to qualifications; family allowance scheme and five weeks holiday.—Write in first instance for application form to Establishment Officer, University College, London, Gower St., W.C.1.

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VOLTAGE CHANGER TRANSFORMERS. Ex-Govt., auto wound. Tapped 0, 10, 20, 25, 90, 130, 150, 190, 210, 230 volts, 1,000 watts, all tapping at 1,000 watts. New and unused £5/10/- each, carriage 5/-.

MAINS TRANSFORMERS by well-known makers. Input 200/250 volts, output 700/0/700 v., 80 m/a. 4 v. 3 a. 12 v. 1 a., 30/-. Ditto, 300/0/300 v., 200 m/a. 6.3 v. 20 amps. 5 v. 3 a., 45/-. Ditto, 450/0/450 v., 150 m/a. 5 v. 2 a. 6.3 v. 4 a., 37/6. Ditto, 500/0/500 v. 150 m/a. 4 v. 4 a. 6.3 v. 4 a. 5 v. 2 a., 55/-. Ditto, 350/0/350 v., 120 m/a. 4 v. 4 a. 5 v. 2 a. 6.3 v. 4 a., 35/-.

AUTO WOUND MAINS TRANSFORMER (Mains Booster). 1,500 watts tapped 0, 6, 10 19, 175, 200, 220, 225, 240 and 250 volts. New, ex-Govt., £5/10/- each, carriage 5/-.

EX-R.A.F. AERIAL COUPLING UNITS, absorption type. Range from 1.2 to 5.3 m/cycles. 7/6 each, post 1/-.

VOLTAGE CHANGER TRANSFORMERS, auto wound, fully guaranteed, immediate delivery, all tapped 0, 110, 200, 220, 240 volts, 250 watts, 45/-; 350 watts, 55/-; 500 watts, 70/-; 1,000 watts, £5/15/-; 2,000 watts, £8/15/-.

SHUNT WOUND D.C. 110 volt motors, 1,500 r.p.m., approx. ⅛ h.p., condition as new, 17/6 each, post 2/-.

MAINS TRANSFORMERS (NEW) EX-GOVT. SURPLUS VOLTAGE CHANGERS. Tapped 0, 150, 180, 230 volts at 2,000 watts, £7.10.0 each c/paid. Ditto 200/250 volts input 14 and 17½ volts output at 30/35 amp. output, useful for small welding or soil heater, £4.15.0, carriage 3/6. Aerial Variometers for No. 19 set complete with Dial, 5/- each, 1/- post.

ELECTRIC LIGHT CHECK METERS, for 200/250 volt 50 cyc. 1 phase, ideal for subletting, etc., guaranteed electrically 2½ amp. load, 12/6, 5 amp. 12/6, 15 amp. 20/-, 20 amp. 25/-, 30 amp., 30/-, 40 amp. 35/-, 50 amp. 45/-, 100 amp. 50/- each, plus 1/6 carriage extra.

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EX-R.A.F. RADAR IMPULSE TRANSFORMERS (new, boxed). We have no actual data on these, but believe them to have an output of 15,000 volts at 3 kW. for a micro second. A bargain for the experimenter at 10/6 each. P.F.

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L.T. RECTIFIERS (new), 6 volts, 1½ amp., 7/6 each, 12 v. 1½ amp. 10/6 each, 9d. post. Instrument Rectifiers, 5.H., 10 or 20 m/a. types, 4/6 each.

SLIDER RESISTANCES (useful as dimmers, etc., ex-Govt., new), 450 ohms, carry ¾ amp., 30/-; ditto, 4,000 ohms, carry ¼ amp, 35/- each.

WESTON MOVING COIL METERS, edge type with knife edge pointers, 2½in. scale, all 2 m/a. F.S.D. 0 to 300 m/a., 30/-; 0 to 2 amps., 27/6; 0 to 60 volts, 27/6; 0 to 150 volts, 27/6; ditto, 0 to 1 volt 1 m/a. 1,000 ohm per volt, 35/-; another 301 model 0 to 3 m/a., 35/-; 0 to 50 m/a., 30/-; 0 to 200 m/a., 32/6; another 501 model 0 to 50 m/a., 27/6; 0 to 10 m/a., 27/6.

EX-NAVAL ROTARY CONVERTERS. 24 volts D.C. input, 50 volts or 100 volts 500 cycles 1 phase at 300 watts output, good condition, £5 each, C/F. Ditto, 80 volt D.C. to 80 volt A.C. at 2,000 cycles 1 phase 8 amps output, £4/10/- each, C/F.

SMALL MAINS MOTORS, ex-naval fan type, approx. 1/16 h.p., series wound with laminated fields 200/240 volts, 27/6 each, carriage 1/6. A few only 100 v. also. Please state voltage when ordering.

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VARIAC BALANCER TRANSFORMERS. Input 200/260 volts, output 220 volts at 1.65 kilowatts. Condition as new, 85/- each.

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LARGE MAINS TRANSFORMERS for welding, etc., input 0 to 250 volts in steps of 5 volts, output 30 volts, at 100 amps, £12/10/- each, C/F. Another, double-wound, ratio 2 to 1, 240 input, 120 output, or vice versa, and 4 kW, £12/10/- each. C/F. Both are new, ex-Govt.

Other items stocked for which please write for quotation. X-Ray Transformers, Control Tables, Switchboard Volt and Ampmeters, Valves. *Sorry we have no lists of our stocks.* Please write your requirements enclosing S.A.E.

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TELEPHONE apparatus designer required by leading company of telecommunication engineers situated in S.E. London district manufacturing for G.P.O. foreign and colonial administration.—Write fully, stating age, experience and salary required, to Box 0/5483, A.K. Advg., 212a, Shaftesbury Avenue, W.C.2.

ELECTRONIC engineer for large industrial concern in North-West London; applicant must have Degree, or equivalent, in Electrical Engineering, and sound theoretical knowledge of electronic control circuits and equipment, age preferably under under 30; applicant should give full particulars of experience, qualifications, and salary reqd.—Box 341.

BRITISH BROADCASTING CORPORATION invites applications from men (British) for the post of engineer in the audio frequency section of the research department based in London. Candidates must possess a University degree in physics or electrical engineering or equivalent qualifications, and must have taken electrical communication as part of their training. A knowledge of electrical measurements, measuring instruments and electro acoustics and experience in microphone and loudspeaker technique is essential. An appreciation of problems of electrical reproduction as applied to music will be an advantage. The work includes research into microphones and loudspeakers and embraces all other aspects of audio frequency research, design and development. Preference will be given to a candidate with the ability to guide development work in drawing office and workshops. Salary on appointment will be dependent on qualifications and experience, and subject to favourable report will rise thereafter by annual increments of £30 to a maximum of £680 per annum.—Applications, stating age, qualifications and experience, should reach the Engineering Establishment Officer, Broadcasting House, London, W.1, within 14 days of the appearance of this advertisement. [7929

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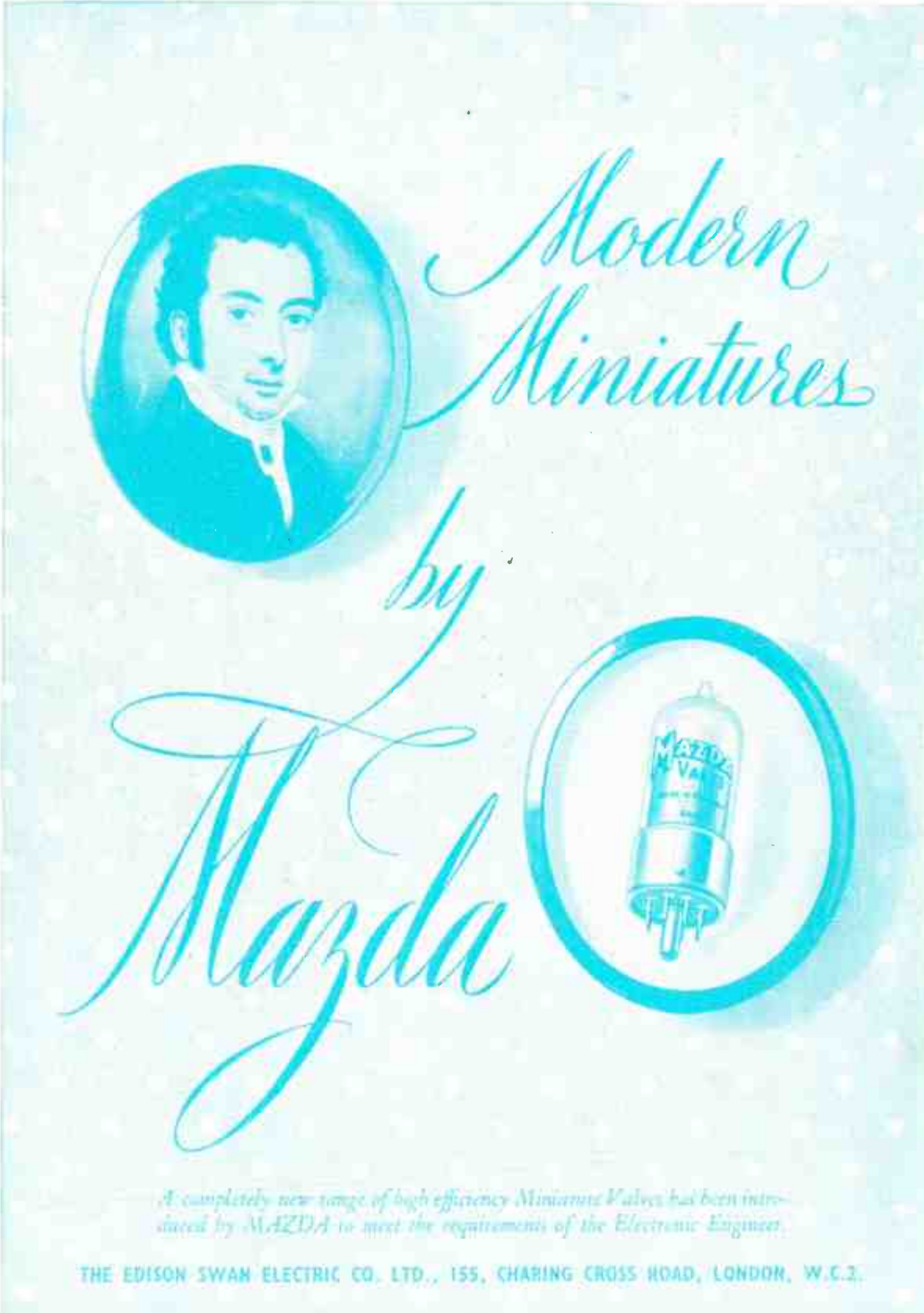
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