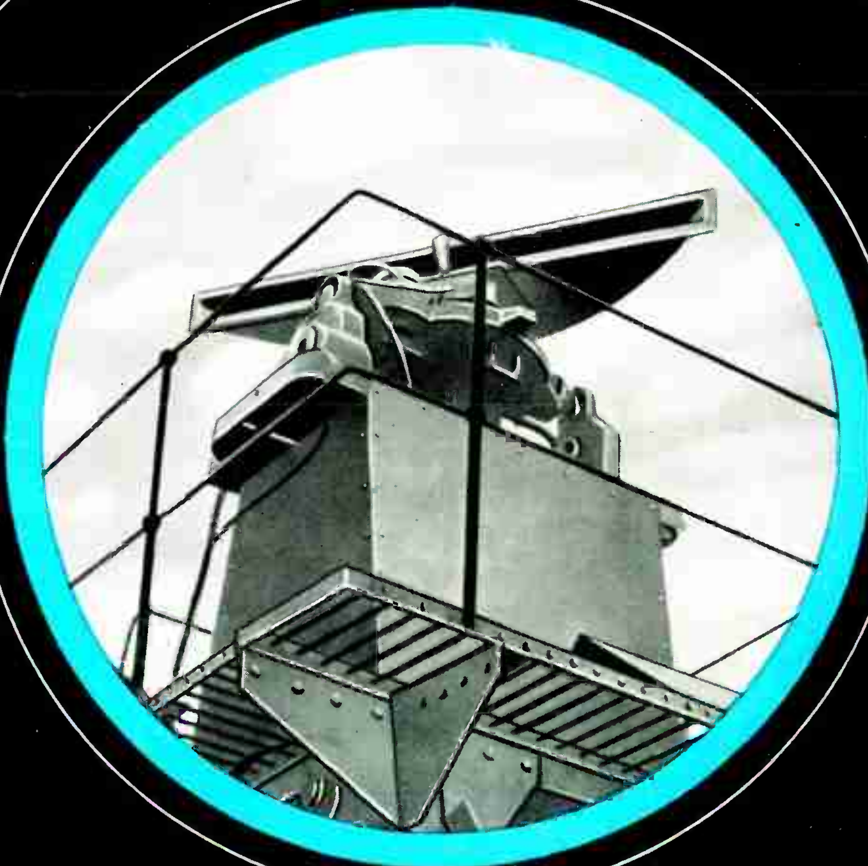
Wireless World

RADIO and ELECTRONICS



MAR. 1946

1/6

Vol. LII. No. 3

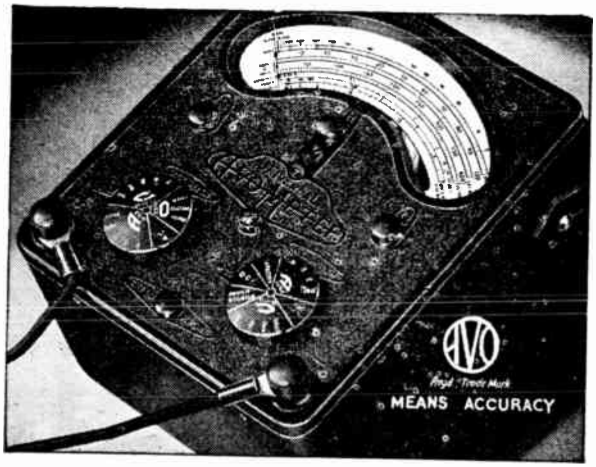
IN THIS ISSUE: SUNSPOTS: EFFECTS ON COMMUNICATIONS

Regd. Trade Mark

PRECISION

TESTING INSTRUMENTS

HIGH accuracy, simplicity, exceptional versatility and proven reliability have won for "AVO" Instruments a world-wide reputation for supremacy wherever rapid precision test work is demanded. There is an "AVO" Instrument for every essential electrical test.



The **MODEL 7** *50-Range Universal*

AVOMETER

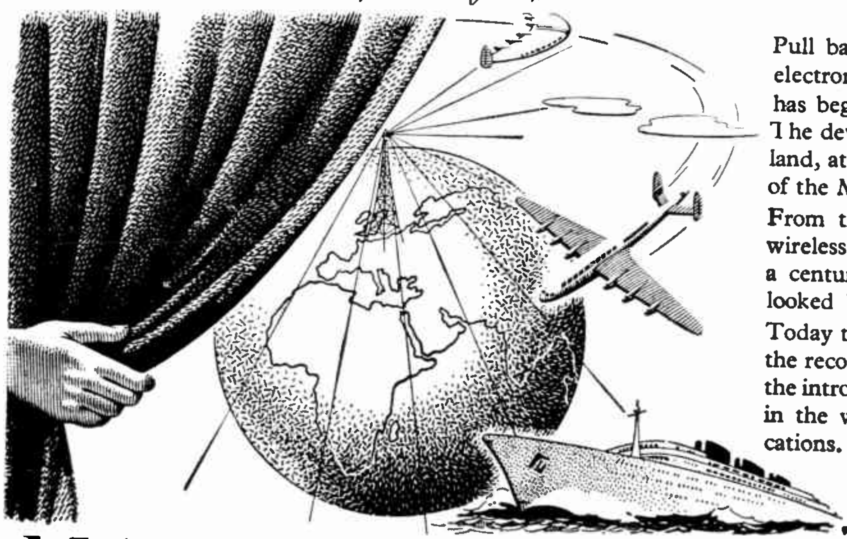
Electrical Measuring Instrument

A self-contained, precision moving-coil instrument, conforming to B.S. 1st Grade accuracy requirements. Has 50 ranges, providing for measuring A.C. & D.C. volts, A.C. & D.C. amperes, resistance, capacity, audio-frequency power output and decibels. Direct readings. No external shunts or series resistances. Provided with automatic compensation for errors arising from variations in temperature, and is protected by an automatic cut-out against damage through overload.

Sole Proprietors and Manufacturers

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD., Winder House, Douglas Street, London, S.W.1. 'Phone: VICtoria 3404/8

Opening of the new world of adventure



Pull back the curtain on the age of electronics—the era of industry that has begun with the end of the war. The development of new services on land, at sea and in the air are all part of the Marconi post-war plan.

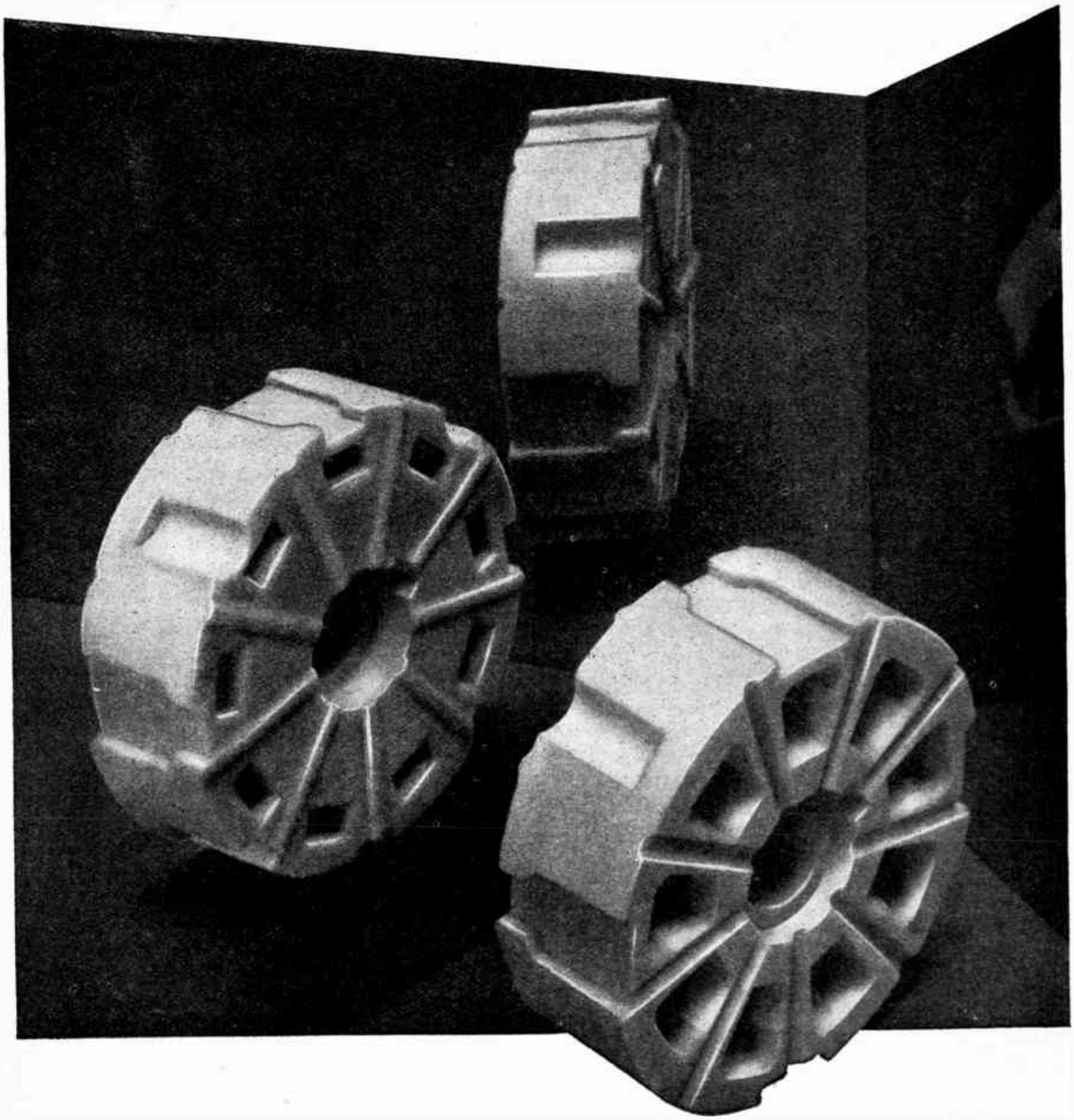
From the first great adventure of wireless communication nearly half a century ago Marconi's have never looked back.

Today they are looking *forward*—to the reconstitution of old services and the introduction of new achievements in the world of wireless communications.

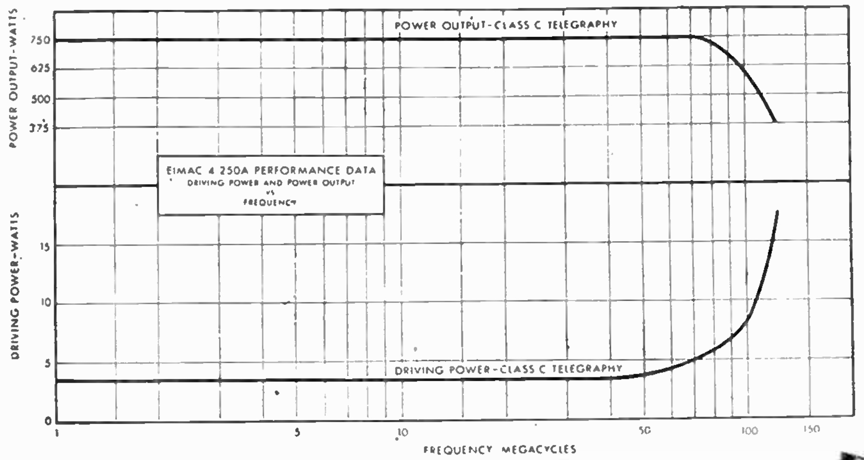
MARCONI *the greatest name in wireless......*

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY LTD · ELECTRA HOUSE, VICTORIA EMBANKMENT · LONDON, W.C.2

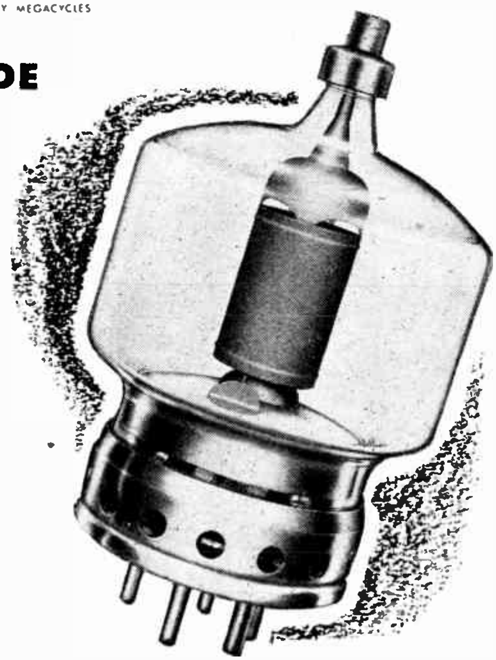
MARCONI'S WIRELESS TELEGRAPH COMPANY LTD.



Eimac VALVES THE COUNTERSIGN OF DEPENDABILITY IN ANY ELECTRONIC EQUIPMENT.



NEW EIMAC 4-250A TETRODE



Heading a parade of sensational new valves now in production, the Eimac 4-250A Tetrode—introduced several months ago—is already in great demand. It may pay to check these performance characteristics against your own requirements.

As can be seen by the chart above, the new Eimac 4-250A Tetrode will deliver 750 watts output at frequencies up to 70 Mc. with a driving power of only 5 watts. At frequencies up to 40 Mc. an output of 750 watts may be obtained with a driving power of 3.5 watts.

The grid-plate capacitance of 0.12 *uu*fd. is extremely low, allowing operation at high frequencies without neutralization. Use of Eimac "X" process control grid reduces both primary and secondary emission which provides utmost stability.

You are invited to supplement the information given here with a technical bulletin on Eimac 4-250A Power Tetrode. It contains an elaboration of the valve's characteristics and constant current curves. Send your name and address and a copy will go to you by return mail.

The Lid's Coming Off... *Watch your favorite trade journals for announcements of other new Eimac valves to be released this year.*

CAUTION! Check serial numbers on Eimac valves before you buy. Be sure you're getting newest types. Look for latest serial numbers.

FOLLOW THE LEADERS TO

Eimac VALVES

EITEL-McCULLOUGH, INC., 1086 San Mateo Avenue, San Bruno, Calif.
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U. S. A.

TYPE 4-250A—POWER TETRODE
ELECTRICAL CHARACTERISTICS

Filament. Thoriated Tungsten	
Voltage	5.0 volts
Current	14.5 amperes
Plate Dissipation (Maximum)	250 watts
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.12 uufd.
Input	12.7 uufd.
Output	4.5 uufd.
Transconductance (ib = 80 ma., Eb = 3000 v., Ec2 = 500 v.)	4000 umhos

Authorised Distributors: BERRY'S (SHORT-WAVE) LTD., 25, HIGH HOLBORN, LONDON, W.C.1.

For Peak Performance

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

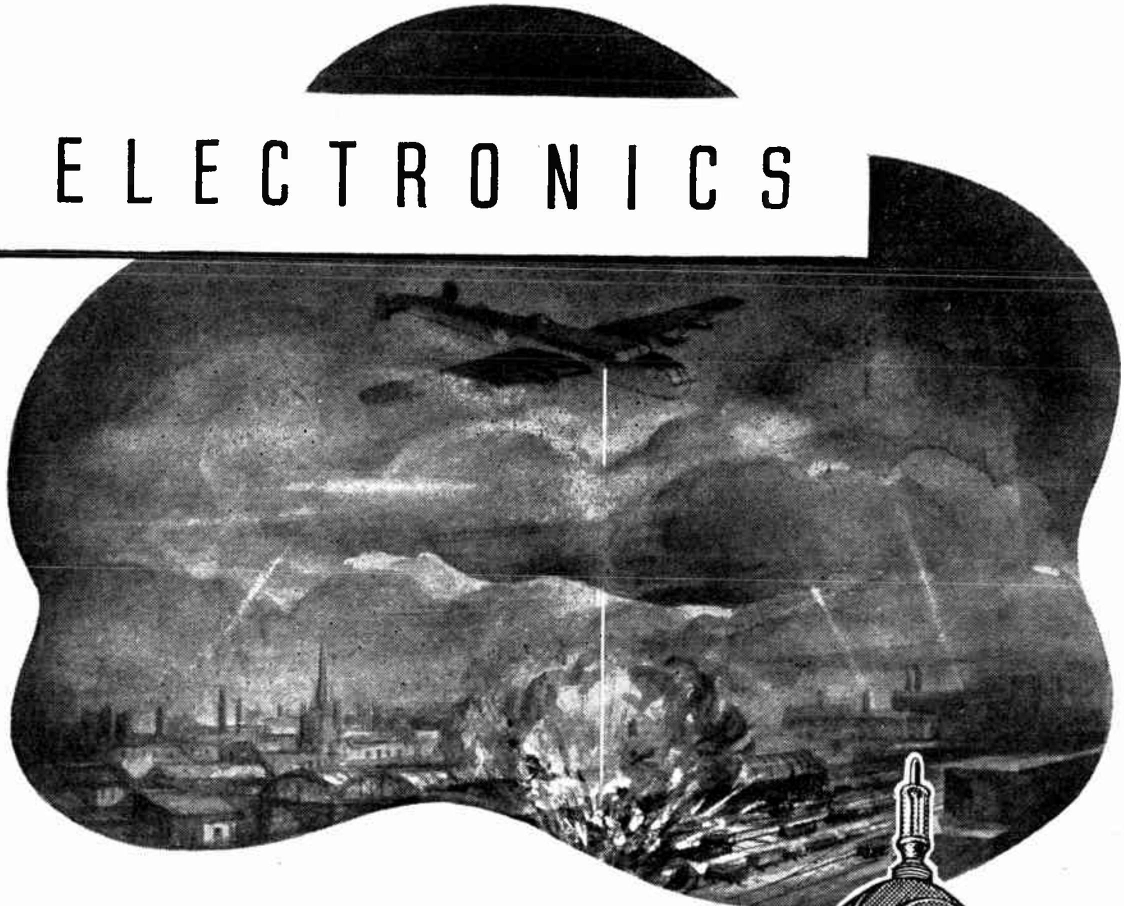
U.I.C.

CERAMIC
High-Voltage
CAPACITORS

UNITED INSULATOR CO. LTD.
12-22 LAYSTALL STREET, LONDON, E.C.1
Tel: TERminus 7383 (5 lines) Grams: Calanel, Smith, London

THE PIONEERS OF LOW-LOSS CERAMICS

ELECTRONICS



made it possible!

Ten-tenths cloud and thick smoke over the target—but still the giant bombers droned their way to a pin-point and released their bombs on the scheduled spot. The science of electronics made it possible, for at the heart of every electronic aiming device lies the valve. OSRAM VALVES were in the forefront of electronic development during the war, and will now bring to the pursuits of peace many well-tried electronic devices to speed, smooth, and make safer, our way of life.

One of the famous Magnetron valves used in many centimetric Radar devices.

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

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

'PERSPEX'

TRADE MARK

TRANSPARENT SHEET

. . . which helped to win the Battle of Britain, the Battle of Germany and the War in the East

is available NOW for essential civilian requirements

IMPERIAL CHEMICAL INDUSTRIES LTD.
LONDON, S.W.1

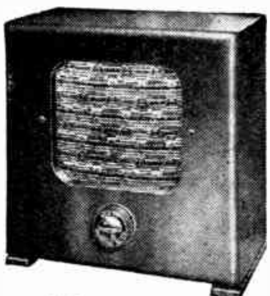
P. 170

Your new STENTORIAN is being made *now*...

Extension Speakers, inc. Cabinet and Volume Control, available from

29/6

It may even be waiting for you at your local Radio Dealer's. Keep in touch with him; these attractive extension speakers with their superb reproduction offer such amazing value that they are being bought faster than they can be produced. More and more people appreciate the convenience of not being confined for their radio to the room the set occupies.



PRICES

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

W B **Stentorian**

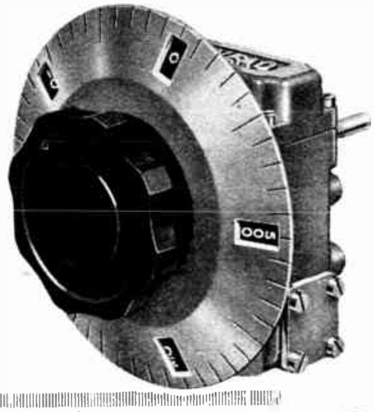
THE PERFECT EXTRA SPEAKER FOR ANY SET

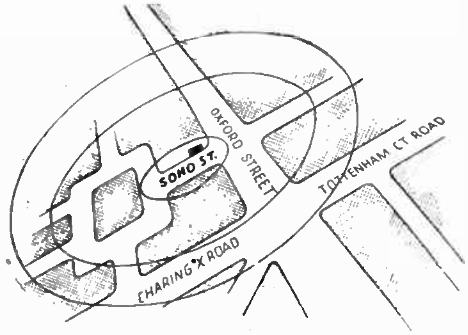
WHITELEY ELECTRICAL RADIO CO. LTD., MANSFIELD, NOTTS.

Keen amateur experimenters know Webb's as the centre where the latest developments can be seen, explained and obtained. Expert technicians test and perfect all classes of radio equipment. A courteous and practical staff is ready to help you at our showrooms. That is why Webb's are recognised as Britain's leading specialists in Radio, Television and Electronics.

The HUB of the "HAM" world

WEBB'S Radio





PRECISION CONTROL DIALS

We have a very wide selection of instrument controls by **Muirhead, Eddystone,** etc., including the **National HRO Type,** now made by Muirheads. This is a dial giving an equivalent of 10 ft. of calibration scale, 500 degrees, each degree ¼ in. long and is too well known for us to emphasise its superlative qualities.

Muirhead type D206A (National PWO), two driving shafts parallel to panel ... **£5 2s. 6d.**

Muirhead type D115A (National NPWO), single drive shaft at right angles to panel. **£4 15s. 0d**

TRANSMITTING VALVES

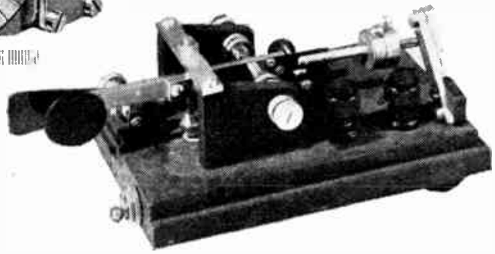
Well known U.S.A. type now available, made by Standard Telephones.

RK34 (Std. Tels. 4074A)	**£1 18s. 6d.**
834 (Std. Tels. 4304CA)	**£3 17s. 6d.**
807 (Std. Tels. 5B250A)	**£1 10s. 5d.**
RK 20 (Std. Tels. 4052A)	**£7 2s. 6d.**
813 (Std. Tels. 5C100A)	**£7 5s. 0d.**
83 (Std. Tels. 22V310A)	**15/-**

AERIAL ARRAYS

Pending our production of complete rotatable arrays we can supply DURALUMIN TUBE for home construction. In light but rigid 8ft. 6in. lengths ⅜ in. outside diameter, 4/6 per length.

NOTE: CALLERS ONLY —REGRET NO MEANS OF DISPATCH.



AUTOMATIC KEY TYPE "RA"

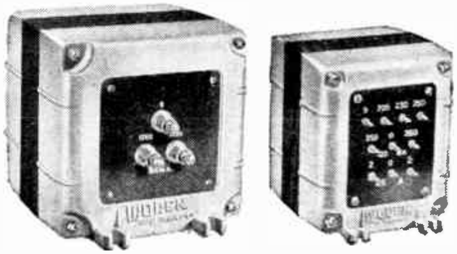
Heavy cast gunmetal base finished fine grey crackle, rubber feet, no desk fixing necessary. Incorporates completely balanced electrical action of improved design. Heavy tungsten contacts, adjustable from 10 to 50 WPM—a key for the really discriminating speed fiend. A shorting switch is incorporated in the base for CW/Phone operation. Key type "RA" **47/6**

TAPPED "BLEEDER" RESISTORS

Vitreous enamel wire-wound resistors, power type with **adjustable tapping clip.**

50-watt rating :

25,000 ohms ...	11/3
50,000 ohms ...	14/9



WODEN TRANSFORMERS

now available in full range from immediate stock, including Filament, all voltages of H.T., Modulation and Driver types. Input and Smoothing Chokes for all current ratings are included. These are the standardised LF Inductors made to match in appearance with grey cast metal end plates, and black laminations. Their use ensures a professional finish to your apparatus. Full list of types and prices available on application.

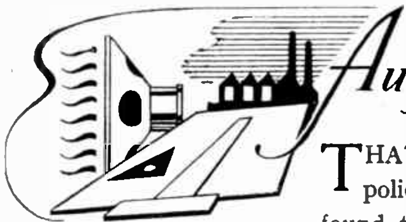
Second printing of our INTERIM CATALOGUE is held up through paper control, etc.—Our apologies to many hundreds eagerly waiting for it. As a temporary measure we are sending details of selected items such as are of interest to the home experimenter.

WRITE, CALL, OR TELEPHONE

14 SOHO STREET, LONDON, W.1.

TELEPHONE: GERRARD 2089

OFFICIAL BUSINESS HOURS : 9 a.m. to 5.30 p.m. SHOP HOURS : 9 a.m. to 5 p.m. (SAT. 9 a.m. to 1 p.m.)



Augury for TOMORROW....

THAT tomorrow must be taken care of today has always been Goodmans policy. Constantly thinking and planning ahead Goodmans inevitably found themselves leaders in the field of Sound Reproduction. As a result, during the past critical years Goodmans have been entrusted with many onerous tasks in the designing and production of Loudspeakers, Microphones, and Earphones. True to their policy Goodmans tested and sifted to build data which might serve in the days to come. Now Goodmans stand ready to give of their greatly enhanced knowledge to the no less onerous tasks of Peace.

The GOODMANS RANGE

Includes Loudspeakers from 2½ dia. (¼ watt output) to 18 in. cone models and Industrial Types up to 20 watts output.

The **TYPE T2/12.** Overall Dia. 12⅝ in. Voice Coil Impedance 15 ohms at 400 C.P.S. Power Handling Capacity 12 w. Peak A.C. on flat 4 ft. baffle (15 w. horn loaded). Flux. Density 13,000 gauss.

GOODMANS *Loudspeakers*

GOODMANS INDUSTRIES LTD · LANCELOT RD · WEMBLEY · MIDDX

PORTABLE BEAT FREQUENCY OSCILLATOR

BSR TYPE LO.50

0-600 CPS

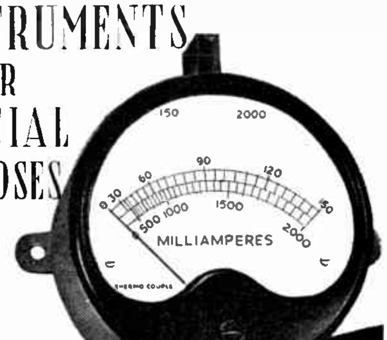
0-15000 CPS

BSR A PRODUCT of PRECISION

BIRMINGHAM SOUND REPRODUCERS LIMITED. OLD HILL, STAFFS.

M.W. 47

INSTRUMENTS FOR SPECIAL PURPOSES



HIGH-GRADE MODERN DESIGN.

SIFAM

ELECTRICAL INSTRUMENT COMPANY LIMITED

TORQUAY DEVON

BELLING-LEE AERIALS

(U.K. Reg'd Designs applied for.)

The illustration above shows the Belling-Lee Skytower Aerial—a 35 ft. lattice mast surmounted by an 18 ft. Skyrod.

Aerials are already in production. Many thousands have been sold, and set makers, in finalising arrangements, are discussing the possibility of riggers undertaking television aerial installations in and around London. Have *you* an aerial problem . . . of *any* description ?

SKYTOWER A 50 ft. vertical aerial suitable for relay undertakings, factories, laboratories, blocks of flats, offices, hotels, etc. *List No.* 574 **Price £90 : 0 : 0**

SKYROD Each kit complete with 12 ft. or 18 ft. vertical collector, matching transformers, screened downlead, available with pole clamps and lashings for chimney.

List No.	*Type of Mounting*	*Price*
355 CK	With clamps for mast	£7 : 2 : 6
355 LK	For chimney lashing	£8 : 8 : 0
370 LK	For mast and chimney lashing	£9 : 10 : 0*
392 CK	As 355 CK but with 18 ft. collector ... 120 ft. downlead	£11 : 5 : 0
392 LK	As 370 LK but with 18 ft. collector ... 120 ft. downlead	£14 : 0 : 0*

**Less mast, normally supplied by us—but at present not available.*

VIEWROD Television aerials with and without reflector, normally supplied with pole (when available) and all lashings. Kits from **£1 : 17 : 6**

WINROD Vertical aerial 8 ft. for use in flats, etc., or where access to roof is considered undesirable. To fix on window ledge, very versatile fixing arrangements. *List No.* L.581 **Price 18/6d.**

CAROD Highly polished stainless steel aerial for fixing to car, extendable rod. *List No.* 582 **Price £1 : 2 : 6**

AEROD Vertical aerial 6 ft. complete with heavy bakelite moulded insulator designed in conjunction with Office of Works and officially specified for use in prefabricated houses. *List No.* 573 **Price £3 : 19 : 0**

BELLING & LEE LTD
CAMBRIDGE ARTERIAL ROAD, ENFIELD, MIDDX

The illustration on the left is the Skyrod Aerial, List No. 370LK. Mast is normally supplied by us—but at present not available.

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD.

CALLERS to 169 FLEET STREET, E.C.4. *'Phone: Central 2833*

ALL POST ORDERS to 167 LOWER CLAPTON RD., E.5. *'Phone: Amherst 4723*

ALL GOODS NEW AND GUARANTEED. TERMS OF BUSINESS, CASH WITH ORDER, OR C.O.D. OVER £1

5-WATT AMPLIFIERS. AC/DC operation, 3 stages, high gain, 3 ohm output, **£8 8s.**

ALUMINIUM CHASSIS. Substantially made of bright aluminium, with four sides, 10in. × 8in. × 2½in., **7/-**; 12in. × 9in. × 2½in., **7/9**; 16in. × 8in. × 2½in., **8/6**; 20in. × 8in. × 2½in., **10/6.**

I.F. TRANSFORMERS. Iron core, litz wound, with or without flying lead, 460/465 K/c, **7/6** each.

PLUG-IN S.W. COILS. Four and six pin types now have Octal Spacing and will fit International Octal Valve Holders. Four-pin type (two windings). Six-pin type (three windings).

4 PIN Type	Range		6 PIN Type	Range	
04	9-15 m.	2/6	06	9-15 m.	2/6
04A	12-26 m.	2/6	06A	12-26 m.	2/6
04B	22-47 m.	2/6	06B	22-47m.	2/6
04C	41-94 m.	2/6	06C	41-94 m.	2/6
04D	76-170 m.	2/6	06D	76-170 m.	2/6
04E	150-350 m.	3/-		These Ranges are with	
04F	255-550 m.	3/-		.00016 Condenser.	
04G	490-1,000 m.	4/-			
04H	1,000-2,000 m.	4/-			

MIDGET COILS. Unscreened Type, size 1⅛in. × ⅞in., designed for I.F. O.F. 465 K/c. Available in the types Osc. H.F. Tran. Aerial and in the following bands, 12-35, 16-47, 34-100, 94-261, 200-557, 250-750, 700-2,000 metres. All types **2/3** each. Trimmers and Padders for all types, **8d.** to **1/9.** Also available, B.F.O. Coils, Aerial Filter, H.F. Filter. Same type and price as above.

YAXLEY TYPE SWITCHES. 2-pole 3-way 2-bank, **5/6**; 2-pole 6-way 2-bank, **5/6**; 2-pole 3-way 3-bank, **7/-**; 2-pole 6-way 3-bank, **7/-**. Any of the following types at **4/-** ea. 1-pole 8-way, 1-pole 11-way, 2-pole 3-way, 2-pole 5-way, 3-pole 3-way.

S/W VARIABLE CONDENSERS. All Brass "Polystyrene Insulation," extended spindle for ganging. Noiseless. 15 mmfd., **2/11**; 25 mmfd., **3/3**; 40 mmfd., **3/3**; 100 mmfd., **3/11**; 160 mmfd., **4/8**; 250 mmfd., **5/8.**

FULL VISION S/M DRIVES. Calibrated 16-47, 200-557 and 700-2,000 with station names, 8-1 Escutcheon, size, 7½in. × 4½in., **10/6.** Junior Model. Calibrated 200-557 and 700-2,000 and station names. Escutcheon size, 5in. × 4in., 8-1, **10/6.**

EPICYCLIC DRIVES. 8-1 reduction, **2/9.**

UTILITY MICRODIAL. Communication Type. Slow and Fast Motion Dual Knob and silver engraved, 6in. circular dial with hairline cursor 100-1 reduction. Fits entirely on front of panel, **8/6.**

AIR-DIELECTRIC TRIMMERS. Ceramic Base 5-35Pf, **1/6.**

MAINS DROPPER RESISTANCES. Variable Type, with sliding adjustment. 1,000 ohms, .3 amp., **5/6**; 800 ohms, .3 amp., **5/6.**

WIREWOUND RESISTANCES. 6 watt. Any value from 40 ohms to 20,000 ohms, **2/-.**

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTS are centre tapped.

Output	Price
175-0-175 v. 50 m/a. 6.3 v. 2-3 a. 5 v. 2 a.	25/-
175-0-175 v. 50 m/a. 4 v. 1 a 4 v. 2-3 a.	25/-
250-0-250 v. 60 m/a. 6.3 v. 2-3 a. 5 v. 2 a.	25/-
250-0-250 v. 60 m/a. 4 v. 1-2 a. 4 v. 3-5 a.	25/-
300-0-300 v. 60 m/a. 6.3 v. 2-3 a. 5 v. 2 a.	25/-
300-0-300 v. 60 m/a. 4 v. 2-3 a. 4 v. 3-5 a. 4 v. 1-2 a.	25/-
350-0-350 v. 100 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a.	29/-
350-0-350 v. 100 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-5 a.	29/-
350-0-350 v. 150 m/a. 4 v. 1-2 a. 4 v. 2-3 a. 4 v. 3-6 a.	36/-
350-0-350 v. 150 m/a. 4 v. 2-3 a. 4 v. 3-6 a. 4 v. 1-2 a. 4 v. 1-2 a.	39/-
350-0-350 v. 150 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 2-3 a.	36/-
425-0-425 v. 200 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-6 a.	47/-
425-0-425 v. 200 m/a. 6.3 v. 2-3 a. 6.3 v. 3-5 a. 5 v. 2-3 a.	47/-
500-0-500 v. 150 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-5 a.	47/-
500-0-500 v. 150 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 3-5 a.	50/-
500-0-500 v. 250 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 3-5 a.	65/-

PLAYING DESKS. A few only available. Consist of an Electrical Gramophone Motor with automatic stop and speed regulator, a quality magnetic Pick-up mounted on a strong metal frame. Price complete **£8 8s.**

MIDGET RADIO KITS. Complete with drilled chassis, valves and loud speaker, only cabinet required, medium and long wave T.R.F., size 10 × 6 × 6, 4 valves, inc. rect., tone control, AC/DC operation, 200/250 v. Circuit and constructional details supplied. Price, including tax, **£6 17s. 6d.** Cabinet, if required, **25/-** extra.

METER KITS. Consist of a 50 microamp (20,000 ohms per volt) meter size 4½ × 4½. Calibrated volts, milliamps, ohms, complete with Multipliers for 5 to 1,000 volts in six ranges for DC. 10 to 1,000 volts in 5 ranges for AC two six-way switches, a full-wave metal Rectifier, a quantity of resistance wire to construct any current shunt required by the "Trial and Error" method. Price **£6 10s.**

SUPERHET TUNING KIT. Nine midget coils to cover 16-47 200-557, 700-2,000 metres for H.F. Aerial and Osc. All padders and trimmers. Pair 465 K/c Iron-cored I.F. Trans. 3-gang Condenser with calibrated S/M Drive, 3-bank wave-change Switch. Price **£3 15s.**

SUPER QUALITY AC/DC AMPLIFIERS. 12 watts output, contained in steel case. Output Transformer matches any speaker 2-30 ohms. Push-Pull Output. Complete with Electric Record Playing Desk with Pick-up. Price **£18 18s.**

A pair of suitable Loudspeakers can be supplied, Goodmans 10in. P.M. Type at **47/6** each. A suitable Transverse Current Microphone with Transformer at **£3 15s.**

BATTERY CHARGER KIT. Consists of a Metal Rectifier, Mains Transformer, and Variable Resistance to charge a 6 or 12 volt battery at four amps. Price **£4.** Senior Model, output eight amps, **£6.**

ENERGISED SPEAKERS. 8in. diameter, 7,500 ohm field. Require 20-30 m/a. 3 ohm V.C. handle, 4 watts, **10/-** each.

.0005 CONDENSERS. Ceramic insulation. "Bar" Type. Single gang, **5/-.** Twin gang, **7/6**; three gang, **10/-**; four gang, **10/-.**

GRAMOPHONE MOTORS. Double spring, complete with handle and speed regulator, no turntable. Price **30/-** each.

FOUNDATION AMPLIFIER KIT. Consists of 16 × 8in. chassis, 2 PX4 valves, 350 v. 150 m/a. Trans., 1 MH41 valve, 2 8 mfd. 500 v.w. oil-filled condensers, 1 Rectifying Valve, 1 Output Transformer to match any voice coil between 2 and 30 ohms, 1 Smoothing Choke. Price **£6 6s.**

MIDGET I.F. TRANSFORMERS. 465 K/c. Permeability tuned, size 1½ × 1 × 1in. Price **7/6** each.

CERAMIC VALVE HOLDERS. 5-pin U.X., 4-pin U.X., **1/-** each. International Octal, **2/-** each.

BUTTERFLY CONDENSERS. Split Stator 50 + 50 pf. variables. All soldered joints, ceramic end plates. Price **3/6** each.

MOVING COIL METERS. 30-0-30 amps., 2in. diam., **19/6.**

P.M. SPEAKERS. 5in., **21/6**; 6½in., **22/6**; 8in., **24/-**; 10in. 6 watt 15 ohm, **47/6**; 8in. 15 ohms, 15 watts when horn loaded, **55/-**; 12in. 15 ohms 15 watts, a high fidelity job, **£6 15s.**

OUTPUT TRANSFORMERS. A super production. By means of ingenious series-parallel arrangement all windings are used at all times. Match any tube, single or push-pull to any voice coil 2-30 ohms. 7 watts, **22/6**; 15 watt, **30/-**; 30 watt, **49/6**; 60 watt, **59/6.**

ENAMELLED COPPER WIRE

	8 oz.	16 oz.
16g.	1/11	3/6
18g.	1/11	3/6
20g.	2/-	3/9
22g.	2/2	3/10
24g.	2/2	3/10
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28g.	2/6	4/2
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36g.	3/1	5/6
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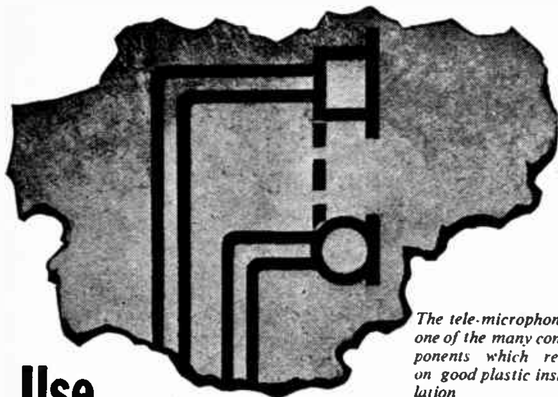

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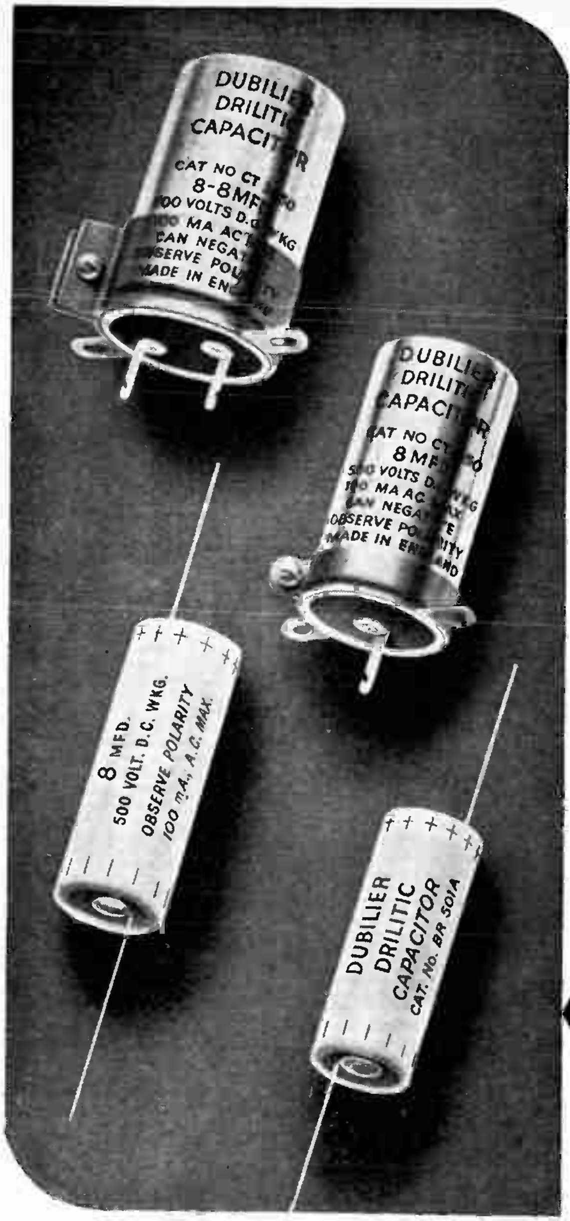

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16	500	1	2	110	CT1650	6s. 6d.
8-8	500-500	$1\frac{3}{8}$	2	*100-100	CT8850	6s. 6d.
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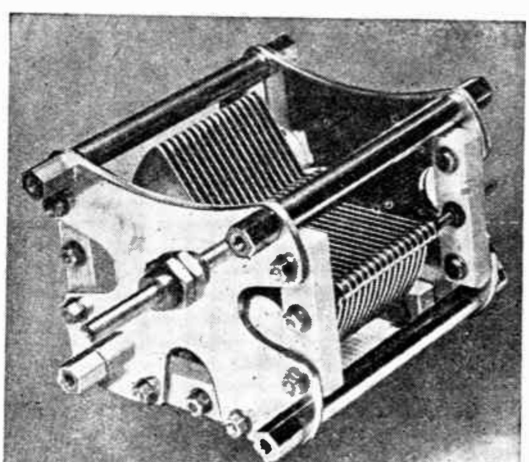

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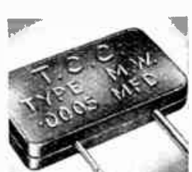
TYPE C.M.20



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Radio and Electronics

35th YEAR OF PUBLICATION

MARCH 1946

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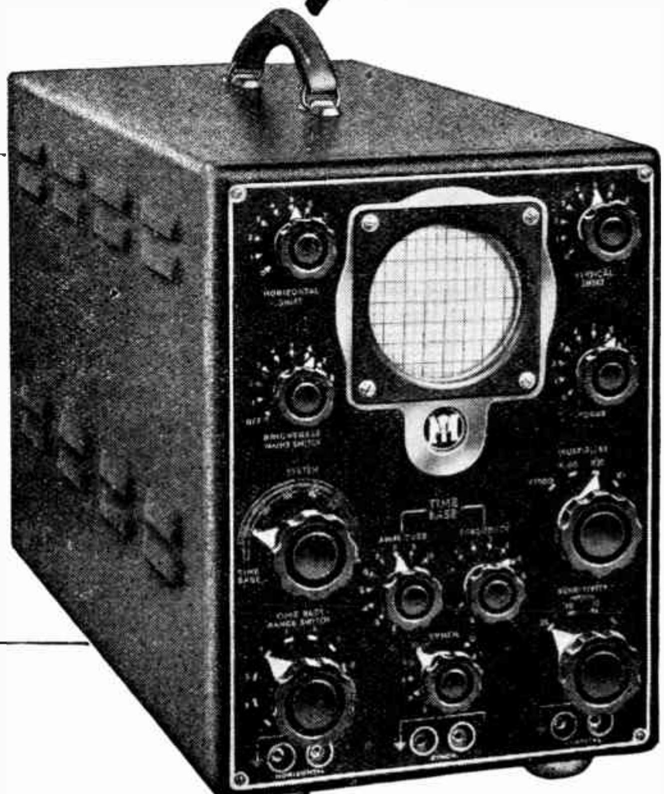

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(134B)

Wireless World

Radio and Electronics

Vol. LII. No. 3 MARCH 1946 Price 1s. 6d.

Monthly Commentary

Lost Prestige

GRAVE harm to the prestige of British radio has been done by ill-conceived and ill-executed arrangements for releasing to the Press information on wartime developments. When so many Government departments are concerned, it is impossible to pick out any particular offender to stand all the blame, but, on the face of it, a body with the cumbrous title of "Committee on Post-war Publication of Results of Wartime Scientific Research," must be considered as largely responsible. The C.P.-W.P.R.W.-T.S.R., under the chairmanship of Prof. A. V. Hill, is supposed to co-ordinate broad policy on publication between British Commonwealth Government departments and with U.S.A. At a lower level, the Radio Board seems to be responsible for implementing policy on the publication of radio matters.

Presumably with the approval of these bodies, the Government departments, including the research organisations, are still withholding from publication in British technical journals detailed information on wartime radio developments. "Security" is sometimes invoked as a reason, though that blessed wartime word can no longer apply to devices and processes about which information has been divulged during the war to thousands who owe no allegiance to the British Crown. Another excuse is that the information is being withheld in order that it may be disclosed later, in papers to be read before learned societies or professional institutions. Under normal conditions one could have little quarrel with this principle, but, as all wartime research has been done directly or indirectly at the public expense, the public has the right to demand quick release if that is in its interest.

Most definitely, the delays that have occurred are not in the public interest. During the past three or four months many devices of British origin, still "secret" here—the cavity magnetron, the reflex klystron, the crystal valve, for example—have been described in detail in American journals. The descriptions have subsequently been repeated in the technical Press of the world with, naturally, little emphasis on their country of origin. Consequently, British radio has lost a golden opportunity to acquire the world-wide prestige that it has earned.

We sympathise with the desire of individual research workers and of development departments and similar organisations to establish priority in accepted form for their great wartime contributions. But they need have had little fear that their thunder would have been stolen by prior publication in the technical Press of this country, which is still so severely restricted by paper rationing that it is quite unable to deal with abstruse matters in the prodigal style of the typical scientific "paper."

A third excuse—that information is being withheld until inventors can obtain patent protection—seems to be no longer plausible. Prior publication in foreign journals has surely invalidated any claims for patents on the devices described. When the "official" disclosures eventually appear, they will have a "non-intrusive" circulation, and, worse still, will deal with matters that are already stale news to most of the world. The lingering shadow of "security," plus delays inherent in reconciling conflicting claims for precedence in matters of development, have brought about a state of affairs that cannot fail to have unfavourable repercussions on the export trade.

* * *

The B.B.C.: A Reminder

WE must not lose sight of the fact that the B.B.C. Charter expires at the end of the year. Interest in this subject ran high until recently, but now, faced with many other and perhaps wider issues, the public tends to forget that, in a few months' time, decisions must be taken that must have a profound and lasting effect, for good or evil, on British radio. Although *Wireless World* does not expect or wish for any drastic change in the fundamental nature of the existing system, we think that the possibilities of remedying its major defects should be fully explored before legislation is rushed through. Time is short, and those with proposals to make should have their case ready.

VENTILATION PROBLEMS

Preventing Overheating and Frequency Drift

By W. TUSTING

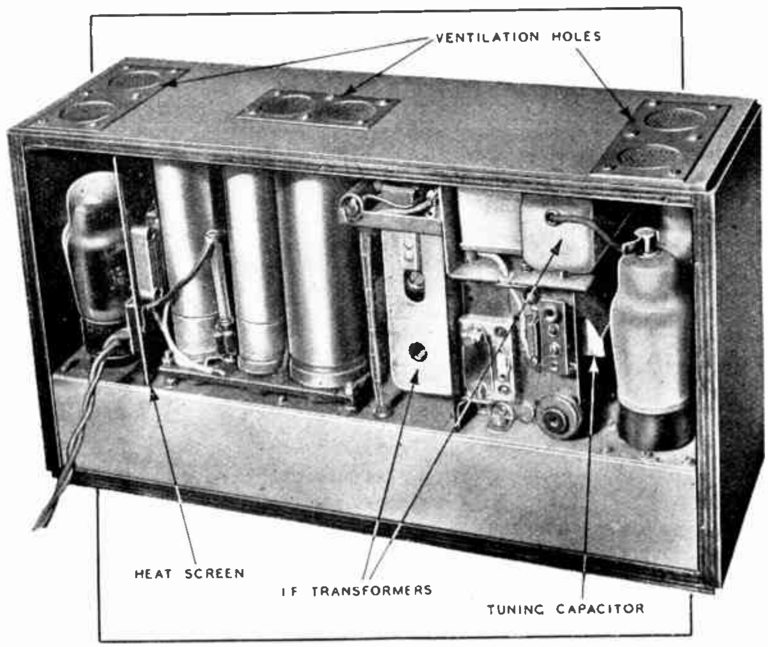
THE avoidance of an excessive temperature rise in wireless equipment is not always given the attention which it deserves in the early stages of design. The difficulties involved in disposing of the heat generated in valves and resistors are all too often underestimated, with the result that the designer finds himself faced with serious difficulty at a late stage of the development.

The proper time to think about heat dissipation is when the general mechanical design of the equipment is first considered. The electrical design is then largely finished; that is, the circuit has been decided on and circuit values have been chosen. At this stage the types of valves and their operating conditions have also been settled, so that the power dissipated as heat and the components in which it will appear are known.

The electrical requirements, the ease of fabrication, the accessibility for maintenance and the appearance of the finished product usually dictate the mechanical form of the apparatus to a large extent. It is only at this stage that the problem of removing the heat generated within the equipment to the outside air as quickly and freely as possible can be satisfactorily tackled.

This problem of heat dissipation has been recognised in transmitters from the earliest days of wireless, but it is only comparatively recently that it has received any serious attention in receivers. This is rather surprising when it is remembered that practically the whole of the power consumption of a set is dissipated as heat within it, and that the consumption is around 60 watts for small sets up to about 200 watts for really large ones.

Two bad effects result from this internally generated heat. In the first place, the life of certain components, especially capacitors, may be materially shortened by a high temperature. Secondly, changes of temperature, which are at their greatest when the maximum temperature is high, affect the resonance frequency of the oscillator circuit and so cause tuning drift.



This rear view of a particularly cramped AC/DC set shows the outlet ventilation holes in the top. The two holes at the left are over the output and rectifier valves and those at the right are over the frequency-changer and IF valves. The middle holes are above the heater-circuit voltage-dropping resistor. The edge of a heat screen can be seen between the rectifier and the electrolytic capacitors.

Oscillator Drift

From the point of view of the ordinary user of receiving equipment tuning drift is the more noticeable effect. The rising temperature causes the trouble by altering the inductance and capacitance of the oscillator, and so, its frequency. The components comprising the oscillator circuit all have electrical values which depend in some degree on temperature. Usually, the temperature coefficient is positive, which means that the inductance and capacitance both increase with a rising temperature; the oscillator frequency consequently falls.

When a set is switched on, its parts are at the ambient temperature of the room and the oscillator functions at a certain frequency. As time goes on and heat is generated continuously the internal temperature rises—at first quickly and then more slowly as the equilibrium temperature is approached. The oscillator frequency falls, and if the set is a selective one, it requires re-tuning.

If the set can lose heat only slowly, the internal temperature will become very high and it will be a long time before equilibrium is reached. This means that oscillator drift will not only be large but will continue for a long time. In the early days of the superheterodyne a drift of 10 kc/s or more was not uncommon on the medium waveband, and it occurred over a period of fifteen to thirty minutes. During this time the set required periodical re-tuning.

As the drift tends to be a constant percentage of the frequency, it is always more apparent at high frequencies than at low. Thus, a drift of 10 kc/s at 1 Mc/s, becomes about 200 kc/s at 20 Mc/s! The switching-on drift should not exceed a small fraction of the band-width of the IF amplifier at even the highest frequency. The band-width of a set intended for broadcast reception might well be 8 kc/s, and the drift should certainly not exceed 2 kc/s and would preferably be considerably lower. At 20 Mc/s (15 metres), the oscillator stability must then be 1 part in 10,000. This is probably impossible to achieve without taking great care in design.

Even perfect cooling of the set, so that it never departed from the ambient temperature, would not give perfect frequency stability. It would completely eliminate the short-term drift when the set is switched on, but as the ambient temperature changes with the weather and the seasons, there would still be a long-term alteration. This would be important only in sets with pre-set or automatic tuning devices, but in those it might well be very important.

Temperature Compensation

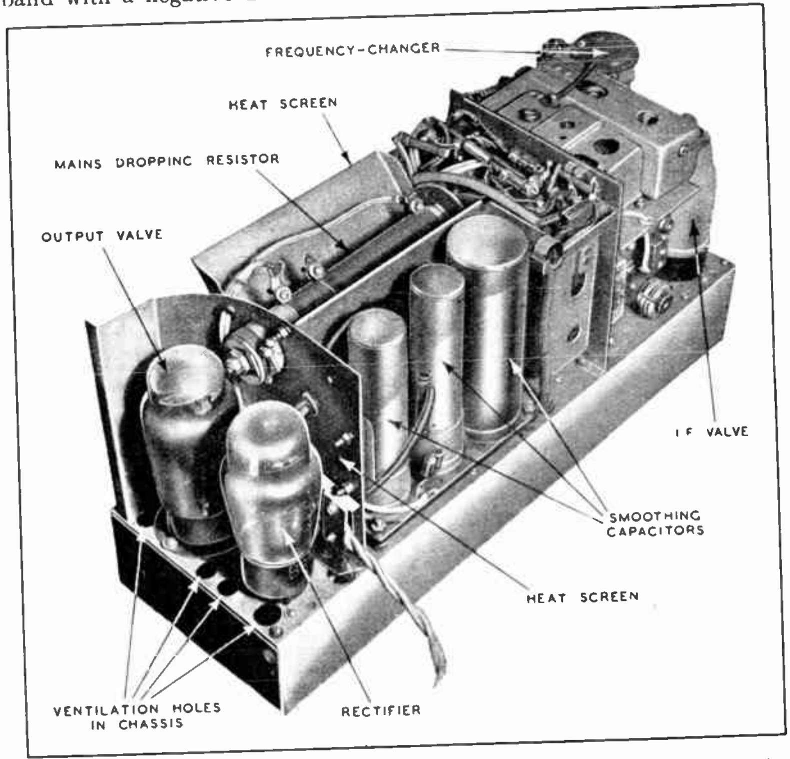
It can reasonably be assumed that a broadcast set will not normally be used at a lower temperature than that of a living room. One might well take the minimum ambient temperature as 50° F to allow a little in hand. The maximum in this country is unlikely to exceed 90° F, and, in fact, will rarely be greater than 80° F.

The maximum normal temperature range is therefore only about 30° F, or 16.5° C. This is very small in comparison with the changes encountered in Service equipment, where the temperature may be −40° C under Arctic or high-altitude aircraft conditions and 60° C under a desert sun. That is a range of 100° C.

The broadcast problem is relatively easy of solution and for the small normal changes practically perfect compensation can be obtained by using capacitors having a negative temperature coefficient of capacitance. This method of balancing the positive coefficient of one component by the negative of another can usually be perfect only at one frequency, and in general there is a positive tendency to have a positive oscillator drift at one end of a waveband with a negative drift at the other and zero drift at the middle of the band.

Temperature compensation need not be confined to correcting for the effect of changes in the ambient temperature, but can also compensate for the internal rise of temperature and so reduce the short-term switching-on drift. It is, in fact, widely used for this purpose, but it is clear that as no compensation of this nature is ever quite perfect, it is wise to keep the range of temperatures over which it is required to function as small as possible.

This means that temperature compensation should not be regarded as the solution of heating problems. The right outlook is to regard it only as the finishing touch to compensate for unavoidable temperature changes. Every effort should be made to get rid of the unwanted heat and so limit the rise above the ambient temperature and then to apply compensation to prevent this unavoidable rise and the unavoidable changes of ambient temperature from causing appreciable drift.



This view of the set out of its case clearly shows the heat screens erected around the output and rectifier valves. There is also a screen round the mains-dropping resistor and this has inlet holes for air immediately beneath the resistor.

It may well be asked at this stage, "How does one get rid of heat?" The answer is by convection, conduction and radiation. The heat is generated in valves and resistances—sometimes also in appreciable quantity in transformers and chokes (!)—and the surrounding air is heated by its contact with them. This air gives up some of its heat to the cabinet, which, in turn, loses it to the surrounding space by radiation and convection.

The rate at which heat is lost through the cabinet depends chiefly on the material used in its

Ventilation Problems—

construction. Wood and plastics are poor conductors of heat and metal is a good one. Other things being equal, therefore, a metal case will lead to a lower internal temperature than one made of a poor heat conductor.

The radiation loss of heat depends on the colour of the case and is highest for a matt black finish and lowest for a bright polished surface. For maximum cooling in this way, therefore, the cabinet should be made of metal with a dull black finish both inside and outside.

Ventilation

In general, however, cooling through the cabinet is inadequate and the need for a good external appearance often prohibits the dull black finish. It is usual, therefore, to provide ventilation for the interior. The object of this is to remove the warm air from the inside as quickly as possible and to replace it by cooler air from the outside. This can be done naturally with the aid of suitably placed openings in the case, for on absorbing heat from the components the air expands. It thus tends to rise and escape from openings at the top of the case and to be replaced by cooler air entering at the bottom.

The openings provided for ventilation are often singularly ill-adapted to this purpose. A common arrangement is the provision of a number of louvres at the back. While some warm air may escape from the upper ones and some cool air enter at the lower, there is no guarantee that the air flow is near the hot components.

If ventilation is to be effective it is essential that there should be an outlet right at the top and another at the extreme bottom with an unrestricted air path between them and that the components generating the heat should be in this air path. What this means in practice can best be seen by considering a typical receiver constructed in the conventional way on a chassis.

The major part of the heat is generated in the rectifier and output valves, but the heater power of some RF pentodes and frequency-changers is by no means negligible. It is important to keep the heat away from capacitors to ensure a long life and from the oscillator components to avoid frequency drift.

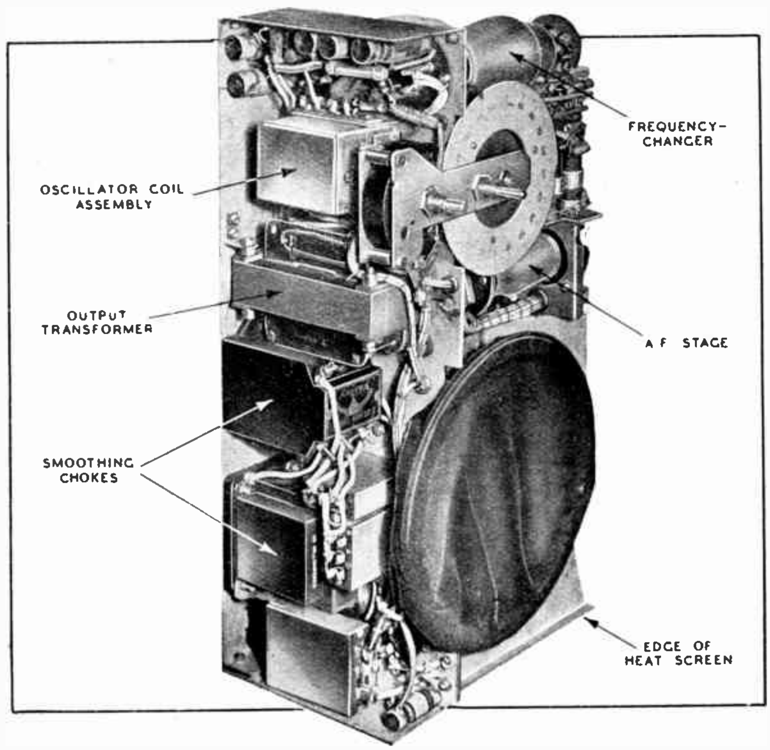
As heat tends to rise, the top of the case will be warmer than the bottom, and this will be especially so if there is adequate ventilation, for the cool air will enter at the bottom. The first essential, therefore, is to place capacitors and frequency-changer parts as near the bottom as possible. This means in the first place mounting them under the chassis, and in the second place avoiding placing any heat generating parts, such as resistors dissipating any appreciable power, under the chassis.

It is not usually difficult to arrange the oscillator coil assembly and its associated padding capacitors beneath the chassis, for this position is convenient for wiring to the frequency-changer. Coupling and by-pass capacitors also fall naturally into position here. Smoothing capacitors, being physically large, are more difficult, and it will often be necessary to mount them above the chassis and protect them in other ways.

The resistors which it is natural to put below the chassis are chiefly ones dissipating only low power, such as grid leaks, AVC filter resistors, RC coupling resistors, and small bias resistors. There is usually little harm in so placing them for the power in each resistor is on the average no more than 1/10th watt, and rarely exceeds ¼ watt for any individual component.

Power dissipation is greater in the output stage bias resistor, screen-feed potentiometers, etc., and there is rarely little difficulty in placing them above the chassis.

In laying out the above-chassis components it is often advisable



The oscillator coil and padding capacitors are mounted beneath the chassis in the coolest place. In spite of the crowded appearance, the components offer little obstruction to the flow of air at important points, for the inlet holes in the bottom of the cabinet are placed so as to bring the air in at points giving a clear path between parts.

to collect the hot ones together in a group—or in two or three groups, well spaced from components which must be kept cool, such as smoothing and tuning capacitors. Holes of large area should be placed in the cabinet immediately above and below these hot groups *and in the intervening chassis*. This last is very important, for the bottom entry holes will do little good if the chassis offers a barrier to the air flow.

Ventilation will usually be adequate if there is a 1in. hole above each hot valve. Such a hole has an area of nearly 0.8 sq. in., but as it must normally be covered with gauze to prevent the entry of small objects, its actual area will not be much more than one-half of this, or, say, 0.5 sq. in. The bottom hole does not need to be so large, because a gauze cover is unnecessary, and a diameter of around ⅜in. is adequate. Holes of total area not less than this should be placed around the valveholder to permit an unrestricted flow of air. Some 6 to 8 holes of ⅜in. diameter are suitable, but it is often more convenient to use a larger number of smaller holes.

Having provided this ventilation it is advisable to do something to prevent the heat spreading sideways from the hot components and to make sure that it takes the direct path to the outlet. This is particularly advisable in cases where components have to be cramped together. This is easily done by erecting heat screens around the hot parts and they can often be combined with electrical screens. The screens should run from the chassis to the top of the cabinet and fit fairly well. They should be of polished metal since it is undesirable for them to absorb or radiate heat. In extreme cases such a screen can be a sandwich of two sheets of polished metal with a non-conductor of heat between them—asbestos sheet, say—but this is rarely necessary.

Chimneys

Individual valves on the RF side are easily taken care of by turning the valve screens into chimneys. The valve screen should be tall enough for its top only just to clear the cabinet, and the top of the screen should be open. If a metal cover is needed for screening this can be provided by gauze—the usually solid top to the can is wrong. The can should not have holes in its side, but there should be holes in the chassis around the valveholder and inside the can. There must be a hole in the cabinet above the valve screen and, of course, one in the bottom under the valveholder. With a polished screen it will be found that relatively little heat escapes, and the current of air through the chimney keeps the valve itself quite reasonably cool.

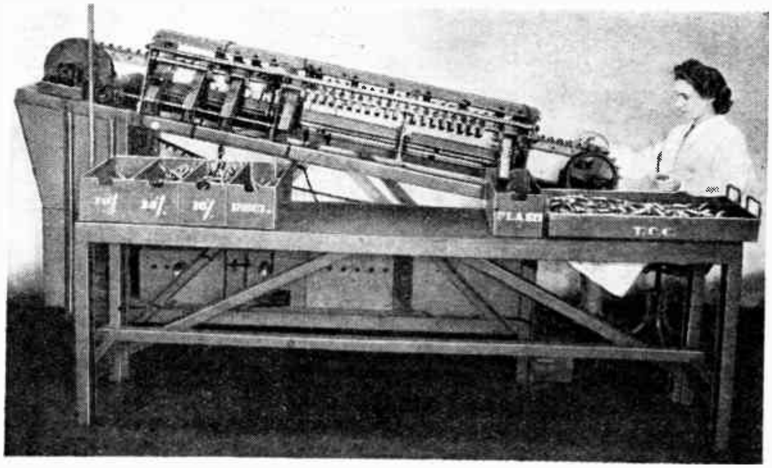
By attention to detail on these lines, it is possible to build quite a compact set which remains unusually cool and suffers but little from drift. The photographs illustrating this article show how the points discussed have been put into practice in a particular case.

The greatest difficulty usually lies in so disguising the exit holes that the appearance of the set does not offend. In the set illustrated no attempt at disguise was made and the holes were covered with gauze held down by brass plates. Incidentally, these plates become too hot to touch during operation!

In the case of a radio gramophone the gramophone equipment often prevents ventilation holes being placed in the top, but the set itself usually occupies only a small part of the total cabinet space. It is then easy to mount the set at the bottom of the cabinet and to arrange a cowling over it to collect the hot air and lead it out at the back just below the motor board. Alternatively, the set itself can be provided with its own light case and tubing fitted to the outlet holes in it in order to carry the hot air to the top-back of the main cabinet.

One further point should be mentioned. Having arranged good ventilation and so obtained adequate cooling, care should be taken to see that the set is so placed in the room that it does not absorb heat unnecessarily from other objects. The very factors which act to assist in the removal of heat from the set also make it particularly liable to gain heat from outside. It will not actually absorb external heat unless the external temperature is higher than the internal, but it will most definitely retard the loss of heat from the set. It is, therefore, more than ever unwise to place the set on a radiator or other heating unit!

AUTOMATIC CAPACITOR TESTER



A fool-proof, labour-saving, electro-mechanical device developed and manufactured by the Telegraph Condenser Company for automatically testing and grading tubular paper capacitors. Volts are applied and failures ejected at the first test; survivors are then given an insulation test and, if up to specification, graded, in three further tests, to capacitance limits of ± 20%, 15% or 10%.

NEGATIVE FEEDBACK

2. *Its Effect on Optimum Load and on Distortion*

By "CATHODE RAY"

IN the first part of this article we got quite used to thinking of the load impedance of a valve in relation to the fictitious valve resistance, r'_a (rather than r_a), and are all set for falling heavily into a trap. Authorities have explained in this journal and elsewhere that the optimum load impedance is related to the valve anode resistance, being equal to it, or twice as much, or some other ratio; but at all events, as the valve resistance appears to the load to be reduced by feedback from r_a to r'_a, one might reasonably expect the optimum load impedance to be reduced in the same proportion. What more natural than to base it on r'_a?

This is where it is essential to adopt a strictly Joadian attitude and insist on knowing what is meant by optimum load impedance. One man's optimum is another man's . . . well!

One sort of optimum load is the impedance — assume it is resistance — that gives the greatest power output for a given voltage input. It is a general law, which can be proved to apply to a valve, that in such cases the optimum load is equal to the resistance of the source. If the input is assumed to be the total signal voltage to the grid (v_i), the source for this purpose is undoubtedly r'_a when feedback is in use. To take the extreme case of the cathode follower, this leads to an optimum load of only a few hundred ohms at most. As the current that can be passed through the valve is strictly limited, the available power is clearly going to be very small, even at its maximum. The reason for this unsatisfactory situation is our definition, which stipulates fixed input voltage. Unless the load resistance is so small as to reduce substantially the voltage fed back, very little of the gross input voltage is available for driving the valve. If, on the other hand, one decides it is the net input voltage, v_{gc}, that is fixed, the feedback does not enter into the problem at all, and the load resistance for the greatest output is r_a.

The input voltage is seldom the real bottleneck, however, generally the limiting factor is the amount of distortion that the listener (or other consumer) can stand when the input is increased. A more sensible sort of optimum load, then, is that which gets the greatest power when the input is increased to the point at which a specified proportion of distortion is caused. We know, of course, that feedback if properly contrived reduces distortion; but it is not at all obvious how, if at all, its use affects the optimum load resistance as just defined. There are two ways of finding the optimum, with or without feedback; by experiment, or by drawing load lines on the valve characteristic curve sheet until the one which appears to give the best results is found. We are going to try both these ways, and as a preliminary to the latter one it may be necessary to explain how valve-with-feedback curves are derived from the valve-alone sort.

Fig. 4 displays (in unbroken lines) a set of anode-current/anode-voltage curves for a typical output tetrode. The makers' working point, 300 volts 85 milliamps, is marked with an o, and is on the "$V_g = -15$" line, which means that the negative grid bias is 15 volts. The recommended load, 2,200 ohms, is represented by a line AB drawn at such a slope that if produced to cut the V_a and I_a scales their ratio would, by Ohm's Law, be 2,200. The valve curves themselves for the most part slope very gradually, indicating a very high resistance r_a. Equal changes of grid voltage (represented by the spacing of the curves) result in unequal changes of anode current and anode voltage; which means distortion. The object of the game is to draw through o a line which represents the greatest output power without too much distortion.

Suppose the input swings 15 volts each way. This is represented by the distance AB. The output power is given by the peak-to-peak anode voltage multiplied by the peak-to-peak anode current divided by 8. From A to B is 385 volts and 175 milliamps; so the output power is 8.4 watts. Quite an impressive output, but a dreadful amount of distortion — the output voltage, starting from rest at 300, swings *down* to 60 (240 volts) and *up* to only 445 (145 volts)! The curves are so unequally spaced that even at a much smaller volume, and along any load-line that can be chosen, distortion is appreciable.

Now to put in the "with-feedback" curves. A different set of them is needed for every degree of feedback used, so one must first decide how much to use. For damping purposes, 1,000 ohms r'_a would probably be about right for 2,200 ohms load. In this valve, r_a is about 50,000 ohms and μ is 300, so:

$$1{,}000 = \frac{50{,}000}{1 + 300B}$$

From which B works out to about 1/6. Call it 1/5 to be on the safe side and to make the calculations easier. The new curves can be called V_i curves, because they show the input voltages; and the method of putting them in is to suppose for the time being that the V_a scale is multiplied by B—one fifth in this case—making a BV_a scale. For convenience, this has been marked along the top of the diagram. Start, say, with the curve for $V_i = -10$. It cuts the $V_g = 0$ curve at the point where $BV_a = 10$, which is point C. Other points can be marked on the other V_g curves, reducing BV_a in each case by the same amount as V_g decreases. For example, the point on the $V_g = -5$ curve must be 5 on the BV_a scale; on $V_g = -10$ it must be 0 on the BV_a scale — and that is as far as the $V_i = -10$ curve (shown dotted) can go. Now

Negative Feedback—
start the $V_i = -20$ curve, at $BV_a = 20$ on the $V_g = 0$ curve, and move 5 volts to the left on the BV_a scale for every 5 volts more negative on the V_g curves. It can be done very quickly when one gets the idea. The key is that wherever a V_i curve cuts the $V_g = 0$ curve the number on the V_i curve must always agree with the BV_a scale.

The resulting dotted curves slope much more steeply than the original ones, indicating that r'_a is much lower than r_a. They are also much more evenly spaced than the V_g curves, so now almost any load line is acceptable as regards distortion and one is free to concentrate on sloping it so as to get the maximum output, within the limits of grid current at one end and anode current cut-off at the other. It generally turns out that with a tetrode or pentode there is not much advantage in departing from the normal load resistance on account of feedback. If one sticks to the same R_L, the main result is that the same output is obtainable with far less distortion, or, for the same distortion, far less output is obtainable without feedback. Actually, in our example a load of 3,200 ohms appears to raise the maximum output slightly (to about 9½ watts). The input swing is measured by the V_i figures at the ends of the load line, and is, of course, much greater because of feedback (65 volts peak each side of -75). But as regards grid bias *the old V_g figures still apply* and the curve $V_g = 0$ is still the no-grid-current limit, on the left-hand side. Another detail; we have been making the load line turn about the point o because we have been assuming — I have, anyway — that the load is transformer-coupled so that there is no DC voltage drop in the load. If the load were a resistance directly in the anode circuit, the load line would have to pass through the point representing the HT voltage at zero anode current.

I haven't shown a sample of feedback curves for a triode, because feedback is seldom applied to triodes, the reasons being that they are pretty good already as regards freedom from distortion, and the input required tends to become excessive. But Fig. 5 shows some experimental results for a small output triode. A 400 c/s signal was used, and the load resistance—fed through a large condenser to cut out the DC—was varied, keeping the 2nd harmonic distortion at 5 per cent.

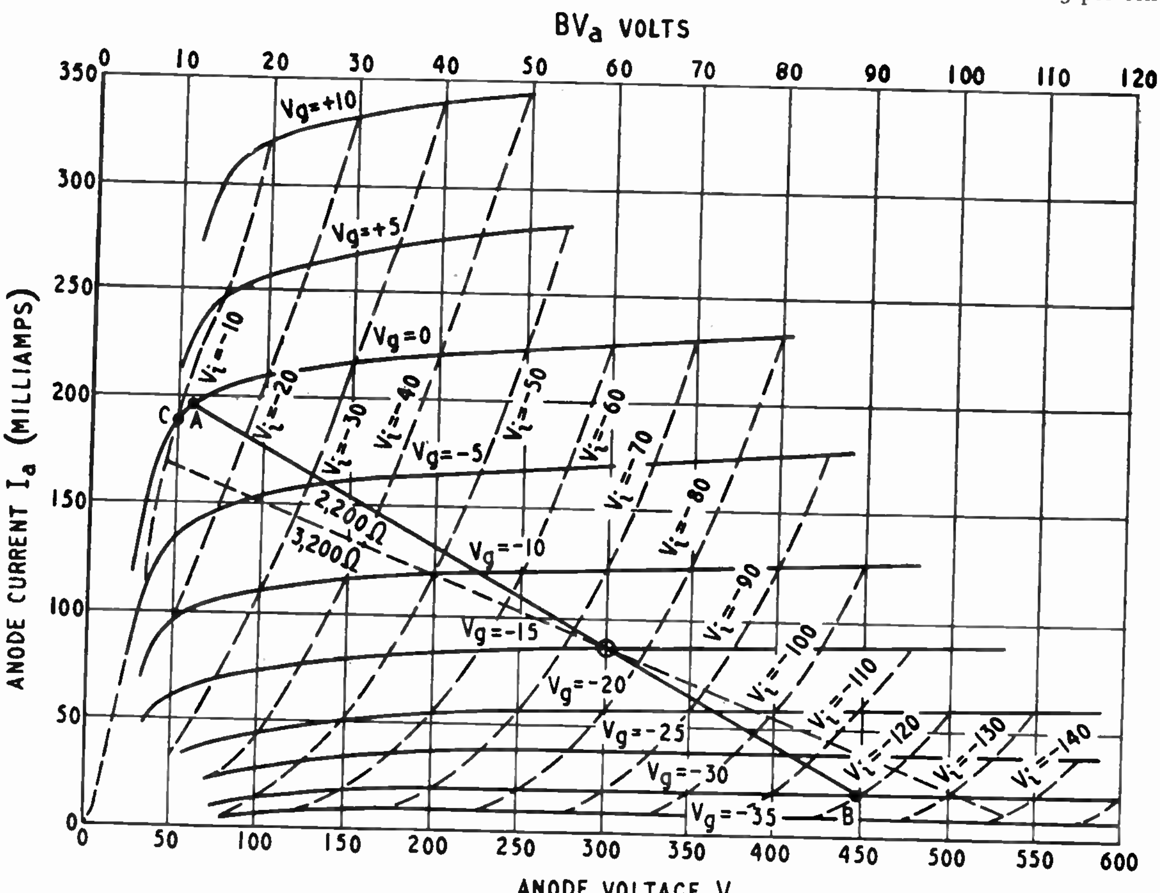


Fig. 4—The full-line characteristic curves are those of a typical output tetrode. With 20 per cent feedback, this valve performs as if its characteristics were those represented by the dotted line curves, which are derived from the others as explained. The straight sloping lines represent loads of different resistance.

Negative Feedback—

every time. As you see, without feedback this distortion limit kept the output remarkably low (the characteristics were unusually curved for a triode). With 100 per cent. feedback the curves were straightened out so thoroughly that the output could be

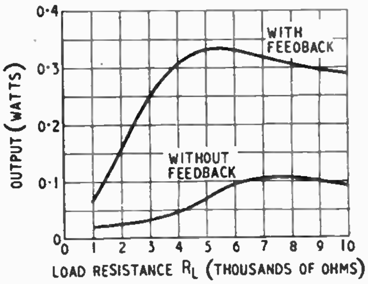


Fig. 5.—Results of an experiment on a small output triode, showing how the output — limited to 5 per cent. harmonic distortion — varies with load resistance.

raised threefold, until it was limited by grid current. The optimum load was reduced by feedback—from 7,500 to 5,400 ohms—but, of course, nothing like as much as r'_a. The output with feedback was very nearly as much at 5,400 ohms as at the optimum, 7,500.

Fig. 6 shows similar results for a small output pentode. Again, feedback resulted in a slight reduction in optimum R_L, but the difference was not very important, and in this case was difficult to judge accurately because of the distortion being a mixture of 2nd and 3rd harmonics in varying proportions. (As I have often emphasised, the harmonics are not themselves the really important part of the distortion, but are a convenient rough measure of the badness of the distortion.)

By the way, the impression is sometimes given that you can use or misuse the valves anyhow, grossly overload them, and so on—negative feedback will reduce the resulting distortion in the ratio $(1 + AB)$ to 1. And a mathematical "proof" of the latter statement may be submitted. It is true that feedback irons out the curves, but it can't make them continue on the negative side of the zero anode current line. So the current cuts off all the more suddenly, and when distortion begins it is bad, whereas without feedback its onset is more gradual. When an amplifier with feedback is good it is very, very good, but when it's overdriven it's horrid.

When I was dealing with the cathode follower (November, 1945) I pointed out that if a tetrode or pentode is used it automatically ceases to be such and reverts to triode status, because the screen and anode are unavoidably "commoned." There is an alternative way of using 100 per cent. feedback, while retaining the power efficiency of the multi-grid valve, and avoiding difficulties connected with grid bias and cathode insulation. Fig. 7 shows how. It is the essence of the circuit used for drawing Figs. 5 and 6, and is a practical alternative to the cathode follower output stage for loudspeakers, advocated by some writers. The only difference between it and a perfectly normal amplifier is that the input is from grid to anode instead of grid to earth.

The use of 100 per cent. feedback like this, or even much less as in Fig. 4, demands a much increased input signal, and if it becomes badly distorted in the effort there is not much, use following it by a beautifully distortionless output stage. That is the chief argument for feeding

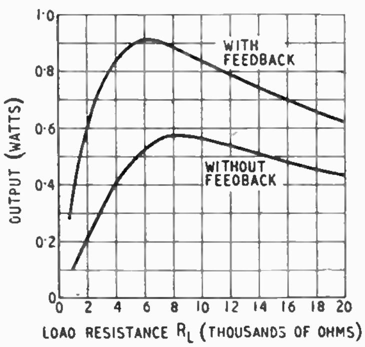


Fig. 6—Similar to Fig. 5, but using a small pentode.

back over two or even three stages. And a very sound argument it is; but it needs to be backed up by very sound practice, because the more valves and couplings are included in the feedback loop the greater the chance that at some frequency (which may be right outside the working range) the total phase shift may cause the feedback to become positive, which means plenty of trouble. Up till now we have been making the convenient assumption that the voltage fed back is exactly 180° out of phase with the input. Within limits, the inevitable departures from this ideal are checked by feedback; but, as with amplitude distortion, once the limits are exceeded the situation gets out of hand.

That is all pretty generally understood, however. But there

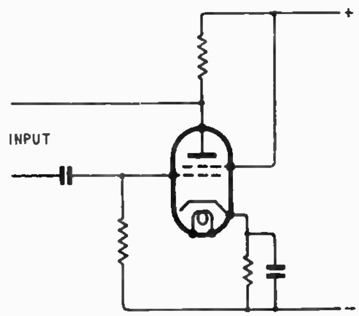


Fig. 7—Simple method of obtaining 100 per cent. feedback without certain disadvantages of the cathode follower.

is one thing—the effect of feedback on hum—on which the most conflicting statements have appeared, and very little real information. So I think it justifies an article to itself, which will appear, Editor permitting, in due course.

QUALITY AMPLIFIERS

THE January, 1946, issue of *Wireless World*, in which were given circuit details of 4-, 8- and 12-watt "Quality" amplifiers, is out of print. A reprint of the descriptive article has now been issued by our Publishers, price 7½d. by post.

CORRECTION

IT is regretted that on p. 52 in our February, 1946, issue the butterfly oscillator circuit covering the range 250—900 Mc/s was incorrectly credited to M.O. and G.E.C. This was actually shown by British Thomson-Houston.

CATHODE-FOLLOWER DANGERS

Output Circuit Capacitance

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

THE virtues of the cathode follower have been so much stressed lately that one might almost be forgiven for considering it the panacea for all ills. Most writers on the subject point out that it employs heavy negative feedback and that its characteristic is consequently extremely linear. Very few, however, even hint that a cathode follower can cause very severe distortion in spite of this linear characteristic.

This distortion may not be serious in the audio frequency applications of the cathode follower, but it is of highly probable occurrence with the pulse waveforms of television and radar. At really high frequencies great care in design is necessary to avoid distortion, and in consequence some at least of the attractiveness of the cathode follower disappears.

In view of the amount of published material on this stage it is not proposed here to review its general characteristics in detail. Those who are unfamiliar with it are recommended to study the excellent description by "Cathode Ray."*

The basic circuit of the cathode follower is shown in Fig. 1, and it will be seen that it differs from the usual one only by the inclusion of a capacitance C_c shunting the cathode resistance R_c. This makes the circuit look like an infinite input impedance detector, and in fact it is identical with it. It is just because the presence of this capacitance turns the cathode follower into such a detector that it distorts.

The capacitance, unfortunately, is inevitably present in all circumstances and cannot be avoided. Even if it is no more than the stray circuit capacitance it may easily total 30 pF; for there are the cathode-to-anode and cathode-to-heater capacitances of the cathode follower itself, the input capacitance of the following stage and the various wiring capacitances to earth.

* *Wireless World*, November, 1945.

Whenever resistance and capacitance are used in association the current cannot respond instantaneously to a change of input voltage. The current changes exponentially with time and only reaches its final value after an interval. The time taken for the current to reach this final state depends on the values of resistance and capacitance, and the product of the effective values is called the time-constant of the circuit.

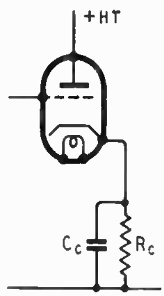


Fig. 1. The basic circuit of a cathode follower with capacitance C_c across the cathode resistance R_c.

In a circuit such as Fig. 1 the capacitance is C_c and the effective resistance is R_c in parallel with the output resistance of the valve. It has been shown many times that this output resistance is $R_a/(1+\mu)$, where R_a is the anode AC resistance of the value and μ is its amplification factor.

The time-constant of the cathode follower thus appears to be $C_cR_c/\left\{1+\frac{R_c}{R_a}(1+\mu)\right\}$ In a typical case, one might have $\mu = 20$, $R_c = R_a = 10\text{k}\Omega$, giving $T = C_cR_c/22$. The cathode follower connection has reduced the time-constant to 1/22 of that of C_c and R_c alone, and it has done this by virtue of its low output resistance. This is all perfectly straightforward, and is a great advantage of the cathode follower. It is an advantage, because it makes the capacitance have little adverse effect on the frequency response, and so far as this alone is concerned the cathode follower can feed a high capacitance circuit quite easily. In the example quoted, the capacitance could be twenty-two times as large as usual for a normal frequency response.

It is facts such as these which make some people so enthusiastic about the cathode follower. Unfortunately, they are true only when the valve is handling quite small signals. The cathode follower is not nearly as simple as it looks, and it contains one very definite trap for the unwary. In spite of its apparently large signal-handling capacity it is very easily driven beyond anode current cut-off when there is capacitance in shunt with the load and all its beautiful characteristics then disappear. As soon as it becomes non-conductive the time-constant at once reverts to C_cR_c.

It might be thought that there is little risk of the valve's anode current being cut off in practice, but this is not so. Except with quite a small input, the valve will inevitably be cut off by a sufficiently *rapid* change of grid potential in the negative direction, even although the magnitude of the change is too small to produce cut-off without C_c.

The mechanism of the effect is probably most easily understood by an example. Suppose that in the circuit of Fig. 1 R_c is 10 kΩ, and that the anode current is 0.5 mA when the grid is joined to earth and that it is 5 mA when the grid is + 50 volts with respect to earth. In the former case the cathode is $0.5 \times 10 = 5$ volts above earth, and in the latter it is $5 \times 10 = 50$ volts. The change of cathode voltage is $50 - 5 = 45$ volts for a change of input of 50 volts, so that the voltage "amplification" is $45/50 = 0.9$ times. The grid-cathode voltage is the grid-earth voltage minus the cathode-earth voltage, or -5 volts in the first case and 0 volts in the second. Let us suppose that anode-current cut-off occurs at -10 volts grid-cathode potential.

These are steady-state conditions which hold dynamically only

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if C_c is zero. Let us now see how the presence of this capacitance modifies them. Assume initially that the grid is +50 volts above earth, so that the anode current is 5 mA, the cathode-earth potential is +50 volts and the grid-cathode voltage is zero. Now from this reference level, let the grid-earth voltage drop instantaneously from +50 volts to zero; that is, let a negative-going pulse of 50 volts amplitude be applied from the reference level of +50 volts.

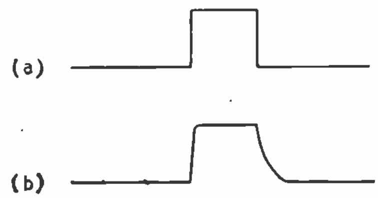

Fig. 2. An ideal input pulse is shown at (a) and the output pulse from a cathode follower at (b).

If it were not for C_c, the anode current would fall to 0.5 mA and the cathode-earth voltage to +5 volts instantaneously. The presence of this capacitance, however, prevents the current from changing instantaneously. The voltage across C_c can only fall as the charge on the capacitance is released through the circuit resistance, and this takes time to accomplish.

Because of this, at the instant when the grid-earth potential becomes zero, the cathode is still 50 volts above earth, and the grid-cathode potential is thus −50 volts. As cut-off occurs at −10 volts, the valve is well and truly beyond current cut-off. It stays so cut-off until the cathode voltage drops to +10 volts. It drops to this value eventually, because C_c discharges through R_c, but the time it takes to do so is governed only by C_cR_c. The normal low output resistance of the cathode follower has no effect at all, for as the valve is cut-off its output resistance is not low, but infinite.

An analogous undesirable effect also occurs on a rising input voltage, but the valve is now driven heavily into grid current instead of being cut-off. Suppose that the grid-earth potential is initially zero, that the anode current is 0.5 mA and the cathode is 5 volts above earth. Let the grid potential be changed instantaneously to +50 volts. Because of C_c the cathode voltage cannot rise at once, and at this instant it is still +5 volts only. The grid-cathode voltage is thus +45 volts.

As the valve is not cut off the time constant is not C_cR_c, as in the case of a negative input voltage, but

$$C_cR_c/\{1+(1+\mu)R_c/R_a\}.$$

This is much smaller, so that the cathode voltage rises to its final value much more quickly than it falls with a negative input. If the grid voltage change is of the form (*a*) in Fig. 2, the cathode voltage change has the shape sketched in (*b*). On the rise at the leading edge, the pulse is reproduced well, the low time-constant of the output circuit causing only a slight alteration in the shape. The trailing edge, however, is badly distorted, for with the high time constant existing with the valve cut off, the voltage can fall only slowly.

In the case considered the grid-cathode potential has been taken as zero at the start of a negative-going change of input voltage, and anode current cut-off occurs at −10 volts between grid and cathode. Moreover, at the instant of the input change the cathode-earth potential remains constant. It follows, therefore, that the maximum input voltage change to avoid current cut-off is −10 volts—the same value as that for the valve without feedback. This is what one would expect, because the feedback in the cathode follower arises from the change of cathode-earth voltage, and if this does not change there is no feedback. The trouble really arises, therefore, because the capacitance across the load prevents feedback during the change of input voltage. To avoid the effect, the input must be limited to the value which the valve will handle without feedback.

All this would suggest that the cathode follower is a singularly useless device. Fortunately, however, matters are not as bad in practice as all this might lead one to believe. The saving fact is that no input pulse can ever have perfectly vertical sides; an instantaneous change of input voltage is a practical impossibility. The most perfect pulse which can be generated does take a finite time to change the grid from one potential to another, even if this time is exceedingly small. If the cathode follower time-constant is made small enough to permit the cathode potential to change at least as rapidly, then the current cut-off and grid-current effects can be avoided.

This demands quite a small time-constant in many cases, and so far from the cathode follower being able by virtue of its low output resistance to feed a circuit of high capacitance it is usually necessary to restrict the capacitance to the lowest possible value. Even then it is often necessary to reduce R_c below the value which would otherwise be desirable.

By assuming that the valve has ideal characteristics, it is not difficult to calculate the performance of a given circuit. One investigation, confined to the cases of perfect input pulses and to a sine wave input, has already been carried out.*

The former case is not of much practical help in design because perfect pulses do not occur. The sinusoidal case is also of little help when considering the pulse waveforms of television and radar. No general exact solution is possible, however, for the reason that it must depend on the precise

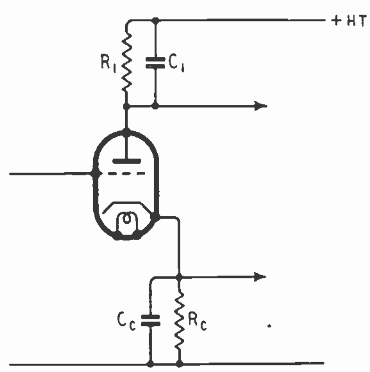

Fig. 3. The push-pull phase splitter is only a modified cathode follower and the analysis in the text applies to both if $R_c = R_1$ and $C_c = C_1$.

* "Cathode follower Internal impedance." By Harold Goldberg. *Proc. Instn. Radio Engn., November*, 1945.

form of the input wave, and this will differ in nearly every case.

The writer has analysed the conditions with an input voltage of exponential form, since this represents a closer approximation to the edge of a practical pulse. The analysis has been carried out for the push-pull phase-splitter of Fig. 3 as well as for the true cathode follower of Fig. 1, since the two circuits are closely related. The results are best presented in graphical form and in Fig. 4 are given a series of curves relating the quantity βT_c to the cut-off factor. Each curve is for a different value of B, which equals

$$(1 + \mu)R_c/R_a$$

in the case of the cathode follower of Fig. 1 and $(2 + \mu)R_c/R_a$ in the case of the phase-splitter of Fig. 3, assuming that $R_1 = R_c$ and $C_1 = C_c$ in the latter case.

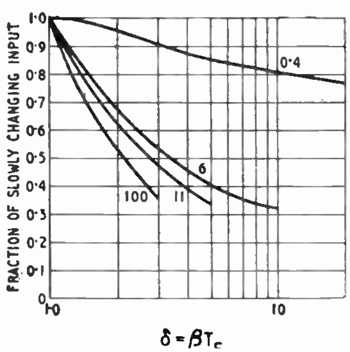

Fig. 4. These curves show how the cut-off factor is related to time-constants of the cathode circuit and input voltage, defined by βT_c, and the valve characteristics, defined by B.

The cut-off factor indicates the maximum input which can be applied without cutting off anode current, expressed as a fraction of the input which the valve would handle if C_c were zero. The quantity βT_c is the ratio of the time-constant of the cathode circuit to that of the input voltage. The former, of course, is $T_c = C_cR_c$, and the latter is $1/\beta$ and needs some explanation. If a perfectly rectangular pulse is applied to an RC circuit of the integrating type, the output voltage has an exponential shape. If the input pulse is like (*a*) Fig. 5, the output is like (*b*). The amount of rounding of the corners and the steepness of the sides depends on the time constant of this circuit.

The wave applied to the cathode follower is imagined to be a perfect pulse passed through such an integrator, so that its time-constant $1/\beta$ is a measure of the input wave.

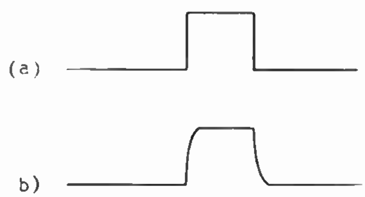

Fig. 5. An ideal pulse has the rectangular shape (a). Its passage through an integrating-type circuit makes the changes of voltage at beginning and end exponential in shape (b).

For practical purposes this must be related in some way to the frequency response of the earlier circuits. A simple way of doing this is to assume that the passage of a perfect pulse through equipment having a response of − 6 db. at a frequency f modifies the pulse in the same way as would the simple integrator of time-constant $1/\beta$ if this also has a response of − 6 db. at f. This leads to $\beta = \omega/\sqrt{3}$ where ω is 6.28 times the frequency in cycles per second.

In practice, of course, the fact that the circuits have the same attenuation at a particular frequency does not mean that they will affect a pulse in the same way. In general they will not. The method however does give one some idea of the requirements of the cathode follower.

The first point to be noticed from Fig. 4 is that for $\beta T_c = 1$ or less, there is no limitation of input. Physically, this means that if the valve is to handle as big an input when it is changing rapidly as when it is changing slowly, then the cathode voltage must be capable of changing at least as rapidly as the input.

The second point to notice is that when βT_c is greater than unity the results are affected only to a minor degree by the value of B. This means, in effect, that the values of C_c and R_c are more important than the valve characteristics.

When the input is of sine waveform, the curves of Fig. 6 apply. These show the cut-off factor plotted against ωT_c for several values of B. In most cases B is of the order of 5 to 50, and it will be seen that again the value of B has only a second-order effect on the performance.

The use of these curves and the magnitude of the cut-off effect is best illustrated by numerical examples, and the following will exhibit its characteristics.

Example 1

Push-pull phase-splitter (Fig. 3)

Let $\mu = 40$; $R_a = 15\,k\Omega$; $R_c = R_1 = 47\,k\Omega$; $C_c = C_1 = 100$ pF; $f = 10$ kc/s. What reduction of input is needed at this frequency to avoid anode current cut-off?

$B = 132$ and $\omega T_c = 0.295$. From Fig. 6 the input is 0.96 of that at low frequencies.

Example 2

Cathode follower for television (Fig. 1)

Let $\mu = 10$; $R_a = 3\,k\Omega$; $C_c = 30$ pF; and the applied

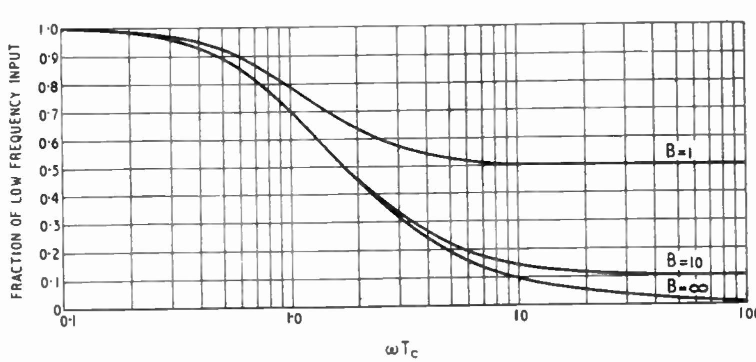

Fig. 6. The relation between the cut-off factor and ωT_c is shown here for sine waves.

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pulse be passed through a circuit of response — 6 db. at 2.5 Mc/s. What is the maximum value of R_c (*a*) to avoid cut-off at full input, and (*b*) for cut-off at inputs exceeding 0.9 of the full ?

(*a*) Since $\beta = \omega/\sqrt{3}$ and the maximum value of T_c is $1/\beta$, to avoid cut-off $R_c = \sqrt{3}/\omega C_c = 3.67$ kΩ.

(*b*) B is unknown, since R_c is unknown. However, in the region of 0.9 for the cut-off factor the results are only slightly dependent on B. We may expect R_c to be a little above the value in (*a*), and we can estimate B on a basis of R_c being about 5 kΩ. This would give B = 18.35, and from Fig. 4 $\beta T_c = 1.16$, about. As R_c is proportional to βT_c, its value is $1.16 \times 3.67 = 4.25$ kΩ.

Example 3

Phase-splitter for television (Fig. 3)

Let the values be as in Example 2, with $C_1 = C_c$ and $R_1 = R_c$. It is required to determine R_c for no limitation of input.

As the presence of R_1 only affects the value of B, and B does not influence the cut-off when $\beta T_c = 1$, the value of R_c is 3.67 kΩ, as in Example 2 (*a*).

Example 4

Cathode follower for television (Fig. 1)

Let $\mu = 20$; $R_a = 10$ kΩ ; $C_c = 50$ pF ; and $\beta = 9.05 \times 10^6$ (— 6 db. response at 2.5 Mc/s). What is the cut-off factor when R_c = (*a*) 20 kΩ, (*b*) 10 kΩ, and (*c*) 5 kΩ?

(*a*) B = 42 ; $\beta T_c = 9.05$; cut-off factor = 0.15 (estimated).

(*b*) B = 21 ; $\beta T_c = 4.525$; cut-off factor = 0.31 (estimated).

(*c*) B = 10.5 ; $\beta T_c = 2.26$; cut-off factor = 0.575.

Now what conclusions may be drawn from this ? In the first place, Example 1 shows that the cut-off effect is likely to be negligible in AF work. The fractional cut-off is 0.96 in this example, so that it is small. Then a phase-splitter is usually employed fairly early in an AF amplifier where it handles only small signals, so that it is never likely to be fully loaded. Then again, a signal of full intensity at as high a frequency as 10 kc/s is never likely to be found in any ordinary musical programme.

The remaining examples for pulses show quite clearly that it is the values of C_c and R_c in relation to the input wave which are important. If the valve is to handle its full input, then these must be kept sufficiently small. The valve itself has only a secondary influence on this aspect, but in general if R_c is small R_a should be small also if adequate output is to be secured. Thus, if an output of 50 volts is wanted and R_c is 2 kΩ, the current change in R_c must be 25 mA and the valve must be capable of providing this. In general, therefore, the value of R_c reacts on the choice of valve through the output required, and usually a low value of R_c needs a low-resistance valve.

Before concluding it may be as well to point out that the curves of Fig. 6 give an indication of the minimum capacitance needed for an infinite input impedance detector. The requirement here is that the valve should cut off for at least part of every RF cycle. B should be large and ωT_c around 100. If $R_c = 0.1$ MΩ and the frequency is 1 Mc/s, $C_c = 159$ pF min.

There is one other point to mention. The calculations on which the curves of Figs. 4 and 6 are based assume an ideal valve characteristic. In practice, characteristics are curved near the cut-off point. This is likely to ease matters somewhat, and the valve will probably cut-off rather less easily than the curves would indicate. In general, the curves should be taken as a guide to the choice of correct circuit values rather than a means of accurately determining them. The accuracy increases as the real valve characteristics approach the assumed ideal and, in the case of pulse waveforms, as the actual wave approaches the exponential shape.

RENEWAL OF B.B.C. CHARTER

Views of "The Economist" on State Monopoly

THE Prime Minister stated in reply to a Parliamentary question some weeks ago that the Government had not yet made up its mind whether to set up a public Committee on the subject of broadcasting before proceeding to the renewal of the B.B.C.'s charter this year. Commenting on this in its January 5th issue, *The Economist* states:

"This is a point of considerable importance—indeed, in the long run, of supreme importance in any free democracy. It would be a pity if each of the many criticisms of the B.B.C. that flare up in the Press and elsewhere from time to time were turned into a party controversy, and a Committee that developed into a witch-hunt would be very harmful. Such criticisms are quite inevitable, and not even the perfect B.B.C. could expect to be immune to them. The majority view is probably that Sir William Haley and his staff do their job about as well as any State-appointed monopolists could be expected to do it.

"But this is not the point. The real point is whether broadcasting should be entrusted to a State-appointed monopoly, no matter how high-minded its intentions. Any suggestion of a State monopoly of the printing press would be met with a storm of protest. Yet any writer or journalist who has broadcast will testify that the effect of his words is infinitely greater, more direct and immediate when spoken through the microphone than in any form of printing. It is really astonishing that in a country so jealous of its liberties the monopoly by the State of such an enormously powerful organ of instruction and persuasion should be so placidly accepted. Nor is it true that the only alternative to a State monopoly is the dominance of the advertiser, as in America (though even that might be less dangerous in the long run). . . .

"A renewal of the charter on the present terms might very well settle the matter for ever. It is of the first importance that an opportunity should be given for the very far-reaching issues of political health that are raised by the monopoly of such a powerful organ of speech to be thrashed out by a Commission of the necessary breadth and competence . . ."

THE NEW SUNSPOT CYCLE

Retrospect and Prospect : Forecasts for Short-wave Working : USW for Long Distances?

By T. W. BENNINGTON

IN *Wireless World* nearly a year ago* it was mentioned that, although it was then too early to say with certainty, the epoch of minimum solar activity appeared to have occurred about the middle of 1944. It now transpires that it was a little earlier than that, and so, considerably more than a year of increasing solar activity having passed, it is interesting to review, so far as possible, the course of the new cycle up to the end of 1945. And now that it is no longer necessary to keep all ionosphere data a close secret, we may take the opportunity of examining some of this in order to see how the solar cycle has actually affected the atmospheric ionisation—and hence short-wave communication—during the past few years. It is a little difficult, however, to keep really up to the minute with solar data, since some time elapses before this becomes available in its final form; again, as will appear later, the most informative method of correlating the solar data with those of the ion sphere critical frequencies is one involving a few months' time delay. However, by making use of provisional solar data, and by a little extrapolation, we can gather a fairly accurate idea as to how solar and ionospheric events were shaping themselves at the end of 1945. Our aim will be to see how the changing solar activity is likely to affect practical short-wave communication during 1946 and after.

In order to show the general course of the last and present sunspot cycles the curve of Fig. 1 is given, this being a plot of the annual means of the relative sunspot numbers. The data for 1945 are provisional only. The relative sunspot numbers — records of which extend back for many years —are an index of the solar activity, and are obtained from the observations made at a number of different observatories, by taking the sum of the total number of sunspots observed plus ten times the number of spot groups, this sum being multiplied by a factor depending upon the telescope used and the seeing conditions, in order to bring the different observations into general consistency. Although this method of assessing solar activity may seem to be somewhat arbitrary, the fact remains that, because of its excellent correlation with ionospheric data and with other phenomena which are dependent on the solar activity, it does appear to give a true criterion of the activity which it seeks to represent.

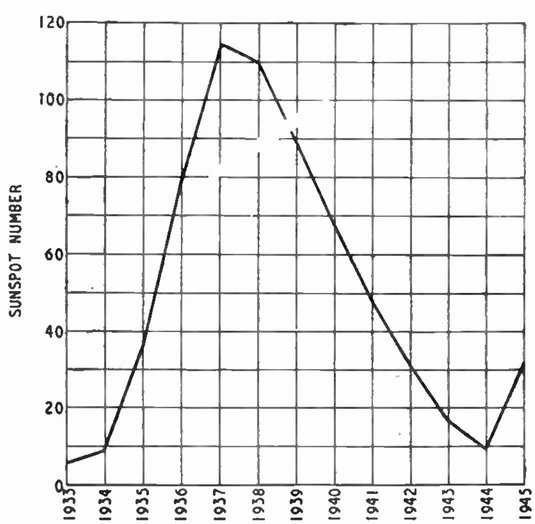


Fig. 1. Annual means of relative sunspot numbers.

From Fig. 1 we see that the sunspot activity was at a minimum in 1944 and that during 1945 it increased considerably. In fact, the activity during the present cycle has increased much more rapidly from the epoch of minimum activity than has been the case during most—though not all—of the preceding cycles, which leads us to speculate upon its course during the next few years. Does the rapid increase mean, for example, that the coming maximum will be an exceptionally high one? It is not possible to say with any certainty, for, although there are numerous methods for the prediction of future solar activity, all devised by men eminent in the subject of mathematical analysis, none of these have claimed to achieve very great accuracy in the long-distant future and none, so far, have proved much more accurate than they claimed to be. There are, in fact, insufficient solar data on which to predict with any degree of certainty very far ahead. Nevertheless, most authorities indicate that there is a distinct probability of the next maximum being considerably higher than the last, and that the "rising" period of the cycle will be of relatively short duration, while, according to one authority, the next maximum is likely to occur before May, 1948. Other methods indicate 1949 as the year of the next maximum. Incidentally, if this is indeed a "high" one it will break the "high-low" sequence for maxima which has persisted since the maximum of 1848, and in which the maximum of 1937 was a high one.

Effects upon Short-wave Communication.—We may now examine some data indicative of the

* "Sunspot Minimum," *Wireless World*, March, 1945.

The New Sunspot Cycle—
way in which the changing solar activity affects the atmospheric ionisation and hence short-wave communication. In Fig. 2 are plotted (top curve) the monthly means of the relative sunspot numbers for the years 1941 to 1945, and (bottom curve) the monthly means of the noon critical frequencies of the F_2 layer as measured in England.

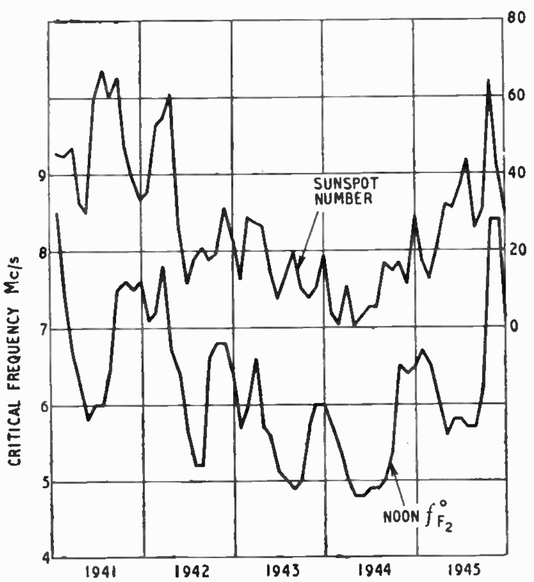


Fig. 2. Monthly means of F_2 critical frequencies for noon and of relative sunspot numbers for the minimum period of the sunspot cycle.

From the top curve it is seen that there were large and erratic variations in the sunspot activity from month to month, though, from the general sweep of the curve, the fall in activity towards April, 1944, and the general rise since then can be clearly seen. In that month the relative sunspot number reached its lowest value for any month since August, 1933—the time of the preceding minimum.

In the bottom curve of Fig. 2 the large seasonal variations in F_2 layer ionisation are reflected as increases in the critical frequency in the winter and decreases in the summer, and these are seen to occur with unfailing regularity as year follows year. In spite of these seasonal variations the general effect of the varying solar activity is also apparent, for there is a general downward sweep in the curve towards April, 1944, and then an upward sweep towards the end of 1945, in sympathy with the general trend of the sunspot curve. The critical frequencies towards the end of 1945—roughly 1½ years after the minimum—were, in fact, back to approximately the same values as obtained early in 1941—roughly 3 years before it. The effects of this rather surprising increase will be apparent if we consider the change in the Maximum Usable Frequency for the longest distance possible in one hop, and, taking this to be roughly 3.5 times the critical frequency, observe that between April, 1944, and October, 1945, it would have increased from 16.8 Mc/s to 29.4 Mc/s.

If the two curves of Fig. 2 are examined for *detailed* correlation it is seen that, despite the seasonal effects which are superimposed on the critical frequency curve, this is not entirely absent. It can best be noticed as a retardation in a seasonal rise of critical frequency by a temporary fall in sunspot activity, or by an enhanced seasonal rise due to a sudden increase in activity, the last six months of 1945 affording one good example. The ionosphere is, in fact, surprisingly quick to react to temporary fluctuations in the solar activity around the minimum of the cycle, which is not the case around the maximum.

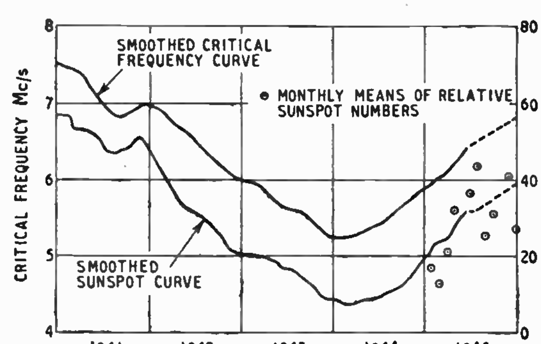


Fig. 3. Twelve-month running average of noon F_2 critical frequencies and of relative sunspot numbers.

Detailed Correlation.—But to observe in detail the dependence of the critical frequency upon the varying solar activity it is best to smooth the curve of relative sunspot numbers so as to remove the temporary fluctuations, and to smooth the curve of critical frequency by removing the seasonal effects. This is done by taking twelve-month running averages of both these quantities; i.e., by taking for the mean for the epoch at the centre of any month the average of the twelve monthly means having that month as centre. Such curves of twelve-month running averages are given in Fig. 3, the last few points in the full line curves being obtained on the basis of provisional data and the dashed portions being obtained by extrapolation. The correlation between the two curves is seen to be exceptionally good, the relationship being approximately linear. It may be said that this same good correlation between twelve-month running averages of critical frequencies and relative sunspot numbers may be obtained over the whole sunspot cycle, and applies to the critical frequencies of all the ionosphere layers and for all times of day, though the magnitude of the critical frequency changes varies with the layer and time of day, being greatest for the F_2 layer and least for the E and greater at noon than at other times.

The two curves of Fig. 3 should,

it is hoped, suffice to remove any remaining doubts as to the dependence of short-wave working frequencies upon the degree of solar activity. Thus, in the 12-month running average of sunspot numbers we have a good criterion as to the variation in critical frequencies, and hence in usable frequencies for short-wave communication, and if we can predict the variations in the one quantity this should enable us to forecast the other. It seems that we ought, as a matter of fact, to be able to estimate the long period, though not the short period, variations in both of these quantities for a short time ahead with good accuracy.

Future Working Frequencies.—What, then, may be said of the future that will be applicable to practical short-wave work. We had best confine ourselves in the main to the immediate future—say the year 1946. As has already been mentioned, the critical frequencies in England were back, towards the end of 1945, to values of the order which were recorded early in 1941, and the daytime MUF for this particular latitude had therefore reached a value roughly of the order of 29.4 Mc/s. But the working frequency for a particular transmission path depends upon the condition of the ionosphere—not only at the end of a transmission path—but upon its condition along most of the route which the wave is to traverse. And ionosphere conditions vary, not only with the time of day, season of year and epoch of the sunspot cycle, but also with geographic and with geomagnetic latitude. In general, the critical frequencies increase as the low latitudes are approached and fall towards the high latitudes, and thus they vary very considerably over a long transmission path. In short, the detailed prediction of working frequencies for various distances and directions—although now commonly achieved with good accuracy—is far too complex to deal with in this article, involving, as it does, the use of world-wide ionospheric charts for the months in question. A few practical indications for a few specific directions from this country are all, therefore, that can be given and these will all deal with communication over distances exceeding 4,000 km, it being understood that these refer to frequencies regularly workable and not to freak results occurring on exceptional days.

For daytime transmission in a direction directly to the south of this country, i.e., to Africa, frequencies as high as 26 Mc/s are already workable for considerable periods. During 1946 it is probable that these will increase to well over 28 Mc/s, the highest working frequencies being attained around the equinoxes, though 28 Mc/s should be workable during peak daylight hours most of the year. As to the night, frequencies up to 10 Mc/s ought usually to be workable the night through, and by next winter this may be increased to 12 Mc/s.

For communication with South America daytime frequencies up to 24 Mc/s are already usable for good periods and it is probable that this will increase to 28 Mc/s during the year, with the equinoxes giving the best high-frequency results. 8 Mc/s is probably the highest frequency on which good results will be obtained during the deep night at first, increasing to 10 Mc/s during the year.

Frequencies up to 22 Mc/s ought to be usable for good periods during the day in the early months for communication with U.S.A., falling to about 17 Mc/s during the summer and increasing to about 24 Mc/s next winter. When all the path is in darkness 7 Mc/s will at first be the highest safe frequency, but next summer frequencies up to 14 Mc/s should be usable most of the night. By next winter 10 Mc/s may be usable throughout the night.

For the Far East and India frequencies up to 22 Mc/s or slightly higher should be usable during daytime in the early part of the year, falling to about 20 Mc/s in June. Next winter it should be possible to get through on 24 Mc/s during the day. During darkness 7 Mc/s or even lower will be the highest safe frequency in the early part of the year, increasing to 13 Mc/s in the summer and falling to about 9 Mc/s next winter.

It may be thought that the above frequencies are somewhat high, and they are certainly higher than it is commonly thought necessary to use. They are, in fact, intended to indicate the extreme highest limits of the *regularly* usable frequency bands, and, whilst good communication should be regularly maintained on lower frequencies where sufficient power is available, they will no doubt be exceeded on certain days when "freak" conditions prevail.

And what of the years beyond 1946—the time towards the sunspot maximum? Well, as we now know, the higher short-wave frequencies were not sufficiently exploited at the last maximum; we could, generally speaking, have used higher frequencies than were commonly put to use. And if the next maximum is to exceed the last one by the amount suggested by some eminent authorities—it is quite possible that 50 Mc/s may become a usable frequency for long-distance communication from this country for periods during the daytime.

Postscript.—An unusually large sunspot group—one visible to the naked eye—appeared on the sun's east limb on Jan. 29th, and, crossing the central meridian on Feb. 5th, was due to reach the west limb on Feb. 11th. It is possible that it may survive its journey across the "reverse" side of the sun and, if so, reappear on the east limb about Feb. 24th, but, on the other hand, it may die out and disappear before that date.

In addition to being large the group appears to have been extremely active, growing rapidly after its first appearance, and several solar flares taking place in its vicinity. Short-wave "Dellinger" fade-outs—most probably caused by the flares—were reported to have occurred on Jan. 31st, Feb. 1st, 2nd and 5th, while disturbed short-wave conditions were expected to start late on Feb. 6th.

But apart from these disturbing effects, the increased solar activity had a very definite ionising effect upon the atmosphere, and the ionosphere critical frequencies were very high from Feb. 1st to 6th. "High frequency" short-wave working conditions therefore prevailed, and 28-Mc/s amateur communication with the U.S.A. was frequently established.

WORLD OF WIRELESS

GOVERNMENT SURPLUS VALVES

IT is believed that the disposal of surplus Government valves is being regularised by the conclusion of an arrangement whereby the very large stocks in the hands of Government Departments will be re-purchased by the manufacturers concerned.

MERCHANT NAVY RADAR

THE recent demonstrations of radar equipment for the Merchant Navy raises the question of training and that of the position of Radio Officers in relation to radar.

There has been no suggestion in official quarters that "Radar Officers," as such, should be carried by merchant ships. On enquiry from the Radio Officers' Union it is learned that it has been agreed with other Merchant Navy officer organisations that radar gear should be in the radio room and be the responsibility of the Radio Officer in the same way as the other radio aids to navigation, such as DF. It will, of course, be expedient for the navigating officer to operate the remote control unit so that the PPI picture can be superimposed on the navigation chart as was done during the tests in H.M.S. "Pollux," described elsewhere in this issue.

Two naval schools are at present training selected Merchant Navy officers in the use of radar. A six-weeks' course is being given to Radio Officers and a 3-day operational course to navigating officers.

NEWS IN MORSE

THE latest schedule of morse transmissions of official news bulletins radiated by Post Office stations is given below. Although these transmissions are intended for overseas reception they may sometimes be receivable in this country.

0130-0315 GBV GBC5 GDB2 GIU GPJ.
1100-1200* GBV GIA GID GIJ GYB8.
1600-1700* GBV GBC5 GIA GIJ GIM.
1800-1900* GBV GBC5 GBL GIM.
1930-2030* GBV GBC5 GBL GAY GIJ GIM.
2200-2300 GBV GBC5 GBL GIJ.
2300-2400* GBV GBC5 GAY GIJ.

The wavelengths are:

GBV 3846; GDB2 44.15; GIJ 42.95; GIU 36.81; GBC5 34.56; GAY 33.67; GPJ 27.56; GIM 22.13. GID 22.13; GBL 20.47; GIA 15.27; GYB8 10.57.

* Weekdays only.

PHOTOTELEGRAPHY. The first of forty picture transmitter-receivers ordered by Cable & Wireless from the G.E.C. and Marconi's, was installed at the Company's headquarters, Electra House, Victoria Embankment, London, W.C.2, for a demonstration when the reduction in the rates for phototelegrams was announced by Sir Edward Wilshaw (right). The prototype of this self-contained set was designed by the G.P.O. research workers at Dollis Hill.

B.A.O.R. AMATEURS !

AMATEURS serving with the British Forces in Germany are to have the opportunity of operating their own stations, on the same frequency bands as those on which transmitters in this country are now allowed to work; 28—29 and 58.5—60 Mc/s.

A block of call signs, comprising four letters and numerals prefixed by "JE," has been allotted to the Secretary of the recently formed B.A.O.R. amateur transmitters society who will allocate them to applicants. The secretary is Flt./Lt. E. J. Fowler, 84 Group R.A.F. (Disarm) B.A.F.O., B.A.O.R.

Authority has been obtained for German equipment to be used by the transmitters, who, if they have not previously held a licence, will be required to pass a test similar to that suggested by the G.P.O.

FARADAY MEDALLIST

THE twenty-fourth award of the Faraday Medal has been made to Sir Edward Appleton, G.B.E., K.C.B., D.Sc., F.R.S., for the conspicuous services rendered by him in the advancement of electrical science, particularly in the field of radio propagation. Sir Edward has been Secretary of the Department of Scientific and Industrial Research since 1939. He was made a Fellow of the Royal Society in 1927, is Chairman of the British National Committee for Radio-Telegraphy, Vice-President of the American Institute of Radio Engineers and President of the International Scientific Radio Union.

The Faraday Medal is awarded by the Council of the I.E.E. not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science. The award is not restricted as regards nationality, country of residence or membership of the Institution.

"THE MIRACLE OF RADIO"

HERE is a book* that is long overdue. It tells the man in the street, in the words of its own subtitle, "the story of Radio's decisive contribution to victory." The story is a non-technical one and well illustrated; the 120-odd pages of this small book contain a mass of information on all the more spectacular applications of radio to purposes of war. Particular emphasis has been laid on the part played

* THE MIRACLE OF RADIO, by Miles Henslow. *Evans Bros. Ltd.* 2s. 6d.

by the industry in providing the radio equipment needed for victory.

THE REASON WHY

REPRESENTATIVES of the industry and the technical and lay Press were recently given the opportunity of touring the B.B.C. television station at Alexandra Palace, in order that we might see what was going on behind the scenes in preparation for the re-starting of the service.

Whatever may have been the intention of the Director of Television in extending the invitation, the visit certainly showed why it will be "some time" before television re-starts. The whole station was humming with activity, but there is a tremendous amount to be done before the station can provide a reliable service. So far as the engineering side is concerned, every section of the equipment is being tested, measured and reconditioned. We were reminded that there are 2,500 valves alone to be tested!

B.B.C. ACCOUNTS

IT is interesting to see from the Government White Paper issued recently giving the B.B.C. accounts for the year ended March 31st, 1945, that 30 per cent. (£2,592,788) of the Corporation's expenditure was for engineering.

Another interesting item is the £45,000 worth of Lease-lend equipment received and put into service during the year.

The Corporation did not receive a proportion of the revenue from licence fees, but was given a Government grant-in-aid amounting to £8,300,000. Its income also included £637,286 from publications.

OBITUARY

We regret to record the death on January 24th of **Charles B. Gregory,** technical recording manager of the E.M.I. Abbey Road recording studios. He joined the Columbia firm in 1894, thus celebrating his jubilee in the sound-recording world in 1944.

PERSONALITIES

The Rt. Hon. The Earl of Mount Edgcumbe, T.D., has been elected an Honorary Member of the Institution of Electrical Engineers in recognition of his distinguished work as an electrical engineer and the services rendered by him to the Institution. He was President for the year 1928/29.

Drs. L. G. Brazier and J. L. Miller have been appointed Research Manager and Chief Engineer (Equipment and Telecommunications), respectively of the Engineering and Research Division of British Insulated Callender's Cables.

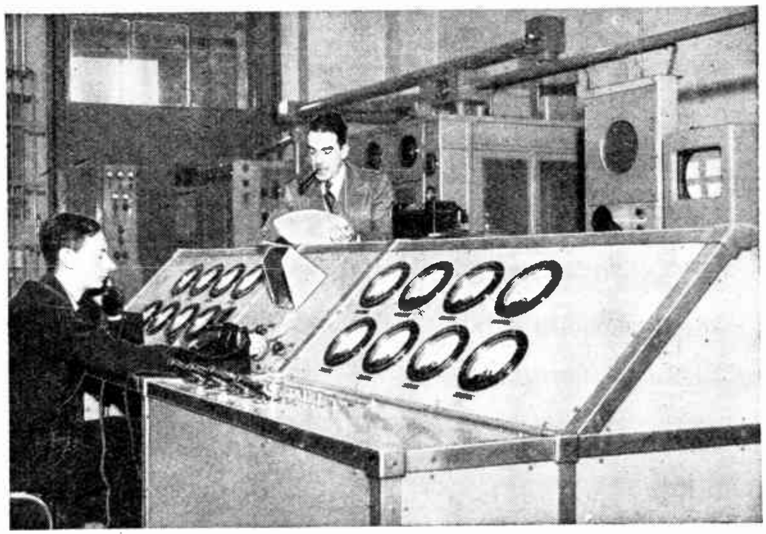
S. Whitehead, M.A., Ph.D., has been appointed director of the British Electrical and Allied Industries Research Association (E.R.A.). Dr. Whitehead joined the Association twenty years ago as assistant director of the E.R.A. Laboratories.

Eric Megaw, B.Sc., M.B.E., has been appointed by the Admiralty to take charge of Naval Radar Research. He was a pioneer in short-wave radio and has contributed several articles to our sister journal, *Wireless Engineer.*

J. W. Ridgeway, O.B.E., Manager of the Radio Division of the Edison Swan Electric Co., has now been appointed a Director of the company.

IN BRIEF

An exhibition of German electronic equipment, sponsored by the Ministries of Supply and Aircraft Production, will be held at Earls Court Exhibition from March 4th to 16th (closed Sunday, 10th). The exhibition is not open to the general public, but is intended for the radio industry and radio research workers. Tickets are, therefore, being distributed by the trade associations, professional institutes and direct to Government departments and research establishments.



TEST TRANSMISSIONS of a still pattern started from the Alexandra Palace on February 1st and are being radiated each weekday from 11.30 to 12.30 and from 4.0 to 5.30. A black cross on a white background is transmitted on the vision frequency 45 Mc/s (6.67 m) and a tuning note and interval signal on the 41.5-Mc/s (7.25 m) sound channel. The test pattern can be seen on the monitoring tube on the right of this picture—note the frame has slipped!—taken in the vision transmitter room. D. C. Birkenshaw, television superintendent engineer, is standing behind the control desk.

J. G. Wright and **T. G. Weaire** have retired from the Board and all activities connected with Wright and Weaire, Ltd., the company which they formed in 1919.

H. F. Schwartz is to be Vice-Chairman and **Grp. Capt. E. Fennessy,** O.B.E., a Director of The Decca Navigator Company.

D. M. Sheil-Small has been appointed works manager of Alfred Imhof, Ltd., and will be chiefly connected with the development of their instrument cases.

R. M. Fiske was awarded the M.B.E. in the New Year's Honours List for his work in organising and building up a machine shop at the Philco radio factory at Perivale during the peak period of the war.

Dr. P. Dunsheath, President of the I.E.E., and **W. K. Brasher,** Secretary, have been on an official visit to Canada at the invitation of the Engineering Institute of Canada. They have also visited the American I.E.E. and I.R.E.

Amateur UHF.—The bands 420-430 and 1,215-1,295 Mc/s have been opened to amateurs by the Canadian and United States authorities.

Aeronautical radio and radio-controlled weapons are included in an exhibition of German aircraft and equipment being held under the auspices of the Ministry of Education at the Science Museum, South Kensington, London, which was reopened on February 14th. The exhibition is open on weekdays from 10.0 to 6.0 and on Sundays from 2.30 to 6.0. Admission is free and the exhibition will remain open for three months. The exhibits are provided by the Royal Aircraft Establishment, M.A.P.

A Course of lectures on elements of the design of automatic control (servo) systems will be given at the Northampton Polytechnic, St. John Street, London, E.C.1, at 6.0 on Tuesday evenings, commencing March 5th. Particulars of the course and tickets, costing 21s., are obtainable from the secretary. The lecturerers are: Dr. A. Porter

World of Wireless—

(Ministry of Supply), M. L. Jofek (Cossor) and Prof. K. A. Hayes (Military College of Science).

Change of Name.—The Marconi School of Wireless Communication, Chelmsford, will now be known as Marconi College.

"Music While you Work."—The Government agreement made in 1943 whereby music was permitted to be relayed in industrial premises without payment of individual licence fees expired on February 24th. It is now necessary for firms wishing to relay music in factories to secure a licence from the licensing organisations—Performing Right Society, 33, Margaret Street, London, W.1, and Phonographic Performance, 144, Wigmore Street, W.1.

Standard Telephones.—A new organisation—the Industrial Supplies Division—has been set up by S.T.C. for the distribution of the company's products in industry. The Division absorbs Stanelco Products, but the trade name Stanelco will continue to be used. Among the products to be marketed by the Division, which has sales offices in London, Birmingham, Bristol, Leeds, Manchester and Glasgow, are rubber- and plastic-covered wires and cables, soldering equipment and wire strippers.

Changes of Address.—The Central Research Laboratory of the Permanent Magnet Association has moved from the Physics Department, University of Sheffield, to 84, Brown Street, Sheffield, 1. Sea Rescue Equipment, Ltd., has moved to Chiltern Works, Clarendon Road, Watford, Herts (Tel.: Watford 6238). The address of the associated distributing company, Radio-Aid, Ltd., is 29, Market Street, Watford (Tel.: Watford 5988). Dawe Instruments, Ltd., are now at Harlequin Avenue, Great West Road, Brentford, Middlesex (Tel.: Ealing 1850).

Philco.—Under a new agreement with the Philco Corp., of Philadelphia, the Philco Radio and Television Corp., of Great Britain, is permitted to export radio and television receivers under the trade name Airmec or any other name, except Philco which is still to be used for the corporation's products sold in this country. The name of the company is also to be changed to Radio and Television Trust, Ltd.

Belling and Lee.—A catalogue of components and accessories (1946-47) has just been issued by Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middlesex. It gives full dimensions and electrical characteristics of the firm's products, which now include heavy-duty industrial suppressors for use with radio-heating equipment, a wide range of interconnector plugs and sockets, miniature fuse holders, glass seals, valveholders and a 50ft. "Skytower" lattice mast. For the time being circulation of the catalogue is restricted to engineers and designers.

R.G.D.—The Radio Gramophone Development Co., Bridgnorth, Shropshire, announce that they have in production a new high-quality radiogramophone which will be available this month. The company is opening depots in London, Manchester and Birmingham.

Department of Overseas Trade.—This department has now moved to 35, Old Queen Street, London, S.W.1, and all enquiries should be sent to the Comptroller-General at this address.

"Britain Can Make It."—A National Exhibition of Design is to be opened at the Victoria and Albert Museum on September 24th. Many industries are preparing new designs in time for the exhibition, and radio and television are in the list of commodities from which exhibits will be selected.

Quartz Crystals.—The tremendous expansion in the production of quartz crystals during the war is revealed by the Telecommunication Quartz Committee. Whereas in 1938 the output was about 10,000, in 1944 production had reached 1¼ million.

A Record?—Within half an hour of receiving his amateur transmitting licence on January 19th at 16.16 GMT, C. G. Allen, G8IG, of McMichael Radio, established, with the Norwegian station LA8C, what is probably the first official international amateur communication since the imposition of the ban in 1939.

Edgware Short-wave Society has changed its name to Edgware and District Radio Society and will in future meet each Thursday at the Constitutional Club, Manor Park Gardens, Edgware. The secretary is P. A. Thorogood (G4KD), 35, Gibbs Green, Edgware.

Amateurs in the vicinity of Chichester and Bognor may like to communicate with L. Frost (G5PF), of Pixies West Parade, Bognor, for details of the West Sussex Short-wave and Television Society which has been revived.

Stockport Amateurs.—The reference to the re-formation of the Stockport Amateur Short-wave Radio Society in last month's issue was a little misleading. The Society was re-formed a few months ago and, with a membership of some 50, now meets every Monday at 7.45 at the Textile Hall, Chestergate, Stockport, Cheshire. The secretary, G. Wood, c/o 121, Garners Lane, Davenport, Stockport, will gladly send particulars of the Society's activities to interested readers.

I.R.T.S.—The following officers were elected at the recent annual general meeting of the Irish Radio Transmitters' Society:—President, Dr. T. D. O'Farrell (EI6F); Vice-President, H. A. Hodgens (EI5F); Hon. Sec., Capt. E. C. Woods (EI3L); Hon. Treas., T. J. Green (EI9N).

"EI" Transmitters.—Although the transmitting gear impounded by the authorities in Eire was returned to the owners some months ago there are no signs of a revocation of the order prohibiting its use. At the annual meeting of the Irish Radio Transmitters' Society a strong plea was made for facilities similar to those granted in the U.K., U.S. and Canada.

B.S.R.A.—The first general meeting of 1946 of the British Sound Recording Association, held in the Kingsway Hall, London, on January 30th, was attended by members from many parts of Gt. Britain. Plans for the future development of the Association were discussed. Details of membership and leaflets outlining the work of the Association can be obtained from the Technical Sec., D. W. Aldous, BCM/BSRA, London, W.C.1.

Slade Radio.—The meetings of the Slade Radio Society are held on the fourth Friday in each month and not the last as was stated in our last issue.

A.R.R.L. Handbook.—The 1946 edition of the American Radio Relay League's "Radio Amateur's Handbook" is now available, but in limited supply, from Arthur F. Bird, 66, Chandos Place, London, W.C.2, price 10s. 6d.; postage 7d.

Year Book.—The Electrical Industries Benevolent Association have issued a Year Book for 1945, copies of which can be obtained from the Secretary, 32, Old Burlington Street, London, W.1. A list of 33 local committees and secretaries throughout the country is included.

For Newcomers.—"Amateur Radio Simply Explained" is the title of a 32-page booklet (price 1s. 3d.) issued by the British Short-wave League, 53, Madeley Road, Ealing, London, W.5.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Tuning Devices for Broadcast Radio Receivers," by Dr. R. C. G. Williams, B.Sc. (Eng.), at 5.30 on March 6th.

Radiolocation Conference.—A four-day radiolocation conference will be opened by a lecture by Sir Robert Watson Watt, C.B., F.R.S., on "The Evolution of Radiolocation," at 5.30 on March 26th. Meetings will be held on subsequent days at 9.30 a.m., 2.30 and 6.15.

Students' Section.—Address by the President, Dr. P. Dunsheath, C.B.E., M.A., at 7 on March 5th.

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

Cambridge Radio Group.—"A Method of Transmitting Sound on the Vision Carrier of a Television System," by D. I. Lawson, M.Sc., A. V. Lord, B.Sc., and S. R. R. Kharbanda. Special meeting with demonstration on March 1st at 6.45 at Pye, Ltd., Radio Works, Cambridge.

"The Design of Band-Spread Tuned Circuits for Broadcast Receivers," by D. H. Hughes, at 6 on March 12th at the Technical College, Collier Road, Cambridge.

British Institution of Radio Engineers

London Section.—"The Effects of Solar Eclipses on the Ionosphere," by Dr. R. L. Smith-Rose, at 6.15 on March 20th at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1.

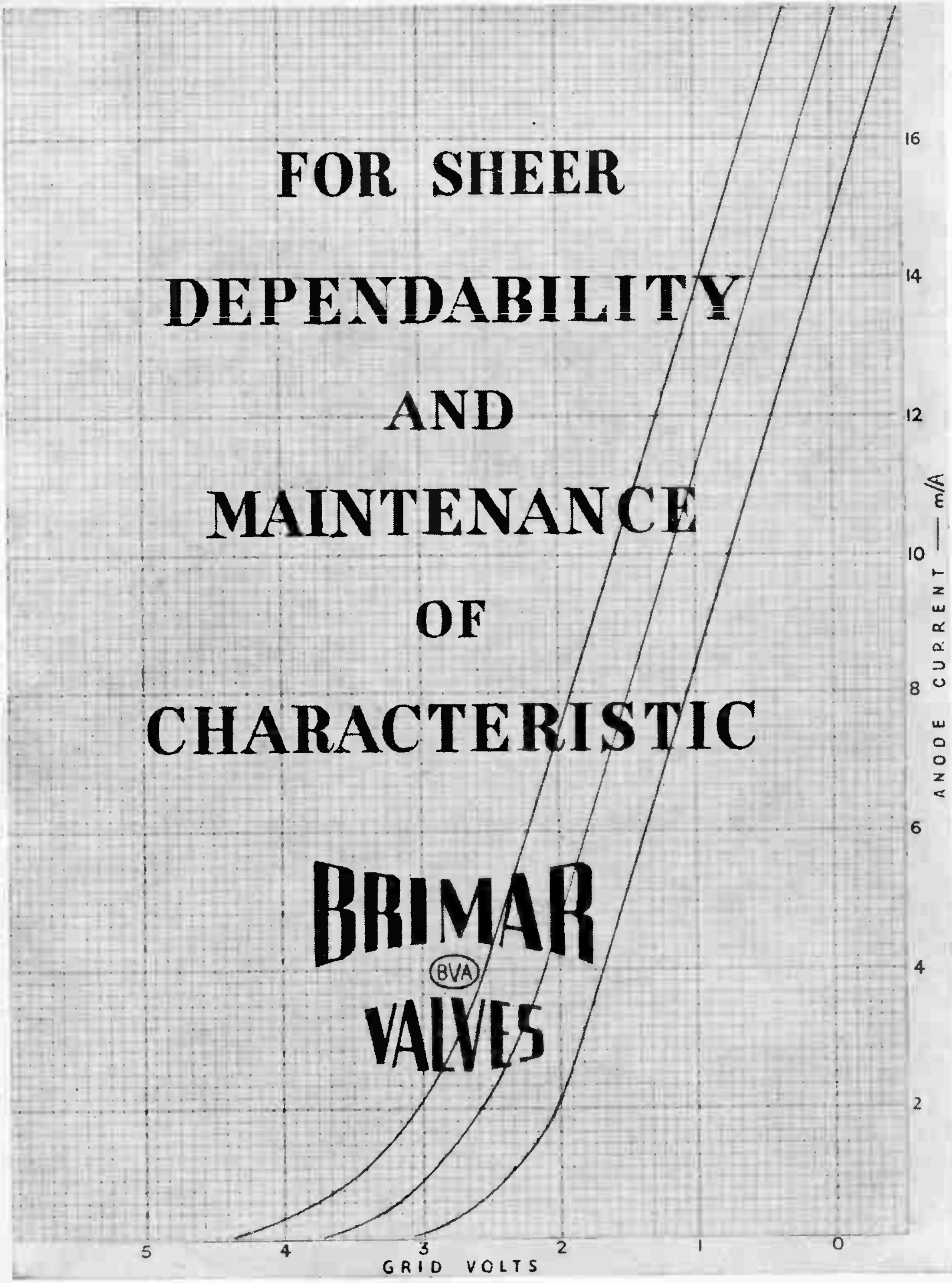
North-Eastern Section.—"Carrier Current Protection," by D. H. Towns, B.Sc., and C. Ollerenshaw, B.Eng., at 6 on March 13th at Neville Hall, Westgate Road, Newcastle-on-Tyne.

Radio Society of Great Britain

"Recent Advances in Frequency Measurement," by Dr. L. Essen, B.Sc., at 6.30 on March 15th at the I.E.E., Savoy Place, London, W.C.2.

Royal Institution of Great Britain

"Acoustic Control of the Flight of Bats," by Dr. H. Hartridge, M.A., M.D., F.R.S., at 5.15 on March 1st at The Royal Institution, 21, Albemarle Street, London, W.1.


FOR SHEER
DEPENDABILITY
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MAINTENANCE
OF
CHARACTERISTIC
BRIMAR
BVA
VALVES
16
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ANODE CURRENT —— m/A
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GRID VOLTS

NAVIGATIONAL RADAR

Experimental Equipment for Use in Merchant Ships

A DEMONSTRATION of experimental radar equipment designed for pilotage and collision prevention in narrow waters was given recently in the Thames Estuary by the Ministry of War Transport and the Admiralty. The object was to prove to shipowners the value of radar as a safety device, and to indicate to the radio industry possible forms which the apparatus might take. The suggestions embodied are the result of experiments carried out by the Admiralty Signal Establishment in H.M.S. "Pollux."

Technically the principal difference between the navigational radar shown and standard service equipment is in the minimum useful range, which has been reduced from something like 500 yards to better than 50 yards by using a pulse duration of only one-fifth microsecond. In addition the receiver circuits have been modified to suppress "clutter" due to random wave reflections near the origin, with the result that the centre of the display in the plan position indicator showing the ship's position is always clearly pin-pointed.

The bulk of the equipment has been designed for installation in any convenient part of the ship, and a separate display unit with the minimum practicable number of controls is available to the navigator in the chart room, or alternatively on the bridge. By means of a half-silvered mirror mounted at 45 degrees to the 9-inch cathode-ray tube the PPI display can be viewed in coincidence with a chart placed on a table immediately below; thus all the essential information of surrounding obstacles above and below the waterline is available at a glance. When out of use the mirror is closed flush with the front of the control unit and the act of pulling it out operates relay switches on the transmitter and receiver. A pilot lamp shows when the set is working.

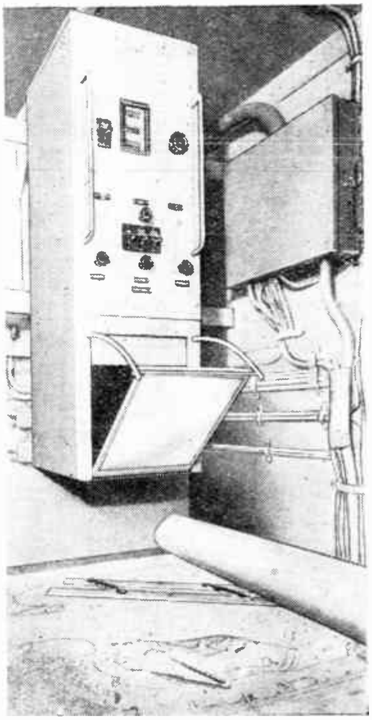


Chart Comparison Unit as used in H.M.S. "Pollux."

The controls available to the navigator include a "strobe" ring which can be expanded to touch any point in the display when the range can be read off directly in yards from a Veeder counter type of indicator. Three ranges are available with maxima of approximately 5,000, 15,000 and 40,000 yards. The first is the one normally used for pilotage and coincides with the charts. Special care has been taken to secure linearity in the time base and the registration is remarkably accurate.

The PPI display drifts with the movement of the ship but does not rotate with alteration of course, as it is locked to the gyro compass repeater supply and always keeps true north at the top of the picture. The direction of the ship's head is indicated by the brightening of a radial line at each revolution of the scanning time base.

Standard Admiralty charts are not altogether suitable for use with this equipment and the Hydrographic Department have produced experimentally some special charts in which the navigational marks are in black and soundings and fathom marks in grey. This is much easier to read in the subdued light required by the cathode-ray display. In addition the charts have been overprinted with contours and other salient features of the land likely to show up on the PPI display.

Experiments are also being made with corner reflectors on navigation marks to increase the return of energy and hence the range at which they can be picked up. Identification of marks by arranging a number of reflectors in simple geometric patterns is also being tried with success. This method has the virtue of simplicity and reliability when compared with the obvious alternative of fitting and maintaining radio beacons.

The corner reflectors consist of hollow sheet metal cones shaped as if cut from the corners of a hollow cube. Four or five of these are arranged in a cluster to trap energy arriving in a horizontal plane and reflect it back approximately in the direction of the transmitter.

A demonstration run of nearly an hour's duration down one of the busiest shipping channels in the Thames Estuary showed that the ship could be conned with complete confidence through the traffic leaving ships and buoys a cable's length on either hand. During the whole time the navigator based his helm orders solely on information given by the PPI display.

OUR COVER

THE 3-cm. aerial of H.M.S. "Pollux," illustrated on the front cover of this issue, rotates at 18 r.p.m. and transmits a beamwidth $1\frac{1}{2}^{\circ}$ in azimuth and 30° in elevation.

Design Data (2)

WIDE-BAND AMPLIFIERS

I.—Single-Circuit RF and IF Couplings : Coincidence Tuning

THE formulae employed for the design of IF intervalve couplings for sound channels are often of little use for the wide-band amplifiers used in television and in pulse technique generally. They are almost invariably approximations based on the assumption that the band-width n is small in comparison with the mid-band frequency f_m. This normally introduces negligible error, for it is but rarely that the band-width exceeds 15 kc/s at a mid-band frequency of 450 kc/s, making n/f_m rarely more than 1/30. For television purposes, however, the band-width is of the order of 5 Mc/s, and even at the television carrier frequency of 45 Mc/s, n/f_m is 1/9. Intermediate frequencies down to 10 Mc/s, or even less are widely used, so that n/f_m is often 1/2 or more.

It is essential, therefore, to employ formulae relieved from the limitation of $n \ll f_m$. It is, however, possible to adopt other approximations which would be invalid for the narrow-band case, but which here introduce negligible errors. In order to secure the necessary band-width, the circuit must be heavily damped and this is usually effected by means of a resistance connected in parallel with each tuned circuit.

Tuned Circuit Losses

The tuned circuit itself has losses which can be represented by series and shunt resistance ; the latter is chiefly dielectric loss and can be allowed for by lumping it in with the added damping resistance. The series resistance represents chiefly the copper losses of the inductance and cannot be included accurately without greatly complicating the equations. In wide-band amplifiers, however, its effect is small in comparison with the total shunt resistance and it can be neglected without serious error. A resonance circuit can, therefore, be considered as merely an inductance, a capacitance, and a resistance all in parallel.

There are many forms which an intervalve coupling can take. In general, the flatness of the response within the pass-band, the sharpness of the cut-off outside and the gain per stage all increase with the number of elements forming the coupling. However, the cost and the difficulty of adjustment both increase with the number of elements and a sharp cut-off outside the pass-band tends to produce a poor transient response.

On account of the difficulty of adjustment and the cost it is not usual to employ more than two resonant circuits in each intervalve coupling, and they are connected as a coupled pair in the familiar band-pass style. With this maximum of two circuits per coupling, the main classes of intervalve coupling are as follows :—

1. Coincidence-tuned single-circuits (i.e., single-circuit couplings, all circuits being tuned to the same frequency).
2. Stagger-tuned single-circuits (i.e., single-circuit couplings with the resonance frequencies of some displaced on one side of the mid-band frequency and of others displaced on the other side).
3. Coupled circuits (i.e., couplings each with a pair of resonant circuits coupled together by a mutual reactance).

Stagger-tuning can be applied to the coupled circuits of Class 3, but there is no advantage to be gained by it and it is normal for both circuits to be tuned to the same frequency. Even then, both Classes 2 and 3 can be sub-divided into groups with different characteristics depending on the amount of stagger and coupling respectively. Then, the same types of coupling need not be used throughout an amplifier, and it is sometimes advantageous to adopt different forms in different stages.

It will be seen, therefore, that with the restriction to a maximum of two resonant circuits per coupling, the possible variations in a multi-stage amplifier become quite large. In addition to the actual capabilities of a coupling, it is necessary also to consider its practical form and its ease and stability of adjustment. In many cases, some of the possible arrangements may be rejected because of adjustment difficulties, although on paper they offer a superior performance.

Coincidence-tuned Couplings

The data given here is confined to Class 1 circuits which are the simplest and easiest to adjust, but which have a rather poor performance. In spite of this, they are often used in the RF circuits of a superheterodyne, because their simplicity is particularly advantageous at very high radio-frequencies. A coupling of this type is also sometimes useful in one stage of an IF amplifier.

In the circuit shown, the tuned circuit comprises L, C, and R. As R is usually fairly low in value it is convenient to place it in the anode circuit of the valve where it carries the direct anode current. Because of its low value, the voltage drop is quite small. R_1 and C_2 are merely decoupling components and C_1 is the coupling capacitance. It is necessary only that C_1 should have negligible reactance at the frequencies employed. Usually, it suffices to make $C_1 \gg C$ and a value of 500–1,000 *p*F is adequate.

The capacitance C is not a component but is the sum total of the stray capacitances. Table I shows how they are distributed in a typical case and it is quite difficult to make the total much less than 30 *p*F. As the amplification per stage is inversely proportional to this capacitance, it is of the first importance to keep it at a minimum.

TABLE I

Capacitance of	*p*F
1st valve, output	4.75
2nd valve, input	15.5
Coil L	5
Wiring to earth	3
C_1 to earth	2
Total	30.25

The amplification per stage is the product of the mutual conductance of the valve and the resistance R and the latter is inversely proportional to both band-width and capacitance. It is quite independent of the mid-band frequency. The formulae enable the circuit values to be calculated for any likely band-width, attenuation at the limits of the pass-band and circuit capacitance. In addition, a curve is given for *n*CR against attenuation, expressed in db. instead of as a voltage ratio, in order further to simplify computation.

As an example of the use of the data, suppose a stage is required for a band-width of 5 Mc/s with a drop in response of 2 db. at the edges of the pass-band. Suppose also that the mid-band frequency is to be 13 Mc/s, that the valve has a mutual conductance of 8 mA/V and that the total capacitance is 30 *p*F. The value of S corresponding to 2 db. is 1.26, so that $\sqrt{(S^2-1)} = 0.765$, and equation (2) gives $nCR = 122$; alternatively, this value can be read directly off the curve. Then $R = 122/(5 \times 30) = 0.813\ k\Omega$, and equation (5) gives $A = 6.5$.

Equation (3) gives the resonance frequency f_r as 12.75 Mc/s, and hence (4) gives $L = 2.44 \times 10^4/(12.75^2 \times 30) = 5\ \mu H$. It should be noted that the resonance frequency f_r is different from the mid-band frequency f_m because the resonance curve is not symmetrical.

At really high frequencies, the two are negligibly different. Thus at 45 Mc/s, $f_r = 45\sqrt{1-(5/180)^2} = 45.017$ Mc/s. At this frequency R is unchanged, but L becomes $2.44 \times 10^4/(45^2 \times 30) = 0.402\ \mu H$. It should be noted that while R is unchanged the actual component used in the circuit in this position may be altered. R is the total damping resistance and the actual component used is only equal to this if other sources of damping are negligible. This is roughly the case at 13 Mc/s, but not at 45 Mc/s. At the latter frequency the second valve may have an input resistance of 2 kΩ or so only. With this value and $R = 0.813$ kΩ the actual component used would be $2 \times 0.813/(2-0.813) = 1.37$ kΩ.

With more than one stage the overall amplification is the product of the amplification of the individual stages. As the number of stages increases, however, the gain per stage drops if the overall band-width remains constant. Thus, if $n = 5$ Mc/s for a drop of 2 db. at the edges of the pass-band, and this is an overall requirement, the drop becomes 1 db. per stage for two stages, 0.5 db. for four and so on.

As a result of this there is a limit to the maximum possible amplification obtainable for a given band-width requirement, and this limit depends on the value of g_m/C. It is of the first importance to make this as high as possible.

Table II shows how the gain per stage varies with the number of stages in a particular case and the slow way in which the overall gain increases. With more stages it would reach a maximum, and with still more it would become less!

As gains of the order of 10,000 times are not uncommonly required, it is easy to see that coincidence-tuned resonant circuits form a most unsuitable coupling for a wide-band amplifier. The use of one or two such circuits, however, is sometimes desirable so that it is necessary to be able to calculate the performance.

TABLE II

$n = 5$ Mc/s for an overall drop of 3 db. at f_1 and f_2
$g_m = 8$ mA/V; C = 30 *p*F.

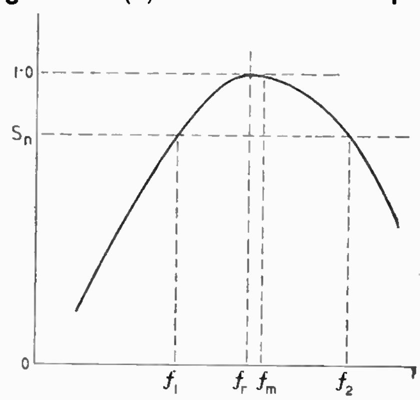
No. of stages	Drop at f_1 & f_2 per stage db.	R (kΩ)	Amplification per stage	Overall Amplification
1	3	1.06	8.48	8.48
2	1.5	0.642	5.13	26.3
3	1	0.54	4.32	79
4	0.75	0.46	3.68	182
6	0.5	0.368	2.94	640
8	0.375	0.313	2.5	1,520
10	0.3	0.28	2.24	3,160

The response at any frequency can be calculated from equation (1). In television the main use of this is to estimate the discrimination against the sound channel. As an example, with $f_m = 13$

Design Data—

Mc/s, and $f_r = 12.75$ Mc/s, the sound channel can be either 16.5 Mc/s or 9.5 Mc/s. If it is the former $m = 16.5 - 12.75 = 3.75$ Mc/s and if the latter $m = 9.5 - 12.75 = -3.25$ Mc/s. From equation (1) in the former case the relative gain is -4.38 db. and in the latter -5.54 db. From the selectivity point of view it is nearly always as well to arrange for the sound channel to be lower in frequency than the video channel.

Design Data (2): Wide-band Amplifiers



Let f_m = required mid-band frequency

n = required band-width

$f_1 = f_m - n/2$ = lower limit of pass-band

$f_2 = f_m + n/2$ = upper limit of pass-band

$f_r = f_m\sqrt{(1 - n^2/4f_m^2)} = \sqrt{f_1 f_2} = 159/\sqrt{LC}$

= resonance frequency of tuned circuit.

= frequency of maximum response

m = frequency difference from f_r.

S_n = Ratio $\dfrac{\text{response at } f_r}{\text{response at } f_1 \text{ and } f_2}$

S_m = Ratio $\dfrac{\text{response at } f_r}{\text{response at } (f_r + m)}$

g_m = mutual conductance of valve.

Units

Frequency (Mc/s); mutual conductance (mA/V); inductance (μH); capacitance (pF); resistance (kΩ).

Relative response at any frequency $= -10 \log S_m^2$.

$$= -10 \log\left[1 + 3.94 \times 10^{-5}(mCR)^2 \left(\frac{2 + m/f_r}{1 + m/f_r}\right)^2\right] \text{ db.} \quad \ldots \quad (1)$$

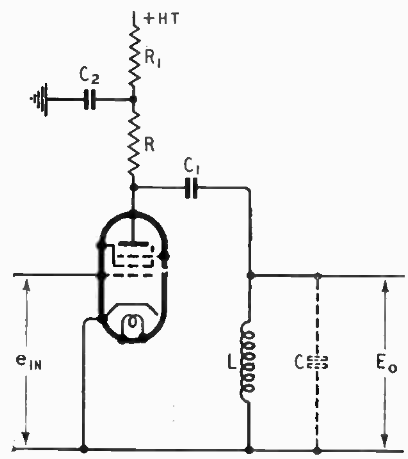
Given f_m, n, S_n, C, and g_m, to determine R, A, and L.

$$nCR = 159\sqrt{(S_n^2 - 1)} \quad \ldots \quad (2)$$

$$f_r = f_m\sqrt{(1 - n^2/4f_m^2)} \quad \ldots \quad (3)$$

$$L = \frac{24{,}400}{f_r^2 C} \quad \ldots \quad (4)$$

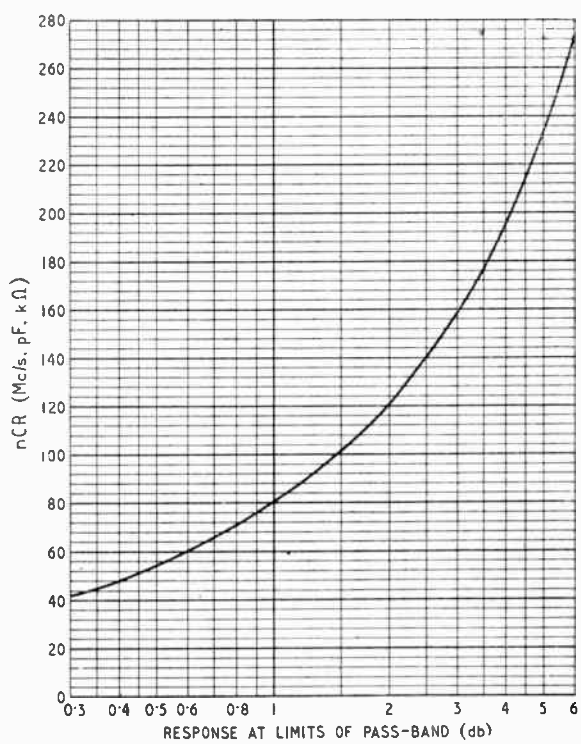
$$A = E_0/e_{in} = g_m R \quad \ldots \quad (5)$$



Conditions of Validity

1. That the series RF resistance of L damps the circuit negligibly in comparison with R.

2. That R represents the total parallel damping resistance of the tuned circuit, i.e., the combined value of the AC resistance of the first valve, the input resistance of the second, the various dielectric losses and the actual physical resistance used for coupling.



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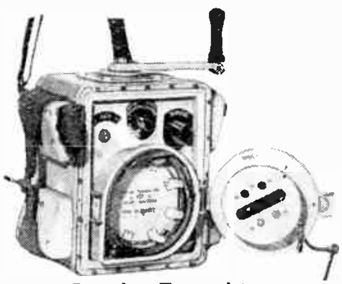

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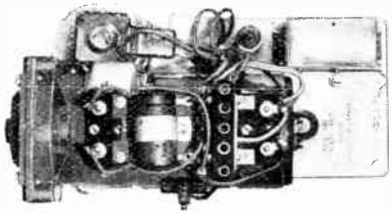

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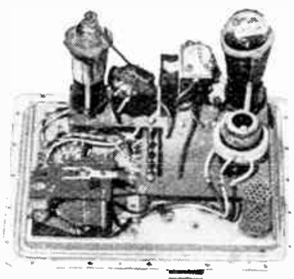

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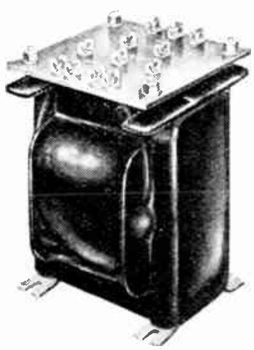

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DECCA NAVIGATOR

Continuous-Wave Navigation System

IT is well known that if the distance of a ship from each of three known fixed points, or the bearings of two fixed points from the ship, can be found the position of the ship relative to these points is completely determined. The measurement of the bearings is the basis of normal position-finding by directional reception. With ordinary DF equipment the operator in the ship takes bearings on two or more signals of known and fixed origin and the ship's position is easily calculated from these figures.

More recently distance measurement has come to the fore, largely because it is possible to measure distance more accurately than bearing by using the pulse technique of radar. The Gee system operates on this principle and proved its value during the war. The disadvantage of a pulse system is that it occupies a large frequency band. Sharp pulses are necessary for accurate range measurement and sharp pulses mean a large band-width. This in turn means a high operating frequency and this again means that the useful range is limited. The really high frequencies most suited to pulse work are limited substantially to ranges within the visual. This places a limit of 20–50 miles range at sea level, depending on the height of the transmitting aerials. For air navigation much larger ranges are possible, because of the great height of the aircraft, and it was largely this which made Gee usable over the Continent.

The use of lower frequencies permits long ranges to be obtained because of sky-wave reception, but the accuracy is reduced. Sky waves inevitably reach the receiver by a longer path than the direct and so give a false measurement of range. This could be allowed for if it were a constant, but in practice it is usually subject to variation.

If accurate range measurement is to be made at great distances it is necessary to work on frequencies which provide a direct ray and preferably, but not essentially, do not provide any sky wave. This means low radio frequencies of, say, 100 kc/s or lower, depending on the range required. But such frequencies can hardly be used with pulses and some alternative method of measuring range is very desirable.

Such an alternative is used in the Decca Navigator. Only continuous waves, normally unmodulated, are used, and the bandwidth needed is thus negligible. Range is measured by comparing at the receiver the phase of signals from known spaced stations.

As an example of the basic principle, suppose that there are two stations A and B in Fig. 1 a distance d_3 apart and that each is radiating a wave of 100 kc/s in the same phase. That is to say,

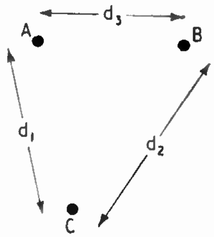


Fig. 1. Transmitters A and B spaced d_3 apart are at distances d_1 and d_2 from a receiver at C. The text explains how this gives a phase difference in the signals at C.

at any instant of time when the wave at A reaches its positive maximum that at B also reaches its positive maximum.

If this maximum is imagined to travel outwards from A with the velocity of light it will reach the receiver at C, after a time $t_1 = d_1/c$ where c is the velocity of light. Similarly, the maximum from B reaches the receiver at $t_2 = d_2/c$. At C, therefore, the two waves are not in phase because they have travelled different distances, and the difference of phase is a measure of the difference of distance.

The transit time of one cycle is $1/f = \lambda/c$, so that the time intervals representing distances are d_1/λ and d_2/λ expressed as fractions of a wavelength. In terms of phase there are 360° to each wavelength so that the phases at C relative to the transmitters are $\theta_1 = 360\ d_1/\lambda$ and $\theta_2 = 360\ d_2/\lambda$. The relative phase of the two signals at the receiver, which is all that can be measured, is $\phi = \theta_1 - \theta_2 = 360(d_1 - d_2)/\lambda$. The relative phase of the two signals at the receiver is thus a direct measure of the difference of distance from the two transmitters.

It may well be asked at this point how the signals from the two stations are distinguished since they appear to be two continuous waves of the same frequency. In fact, they are not. The frequencies transmitted are different but have a common

A marine model of the Decca Navigator.

Decca Navigator—

harmonic. Thus, A might radiate on 85 kc/s and B on 113.3 kc/s. The receiver at C receives these signals separately and generates harmonics of each. The fourth harmonic of 85 kc/s is 340 kc/s, and the third of 113.3 kc/s is also 340 kc/s, so that in this way the effect of two signals of the same frequency is produced and it is the phase difference between these harmonics which is actually measured.

This is done by a phase-meter. The signals are applied to discriminators which produce direct currents proportional to the sum and difference of the phases. These are passed through coils at right angles and a magnet in the field, coupled to an indicating pointer, takes up a position along the resultant. The phase-differences can thus be read directly from a dial.

This measurement of the phase-difference between the signals from two stations does not enable one to determine one's position, for there are an infinite number of points of equal difference of distance from the stations. It is easy to see that a receiver on a line bisecting at right angles the line joining the transmitters is always at the same distance from each, and hence that the phase difference is zero. All that the reading tells one is that one is somewhere on that line.

Similar imaginary lines exist for each phase angle and take a hyperbolic form. Such a set of lines can be drawn as a grid on a map or chart, and would take the form shown in Fig. 2 by the solid lines. An indicator reading of 240 would then indicate that one was somewhere on a line passing through Dover.

This difficulty is resolved by using a third station, in the example of 127.5 kc/s, in conjunction with the 85 kc/s transmitter. The second harmonic of the one (255 kc/s) and the third of the other are the same frequency, and these two stations lay down a further grid, shown dotted. The receiver is provided with a second phase-meter to measure the phase difference between these signals and the two readings give a definite fix. Thus, if the phase reading is 240 on the solid grid and 710 on the dotted, the two cross at Dover. For Brussels, the readings are 242 solid and 760 dotted.

There is another point of possible ambiguity. The phase angle does not indicate only one line on the grid, for a given phase angle can represent many differences of distance. The formula given earlier can be written $d_1 - d_2 = \phi\,\lambda/360$, but this is not

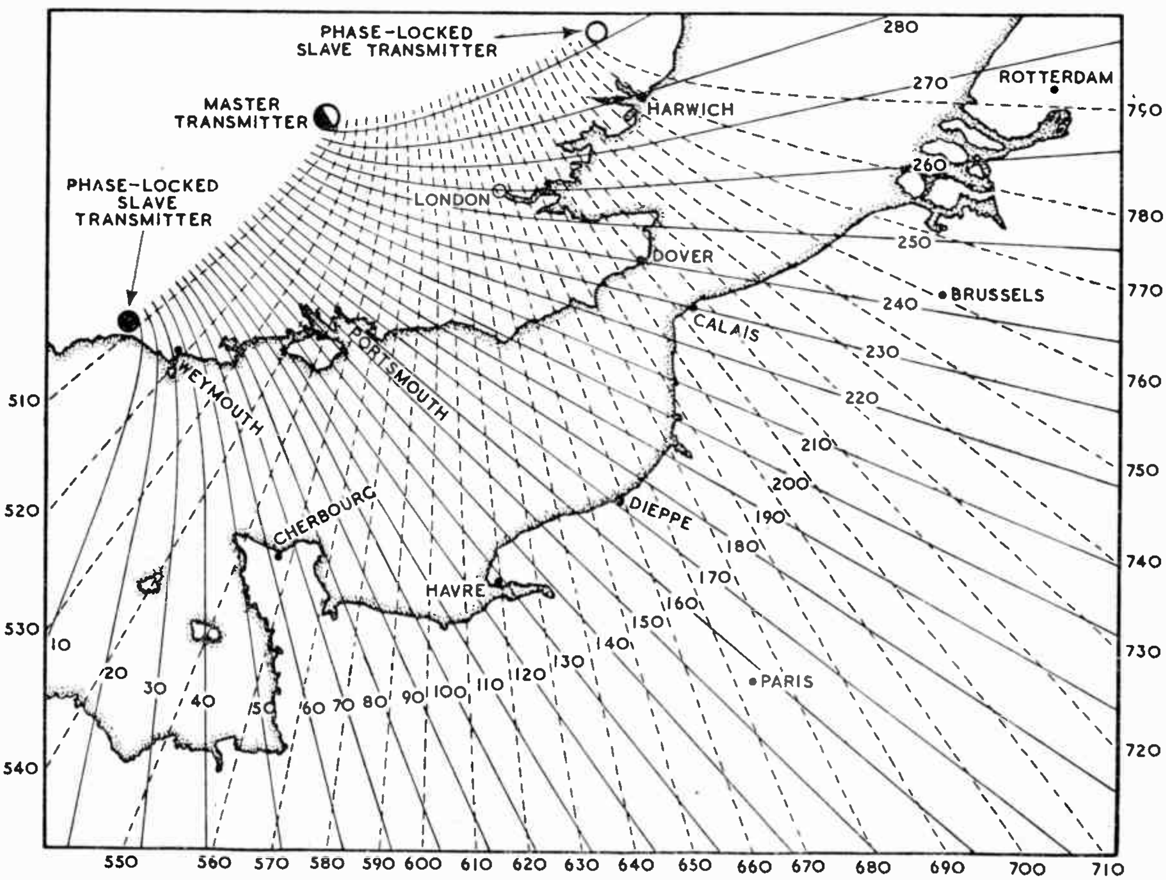
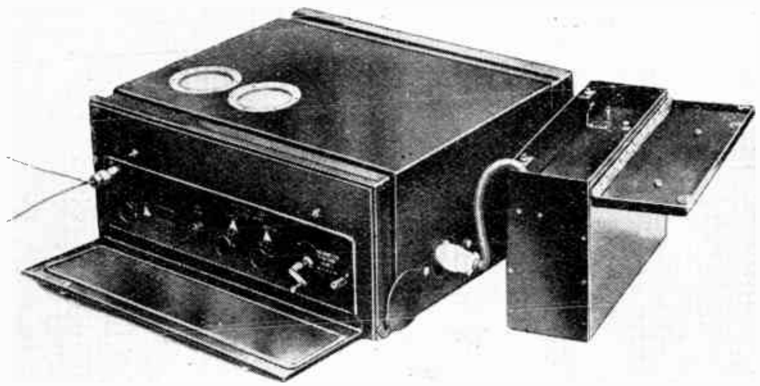


Fig. 2. This diagram shows how the use of three transmitters enables a double-grid to be placed on a map to indicate the position of a receiver. The solid lines indicate a grid produced by one pair of stations and the dotted lines that caused by the second.

necessarily correct, for the phase difference repeats itself every wavelength. The addition to ϕ of $360\, n°$ makes no difference, so that the formula is more correctly $d_1 - d_2 = (\phi \pm 360\, n)\lambda/360 = \phi\lambda/360 \pm n\lambda$ where n is any integer. A given phase difference thus indicates any number of differences of distance varying by whole numbers of wavelengths.

ceivers of high stability and incorporating an oscillator with the aid of which a zero adjustment for phase drift can be made at any time. Usually, a daily check is sufficient. Two indicators are provided each with a series of dials rather like a gas-meter and calibrated in "lanes."

In use, the operator starts from a known position and sets the



The aircraft version of the equipment is produced in this form.

With a third transmitter this leads to a number of possible positions. Some of these may be excluded on extrinsic grounds; thus in a surface vessel any positions on land are obviously ruled out.

In order to overcome this two means are adopted. The first is to start from a known position and keep the receiver operating continuously. The phase difference indicator makes a complete revolution for every wavelength passed through, so that a revolution-counter attached can indicate the total number of waves passed through and ties the reading down definitely.

This fails, of course, if reception is interrupted and to enable a fix to be obtained at any time, an 85-kc/s signal is periodically transmitted in addition to the normal signals from the other stations. This has the effect of swinging the grid and from the second set of readings the true position can be obtained.

All this sounds very complicated, but the apparatus is actually very simple to use. It consists essentially of three straight re-

dials to read correctly by a hand control. The gear is in continuous operation and to find the position at any time it is necessary only to read the dials and refer to the gridded chart. If the initial position is not known or if reception has been interrupted, the operator takes additional readings at a time when the 85-kc/s signal is being transmitted from the other stations and from this additional data a simple calculation gives the true position.

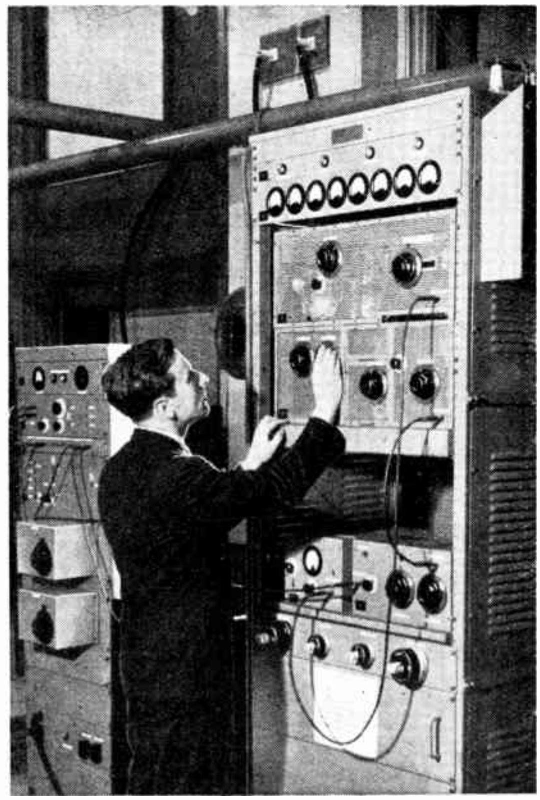
Reference has been made to the indicators being calibrated in lanes. They actually measure phase difference and one revolution of the main indicator covers 360 degrees. This is called one lane and sub-divided into 100 divisions. The subsidiary dials geared to it as revolution counters read tens and hundreds of lanes. The lane is thus a purely arbitrary measure and is adopted as more convenient for the non-technical than a calibration in phase angles.

The apparatus is produced by the Decca Navigator Company, a subsidiary of the makers of Decca broadcast receivers and gramophone records.

IS THE B.B.C. DOING ITS JOB ?

Unwanted Legacies from the War

By "CATARACTACUS"



Is the B.B.C. making full use of the technical advances in radio? At any rate, the engineering division is active in testing new methods: this photo shows an experimental FM transmitter recently installed at Alexandra Palace. Tests are being made on about 90 Mc/s.

IT cannot be denied that the well-being of the wireless industry, and therefore that of many readers of *Wireless World*, is closely bound up with the success of broadcasting as a national source of entertainment. The telecommunications side of wireless is large and important, and the electronics branch is growing rapidly, but in volume of business and the number of people employed, both are small in comparison with the manufacture of broadcast receiving sets. The sale of these sets, and therefore the prosperity of the industry, depends almost entirely upon the quality of the programmes put out by the B.B.C. Admittedly there are not a few enthusiasts whose interest in wireless lies in other directions, but they are a small part of the whole body of wireless users, and it is ultimately upon the ordinary listener who wants his receiving set to bring him in good entertainment from the local station or stations that the industry as a whole must mainly depend.

Austerity Programmes

Is the B.B.C. really doing its stuff? Recently I have had a unique opportunity of going rather thoroughly into that question. For more years than I care to remember wireless has been the greatest of my hobbies; but until recently I have never had to rely upon B.B.C. programmes as my chief—almost my only—source of entertainment. I have had to do so for the last two months, and it happened in this way. I lost the sight of one eye during the war and the other began to fail about three months before this article was written. So rapid was the loss of sight that I passed in a few weeks from stronger and stronger spectacles to a reading-glass and then to complete inability to read. There followed three weeks in hospital and further almost sightless weeks at home.

Now, if anybody is qualified to judge whether wireless offers a reasonable amount of reasonably good entertainment it is one who cannot see to read. I very soon came to the conclusion that what the present B.B.C. broadcasts do provide is a small amount of really good entertainment, a larger, but still not great, amount of fairly good entertainment, some items which are neither entertaining nor definitely annoying and a much too large amount of noises of various kinds which are not entertaining in any way.

Lest I should be thought to be a crank of some kind with marked predilections for the high-brow, low-brow or middle-brow type of programme, let me say that I had ample opportunities, which were used to the full, of discussing the question with other victims in hospital. They agreed heartily with my conclusion that it was high time that the B.B.C.'s austerity programmes came to an end and that Broadcasting House should take immediate and long-overdue steps to set itself in order.

It has been stated (I remember seeing it in print somewhere) by some B.B.C. official that the listening public "did not mind canned programmes." Let me hasten to disabuse that official and the B.B.C. at large of this idea. The public, though it accepted reproductions by various methods as a wartime necessity, is now most heartily sick of them and most completely convinced that they should cease except, of course, when some outstanding item is repeated at a later date. Please do not think that my cross-section was confined to hospital patients. I have raised the point with dozens of other people, and the only voice I have heard in favour of broadcast reproductions was one who said, "I like the fill-up gramophone records because they often give you such jolly music."

I agree with this lone voice up to a point. What I do regard as little short of disgraceful is that gramophone records as broadcast should still be scrapy, that records with a radial scratch which produces a tick at every revolution should be retained in the library, and that such things as a wobbly record should be allowed in the studio.

"That Was a Recording . . ."

If you are sceptical about the amount of use made by the B.B.C. of recorded programmes at the present time, do a bit of solid listening and make a note of the number of times that the announcer says "that was a recorded item." I remember once even hearing "that was a recording of a recorded programme." Is there any excuse for the very large proportion of canned stuff that we now have in our broadcast programmes? I cannot think that there is. The B.B.C. has drawn a large income during the last six years, and must have been put to comparatively small expense in the entertainment which it has provided. We still have only two main programmes, though a third, the "C" programme, is stated to be coming shortly. If financial stringency is the excuse, that will not hold water when the licence fee is increased to £1, but even now there must be plenty of money available. The only other excuse for excessive use of recordings is shortage of staff. At the present rate of demobilisation the B.B.C. must have a continual inflow of returning members of all branches of its staff; but the programmes do not reflect this.

They strike one in general as utterly lacking in life and liveliness. The use of so much recording is symptomatic of both these things. Surely one way in which wireless should score over other forms of entertainment is that it enables sounds to be sent out to listeners as they actually occur. There is much the same fundamental difference between wireless and the gramophone as there is between television and the cinema. Wireless and television can broadcast actual happenings; the gramophone record and the cinema screen reproduce sounds and events that took place some time previously. In the recorded programme one of the strongest appeals of wireless is entirely lost.

And there are other points to be considered. The general level of recording is not particularly good. In this respect we appear to be far behind the German broadcasting stations which, in the magnetophone, had developed something much better than we possess. If we must have recorded programmes they should be of the very highest quality. No one, I think, will maintain that this is so at the present time. Again and again, if you happen to switch on in the middle of an item you can say, from obvious shortcomings in quality, "that's a recording."

To turn to another side of the question, one is puzzled that so many mediocre artists should be allowed to appear before the studio microphones. With its great financial resources, the B.B.C. should be able to pay for the best in any entertainment category. I can see no excuse for their presentation of alleged funny men, who are not merely second-rate but fifth- or even tenth-rate. Not long ago I heard one of the last tell a story which I well remember my grandfather citing as a typical example of the stale joke of his boyhood days.

I do not see why we should suffer the puddingy contralto, the wobbly soprano or the adenoidal tenor. Yet they are inflicted upon us time and again.

A Gloomy Outlook

Unless the B.B.C. realises its responsibilities and makes real efforts to bring the programmes up to the standard which we ought to be able to expect of them I can see a real slump in the wireless market. Already there is a tendency to make use of the receiving set for the news and just for odd outstanding musical and other items. Should this grow, it will be a sad day for one of the biggest industries of this country, for if little use is made of the receiver the feeling will grow that any old set will do. I find even now that quite a number of people are beginning to say that the old set which has gone quite well during the war still does all they want and that they therefore do not see the point of getting a new one. Let this tendency grow by providing unattractive programmes, and the results will be too horrible to contemplate.

UNBIASED

By
FREE GRID

Differential Cookery

NOWADAYS everywhere seems to be infested with preview exhibitions of the so-called wonders which, so the manufacturers threaten us, we are going to have installed in our homes when production gets into its full stride once more. As a result of all this I have been dragged hither and thither from exhibition to exhibition by Mrs. Free Grid until I scarcely know what I am doing.

Even *I* was surprised.

Probably the least boring of these exhibitions was one staged a few weeks ago in Lower Regent Street by the electrical industry. At one stand the attendant female expatiated at some length on the ultra-modern "stream-lining" of the post-war electric cookers. It was at this moment, I think, that I first realised what the late lamented Adolf really meant when he talked about his patience being exhausted, and I somewhat tartly asked what benefit streamlining conferred unless it was proposed to mount the cooker on the roof of a car. Even *I* was surprised at the ferocity with which the assembled females rounded on me, and I was rescued with difficulty by a wild-eyed, long-haired young man who asked me if I would like to see something really interesting in cookers which was being deliberately kept off the market by certain vested interests.

At his suggestion we took a taxi to the wilds of Camden Town and before long I was enjoying such cooking and such a variety of dishes that even Lucullus himself might have envied. My surprise was intense when my host said that the sole ingredients were Spam and dried eggs and that the apparent variety of dishes was obtained by a method of cooking which he had been inspired to develop by reading an article on diathermy in this journal some six years ago.

By means of the diathermic radio cooker which my new-found friend had developed he could not only do such simple tricks as heating the middle of a cake before the outside, in contrast to ordinary methods of cooking, but by means of various adjustments he could take a cake, a lump of Spam or anything else and arrange that alternate layers of it could be cooked and uncooked, or semi-cooked to any desired degree. It was by this method of differential cooking that he obtained such superb and varied culinary effects. His *pièce de résistance* was to take me to a tank of live trout and invite me to select my victim just as they used to do in certain restaurants. Having done so it was but the work of a moment for him to cook it alive *in situ* without the slightest raising of the surrounding water temperature.

I thoroughly enjoyed the occasion until shortly after we left in the taxi I noticed that we were passing through Hilldrop Crescent which figured so prominently in the B.B.C.'s Crippen broadcast of a little while ago. It is a far cry to 1910, but nevertheless, thinking of the variety of dishes I had tasted, I felt distinctly uncomfortable.

Pictures in the Fire

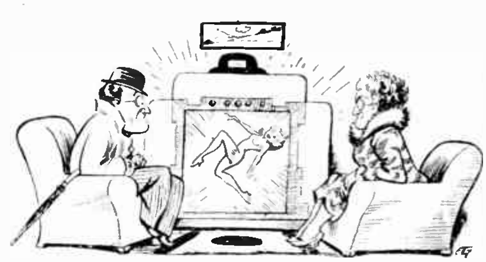
ONE of the things which never ceases to astound me is the extraordinary lack of imagination possessed by those whom one might expect to be the very people to have it in abundance. The cause of my astonishment on this occasion is a discussion which has been going on in a Sunday newspaper about television, a discussion to which some of the leading lights of the technical world have been contributing.

The discussion has mainly revolved round the question of the correct position, in the average living room, of the receiver so that the picture may be looked at in comfort by the whole family. It has been rightly pointed out that the average Englishman is so much a creature of habit that he still insists on sitting round the fireplace just as though there were a fire in the grate as in pre-war days.

Amid the welter of utterly absurd suggestions which have been made, including the projection of the picture on to the ceiling, it has apparently not occurred to any of the leading lights of the technical world who have been taking part in the discussion that there is one obvious place for the screen which is not only ideal from a seeing point of view but ideal also from the technical aspect. I refer, of course, to the usual rectangular fireplace aperture into which the viewing screen would fit nicely. It would also be in the correct position for everybody seated round the fireside circle to obtain first-class entertainment.

The innards of the television receiver itself would be built into the space behind the screen, usually occupied by the grate, and the control knobs would be suitably arranged at the top of the screen. Not the least of the advantages of this arrangement would be that the television set, an ugly and cumbersome thing at its best, would be stowed away out of sight: but the greatest advantage of all from a technical point of view would be that the chimney would form a short and direct path for the connection to the aerial perched on the chimney pot above.

As for those who would attempt to throw cold water on my suggestion by asking what about the days when we *do* get some coal, my reply is that by this time every house will be centrally heated. But, as a concession to the old-world sentimentalists who enjoy the "flickering firelight's fitful gleam," as the poet puts it; why, even they could be catered for, as the B.B.C. could very appropriately adopt the flickering gleam as an interval signal and throw a recorded moving picture of it on to the screen. Any objections, please?



Fireside Flicks.

Letters to the Editor

Solar Signals • Distorted Definitions • B.B.C. Quality

"Signals from the Sun"

RECENT pronouncements on the radio and in the Press, also your extract from *Nature*, in the January *Wireless World*, would appear to credit Sir Edward Appleton with some interesting discoveries and theories, in connection with the radiation known as the hissing phenomenon. I think credit should have been given to myself for more than just "sending reports on a strange hissing sound"!

In actual fact, I, together with several other people, particularly Mr. E. J. Williams and Miss N. Corry, did a very considerable amount of observation and theoretical work on the subjects between 1936 and 1939, and I think I am correct in claiming to be the first to have pointed out the reception of the radiation, also to conclude that it was a radiation originating on the sun. Its relation with ionosphere storms and short-period fade-outs was also pointed out by myself, and Mr. E. S. Williams showed that the appearance of the radiation coincided with the times of chromospheric eruptions on the sun.

Published letters and articles, together with my own correspondence on the subject, will confirm the above claims.

D. W. HEIGHTMAN.
Clacton-on-Sea, Essex.

Defining Distortion

YOU may be interested to know that I have recently written to the British Standards Institution to urge reconsideration of certain definitions given in BS204 (Glossary of Terms used in Telecommunications). Some of the definitions to which I take exception are:—

1301 **Distortion.**—"The change in wave-form. . . ."

Distortion is not *necessarily* a change in wave-form. Suppose an amplifier used in conjunction with a constant-output variable-frequency audio oscillator fails to amplify to the same extent over the whole range of frequency. It is then guilty of frequency distortion, notwithstanding which it may preserve the original sinusoidal wave-form of the oscillator unsullied. In quite a practical case, therefore, the definition breaks down.

1302. **Attenuation Distortion.**—The deprecated alternative "Frequency Distortion," is the generally accepted term, whereas "Attenuation Distortion" is rarely if ever used. The former might be attacked by purists on the ground that it is not distortion of frequency (but see 1305 below) but at least the term is descriptive, and accurate as normally understood. "Attenuation Distortion" on the other hand is not only self-descriptive but is misleading, e.g., an amplifier subject to this distortion may not attenuate at any frequency concerned. Nor is it distortion necessarily associated with the function of attenuation; on the other hand, there are other sorts of distortion that may accompany attenuation. It is difficult to discern a motive for attempting to displace a universally and internationally used term by one which is obscure and ambiguous. A few writers may be led to adopt the new term, thereby introducing non-uniformity and confusion.

There appears to be some involuntary "distortion" of the text in the description of the method of measurement. Incidentally, if definition No. 1301 were sound, there would be no need to say "when harmonics are present"—they would necessarily be present.

1304. **Delay Distortion.**—It is not quite clear why "Transient Distortion," the commonly understood meaning of which is correctly defined in BS661 No. 4135, is given as an alternative. Transient distortion may take place in systems into which the consideration of propagation time does not enter. "Transient Distortion" has therefore been introduced as an alternative to a term with a

Letters to the Editor—

different meaning, leaving no term to cover its own meaning. Here again, the result of the more recent work is likely to be confusion.

1305. **Non-Linear Distortion.**—If it is necessary to be pedantic enough to reject "Frequency Distortion," surely this term fails too, as it is not the distortion that is non-linear. Strictly speaking, it should be "Non-Linearity Distortion."

1307. **Harmonic Distortion.**—The words "of a network" introduced an unnecessary limitation in meaning, and are inconsistent with preceding definitions, which refer to a "system."

1308. **Intermodulation Distortion.** — The use of the word "tone" here is inconsistent with the only definitions of that term given in either of the Glossaries. The word is not used at all in No. 1307, so there seems to be no need for it in 1308.

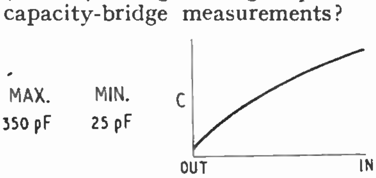
M. G. SCROGGIE.

Bromley, Kent.

Marking Variable Condensers

I WONDER why manufacturers hardly ever supply any data concerning capacitance and characteristics of variable condensers.

Would it not be very easy to stamp this information on one of the endplates, whereby one could tell at a glance what to expect of any particular component, instead of having to trust one's judgment (or luck) or to go through repeated capacity-bridge measurements?



All that is needed is something like the above.

G. KIRSCHNER.

[It seems doubtful if anything useful about the capacity law can be conveyed in a graph of practicable size. One could learn as much by looking at the vanes. Minimum and maximum values are highly desirable—they could very simply be marked, to take the example given, as 25/350 pF. —Ed.]

Wartime Hangovers

I CANNOT allow your reference to the quality of BBC transmissions to pass without endorsing your opinion in the strongest terms.

BBC quality before the war often left much to be desired. During the war and since its termination, as you point out, the distortion introduced by the BBC has in many instances been deplorable. It is, of necessity, admitted that under wartime conditions undue criticism in this direction would be unfair. To-day, however, it is high time that steps were being taken to rectify this state of affairs. Apart from the psychological aspect, recordings, however good (and most are far from good) can never provide the high quality that may result from direct transmission. Notwithstanding this, how often it is that the majority of the principal evening broadcasts consist of recordings?

Furthermore, direct broadcasts are subject to varying degrees of distortion of such divers types as to defy definition. It is not simply absence or excess of top or bass, which can be corrected quite easily in the receiving circuit, but additional extraneous matter, which I suppose would be classed as amplitude distortion, which it is quite impossible to correct. Clarity, atmosphere and intimacy of the broadcast are problems in themselves which one finds rarely solved to the satisfaction of the listener. We hear of the coming of high-fidelity television sound channels, but mere increase in frequency range will only make matters worse if the more important types of distortion are not prevented from appearing in the modulated carrier.

The BBC can and does sometimes transmit excellent quality. In most cases, however, this is confined to studio broadcasts of either plays or dance bands.

In view of this, may I suggest that listeners with high-quality receiving gear tabulate broadcasts to which they listen, and set out briefly their opinions and criticisms, with a view to ascertaining if there is general agreement as to which broadcasts are good, and which are bad? A scale could be devised such as Deplorable, Bad, Poor, Moderate, Fairly Good, Good, Excellent, with a short note stating the reason for such comment. These criticisms would, of course, involve the audio quality alone, and not relate in any way to the subject-matter of the programme.

The tabulated results, epitomised, might be published in *Wireless World* in a like manner to readers' views on gramophone recordings.

I suggest that quality enthusiasts forthwith commence to agitate for a considerable improvement in the acoustic quality of our broadcasting system.

A. A. COTTERELL.

Wednesbury.

Surplus Disposal

THERE will be general support for the suggestion that test equipment should be available to ex-Service technicians on favourable terms. At the same time, it becomes difficult to know where to draw the line.

There are many now returning to their former occupations, or starting new, who have been working in the various establishments designing and developing equipment for the Services. The decision as to being Service or civilian workers was not always theirs to make.

I feel that these people also should be given an opportunity to buy test equipment on terms similar to, though not necessarily identical with, the men from the Services proper.

I think that in either case there should be some assurance that the equipment is for their own use, for experimental work or business purposes, and not for resale.

W. H. O. BANHAM.

Mersea Island, Essex.

BOOK RECEIVED

The Cathode-Ray Tube Handbook. By S. K. Lewer, B.Sc. This brief handbook gives an elementary description of how the cathode-ray tube works and of the associated time-base, amplifier and power supply which are needed to form a complete oscilloscope. It concludes with a chapter illustrating some of its applications. Pp. 100+xviii. Published by Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 6s.

SHORT-WAVE CONDITIONS

Expectations for March

DURING January, 1946, short-wave conditions were somewhat more stable than during the previous few months, though a few ionosphere storms did occur. The first and most serious of these started on the 2nd, became severe on the 3rd and 4th and did not finally clear up till early on the 7th. Conditions were then stable until the 11th, when a slight deterioration in reception occurred and persisted through the 12th. Further slight disturbances occurred during the periods 18th to 21st and 24th to 25th, the latter being the more serious of the two. During the rest of the month stable conditions prevailed, apart from a sharp "Dellinger" fade-out, which occurred between 1240 and about 1330 GMT on the 31st. It is thought that this was associated with a very large sunspot which was near the sun's east limb.

Apart from the effects of ionosphere disturbances conditions during January were such that the maximum usable frequencies for this latitude were somewhat higher than for the previous month, both for noon and midnight. This followed the normal seasonal trend—mid-winter being past—but the increase appeared to be enhanced by an increase in solar activity which occurred during the month.

Forecast. — Conditions during March—apart from ionosphere storm effects—should be such that considerably higher night-time frequencies would be usable, whilst the daytime frequencies should, in general, be *slightly* higher than at present. Below are given, in terms of the broadcast bands, the wavelengths which should be most reliable during March, for four long-distance circuits running in different directions from this country. It is to be noted that other wavelengths — generally longer — will often be usable at the same time of day, and also that shorter wavelengths will sometimes be usable. For example, during the times when the 11 m. broadcast band is given as usable the 10-m. amateur band is most likely to yield results.

Montreal: 0000, 25 or 31 m; 0500, 41 m; 1000, 25 or 31 m; 1100, 16 or 19 m; 1300, 13 or 16 m; 2000, 16 or 19 m; 2200, 25 m.

Buenos Aires: 0000, 25 or 31 m; 0400, 41 m; 0800, 25 or 31 m; 1000, 13 or 16 m; 1400, 11 or 13 m; 1700, 13 or 16 m; 2000, 16 or 19 m; 2200, 25 m.

Capetown: 0000, 25 or 31 m; 0600, 25 or 19 m; 0700, 13 or 16 m; 0900, 11 or 13 m; 1600, 13 or 16 m; 1800, 16 or 19 m; 2000, 25 m.

Chungking: 0000, 41 m; 0500, 25 m; 0700, 16 or 19 m; 0900, 13 or 16 m; 1300, 19 or 25 m; 1500, 25 m; 2100, 31 or 41 m.

A considerable amount of ionosphere disturbance usually occurs around the equinoxes, so that conditions during March are quite likely to be erratic, particularly over dark transmission paths. Although it is impossible to say with certainty, it would, at the time of writing, appear probable that during the periods 7th-8th, 17th-21st, and 26th-28th, conditions are more likely to be disturbed than on other days.

TRADE NOTES

Agents.—The Dubilier Condenser Company has now appointed agents in all the principal centres of the country for the sale of its products. The address of the local representative can be obtained from the Company's Head Office, Victoria Road, North Acton, London, W.3.

New Stroboscopes.—Two new models have been introduced by Watford Instruments, Loates Lane, Watford. The "Strobospeed" has been redesigned and gives greater light intensity up to speeds of 50,000 r.p.m., and the "Stroboflood," which makes use of a new Ferranti tube, is designed to give good illumination over an area of several square yards.

Leaflets describing the "Pylon" hearing aid are issued by the makers, Park Royal Scientific Instruments, Ltd., 52, Minerva Road, London, N.W.10.

The "Labpress," made by Wright and Weaire, High Road, Tottenham, London, N.17, for small-scale laboratory production of plastic mouldings, is described in a recent leaflet.

Comprehensive illustrated catalogue of public address, intercommunication and other acoustic products has been issued by Ardente Acoustic Laboratories, Guildford.

RANDOM RADIATIONS

By "DIALLIST"

The Magnetophone

A FRIEND home on leave from BAOR has given me a few facts about the Magnetophone which may be of interest to readers. He couldn't tell me if this German recording system has been greatly modified since it was first described in 1937, but he says that the strip used for magnetophone recording is not just provided with a metal coating; it is actually impregnated with minute particles of metal. Anyway, the results are said to be so good that (unlike too many of the B.B.C.'s efforts) a recording can hardly be distinguished from the original. My friend understood that during the war, and probably for some time before it, no speaker in a German broadcast studio ever poured his words direct into the transmitter via the microphone. He may have thought that he was doing so; but actually the microphone before him was connected to Magnetophone recording apparatus. Everything he said was carefully monitored and if he should let fall anything indiscreet or unwelcome to the then authorities, the words disliked were removed by the simple process of cutting the tape and quickly joining it up again. The actual delay between the microphone and the transmitter was only a matter of seconds, but the intervening Magnetophone thus made it impossible for any speaker to bring off a *coup* by dropping a few surprise words into his talk.

□ □ □

Radiolocation at the I.E.E.

THE I.E.E. is running a Radiolocation Conference (I am glad they call it Radiolocation, for I do prefer that genuine English word to the American Radar) from March 26th to 29th. In those four days ten important papers will be given dealing with many aspects of radiolocation. Further, the Radio Section of the Institution has provisionally allotted five more evenings between April 3rd and May 21st for papers or discussions on this thrilling subject. I hope that all readers who can do so will attend either in their own right or as guests for this is a unique opportunity of learning something about one of the most hush-hush developments of the war. Authors of papers other than the introductory one by Sir Robert Watson Watt have not yet been announced but I trust that amongst them will be some of the pioneers of radiolocation, too many of whom still remain unknown and unsung. I know something of the hard slogging work put in by some of these and of the genius which they displayed in overcoming problems of the most perplexing kind. The country owes them a big debt of gratitude and I do sincerely trust that something may be done at the I.E.E. Conference to let us know more of the men who were responsible for the work of development in all branches of radiolocation.

□ □ □

Tuning Indicators

AT a meeting of the Radio Section of the I.E.E. held some months ago there were considerable differences of opinion on the subject of tuning indicators. Some, following the lead of one eminent designer, heartily damned all tuning indicators and expressed particular hatred of those of the "magic eye" type; others, less vehement, held that there was something (though not much) to be said in favour of TI's; yet others contended that they were highly desirable parts of any "broadcast" receiver. Personally, I belong to the third school of thought, for my experience is that very few average wet-nose listeners can tune a superhet correctly by ear alone. How often does one hear a good receiver producing horrible distortion simply because it is mistuned! Perhaps you show the owner how tuning should be done: he is interested and admits that it "sounds a lot better like that"; yet the next time you hear that set it is being worked as far from resonance as it was on the first occasion.

□ □ □

The £1 Licence

THE announcement that wireless licences were going to be increased in cost from 10s. to £1 came rather out of the blue, and no-one can yet say what its general effects are likely to be. I think that the majority of listeners are agreed that they want better programmes and that if doubling the licence fee means increasing the quality of the broadcasts 100 per cent., there will not be much general grumbling. On the day when these notes were written I happened to attend an informal meeting of about a dozen people who are keenly interested in wireless. When the opportunity arose I asked for their reactions to the increase, and these were distinctly interesting. One section felt that wireless had become so much a part of our everyday life that we simply had to have it and that people would pay the additional amount with the same shrug of the shoulders that accompanies the payment of other increased prices for ordinary everyday things. Others held that if the licence fee went up there would be insistence upon a real change of heart on the part of the B.B.C. Another suggestion was that more expensive licences would lead to a great increase in wireless piracy. I think that all agreed that the only people who would really feel the draught were those with small fixed incomes who had found even 10s. something of a drain on their resources. Everyone was of the opinion that even at a £1 a year wireless was by far the cheapest and most generally appealing form of entertainment that had ever been devised. Only one of those present took a gloomy view and predicted that the increase would lead to a marked falling off in the number of licensed listeners. Personally, I believe that the increased cost of wireless licences will not be generally resented. Nor do I hold that there will be any marked falling off in the number of licensed listeners, or any great increase in piracy. I do, though, hope that something will be done to help those who have little or no financial margin. This could very well be done by making the licence payable in two or even four instalments. The licence itself might be issued on payment of the first instalment, with, say, a five-shilling stamp fixed to it. Further five-shilling stamps to be stuck on at three monthly intervals.

□ □ □

An American Spot of Bother

A LETTER from an American friend who is rather a big noise in the radio industry there gives some surprising news about the present position in the world of wireless in the United States. Many radio set manufacturers do not make their own components, any more than they do in many other countries: they order them in pretty large quantities from component manufacturers. In the United States price control is still in force in quite a few industries, including that concerned with the making of radio components. The price-fixing authorities are fired with a desire to prevent the public from being exploited by any kind of ramp to push the cost of components up to unduly high levels. That is a laudable aim; but so far as radio components are concerned they seem to have gone rather too far. They have fixed prices so low that component makers complain that they cannot even cover expenses, let alone make any profit if they turn them out at the prescribed cost. The result is that the manufacture of wireless components of many kinds is now going on on a very small scale and set manufacturers cannot obtain the parts that they need. Some set manufacturers make their own components and they are going ahead, though not at full pressure. The nett result is receivers of many kinds are scarce and that there is a big market in second-hand sets of the larger kind. Prior to America's entry into the war the value of second-hand receivers was small but it seems to have rocketed of late. Another friend out there who wanted to buy a communication receiver has spent some time making the rounds of the Chicago shops. He told me that "the price ceiling was not just the sky; it was far above that."

□ □ □

Spot Welding

MORE than once in these notes I've suggested that the spot-welding of wiring connections in radio sets might be a big step forward in construction. Soldering is all very well, but no-one can deny that it does produce too many dry joints, even in the best-regulated establishments—and the dry joint is a menace. A kind reader, who returned some time ago to this country after two years as a prisoner of war in Austria, sends me some interesting facts about the development of a simple spot-welder for radio and electrical wiring which was developed by the Germans. It was in two parts. The first was a metal box, probably containing a power rectifier. Stout flexible leads connected this to the actual welding tool, which was in the shape of a pistol or "gun." The trigger of the gun brought the electrodes together when pressed. He was convinced that it was the most admirable tool for making completely reliable wiring connections. I've heard that spot-welding is used in wireless receiver construction by some American firms, though I've never come across a set made up in this way. I wonder if any readers have?

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

DIRECTIVE AERIALS

THE dipole of a parabolic beam aerial is set in the local plane of the mirror, and is usually energised by a coaxial feeder which, in order not to interfere with the field of the beam, is brought in from the rear through a small opening at the apex of the mirror. In order to keep the beam centred about the axis of the mirror, the dipole should radiate symmetrically, so as to simulate a "point source," but in practice it is found difficult to connect the coaxial feeder to the dipole with the necessary precision.

According to the invention, the coaxial feeder is replaced by a solid wave guide made of an insulator of high permittivity, such as "Faradax"; a rod 1.5 cm. in diameter will be suitable for transmitting a 15 cm. wave. The guide may be arranged to radiate freely from its open end towards a small plate, which reflects the waves back on to the main parabolic mirror. Alternatively a metal rod or dipole is thrust through a transverse hole in the wave guide so as to lie in the focal plane of the system.

The General Electric Co., Ltd., and R. J. Clayton. Application date January 7th, 1942. No. 570038.

INDICATOR FOR WAVE GUIDES

STANDING waves are usually detected by inserting a probe at different points along the length of a wave guide, so as to indicate the potential prevailing at each point. Obviously a number of such tests must be made in order to secure the desired information.

To simplify matters, it is now proposed to fit a glow discharge tube into a longitudinal slot made in the wall of the wave guide, the tube being long enough to indicate by bright zones the distance between two successive nodal points in the standing-wave formation. The tube lies mainly on the outside wall of the guide, projecting only a small distance inside, so as not to interfere with the normal transmission. It may contain two electrodes, one a graphite deposit on the inside wall, and the other a longitudinal wire which is earthed at one end to the outside wall of the guide.

Application date February 23rd, 1943. C. J. Carter and Pye, Ltd. No. 570080.

RADIO BEACONS

RELATES to blind-approach systems of the kind in which an equi-signal path is marked out by the overlapping fields from a centre dipole flanked by two reflectors which are alternatively switched into and out of action. Actually three fields are radiated, one is the circular field due to the dipole alone, the other two being divergent lobes produced by the side reflectors.

The width of the approach path, which is determined by the mutual inclination of the two lobes should be as narrow as possible. Moreover, within the equi-signal zone, all three fields should be of equal strength; otherwise signal-keying "clicks" are heard, and tend to confuse the pilot.

According to the invention, the centre dipole is replaced by two separately excited dipoles, which are displaced along the line of the approach path. By adjusting the distance between them and their spacing from the side reflectors, the approach path can be narrowed and keying clicks eliminated.

Standard Telephones and Cables, Ltd., and L. J. Heaton-Armstrong. Application date January 12th, 1942. No. 570201.

WATER-COOLED VALVES

THE surface in contact with the cooling fluid should not be at a higher temperature than the boiling-point of the fluid, otherwise vapour-bubbles will form and act as a heat-insulating layer. If water is to be used, say for a valve that is required to dissipate 2,000 watts per square inch, and if the highest temperature at which the anode can be worked, without injury to the valve, is 320 degrees C, then it becomes necessary to interpolate a temperature fall of over 220 degrees before the circulating fluid can be brought into action.

According to the invention, the anode is fitted with metal fins having the length, breadth, and width required to bring the temperature down to less than 100 degrees, preferably with the assistance of external spraying. The water-cooling pipes are laid along the outer edges of the fins, to maintain and dissipate the flow of heat.

Standard Telephones and Cables Ltd. (assignees of C. V. Litton). Convention date (U. S. A.) October 5th, 1942. No. 570679.

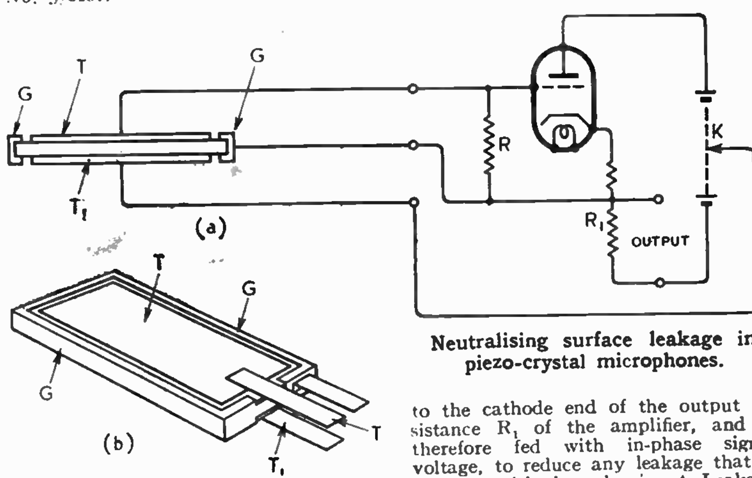
PIEZOELECTRIC CRYSTALS

IF a piezoelectric microphone is coupled to a high-impedance amplifier, any leakage across the surface of the crystal will adversely affect the response of the amplifier, particularly at the lower frequencies.

A guard ring is therefore mounted between the two electrodes on the crystal, and is fed with a voltage that is in phase with the signal voltage and as nearly as possible equal to it, so that there is little or no potential-gradient along which current can flow.

As shown, the crystal electrodes T,T, are respectively connected to the grid of the amplifier and to a tapping K on the HT supply adjusted to the same DC potential as the grid leak R. The guard ring G is connected to the cathode end of the output resistance R_1 of the amplifier, and is therefore fed with in-phase signal voltage, to reduce any leakage that is in shunt with the valve input. Leakage between the electrodes T_1 and the guard ring is immaterial, since it is in shunt with the low-impedance output of the amplifier.

The Brush Development Co. Convention date (U.S.A.) January 8th, 1942. No. 570043.



Neutralising surface leakage in piezo-crystal microphones.

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.

BLOWERS for Electronic Equipment

Manufacturers of Electronic Equipment are invited to let us know their requirements.

We shall be very happy to discuss with you any Air Treatment problems in connection with your products, equipment or premises.

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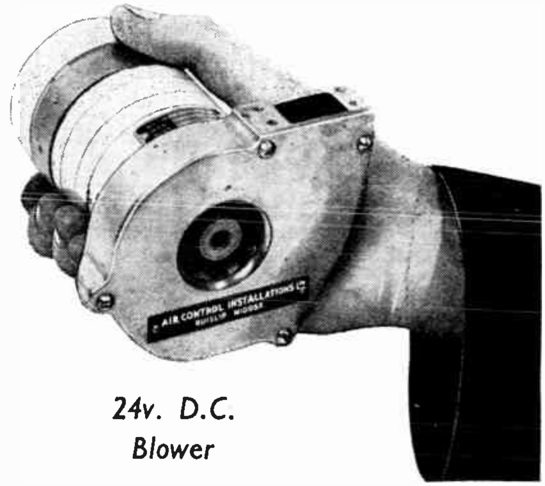

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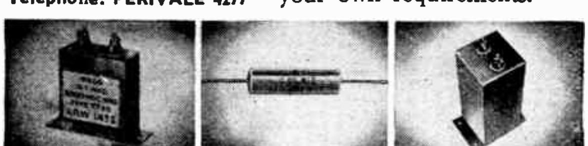

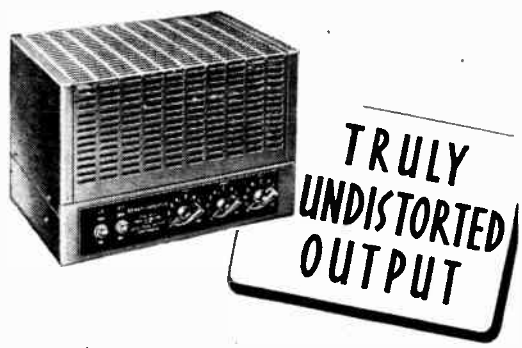

The design of the M.31 amplifier incorporates an entirely new output circuit, resulting in a very low percentage of harmonic distortion with loudspeaker or resistive load. Efficiency is extremely good and has enabled a really compact quality amplifier to be produced. The mechanical design is exceptionally robust and reliability is assured.

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30 Watts output ● A.C. 200-250 volts operation. Overall gain 90 db. ● Mic/Gram mixing ● Frequency weighted microphone control ● Two microphone input impedances ● Tapped output impedance, Tone control, etc.

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Rate 6/- for 2 lines or less and 3/- for every additional line or part thereof, average lines 5-6 words. Box Numbers 2 words, plus 1/-. Press Day: April 1946 issue, first post Thursday, March 7th. No responsibility accepted for errors.

NEW RECEIVERS AND AMPLIFIERS

COMMUNICATION receivers.—As soon as civilian supplies recommence we shall be at your service.—A.C.S. Radio, 44, Widmore Rd., Bromley, Kent. [4528

COMMUNICATION receivers. — "Dale" will have them as soon as trading conditions allow.—Remember—Dale Electronics, Ltd., 105, Bolsover St., W.1. Mus. 1023.

T.R.F. ac/dc medium and long wave kit of parts, with drilled chassis, size 9½×4½×1½, and all components, condensers, etc., and circuit, nothing else to buy, £4; valves £2/10; 5in speaker, trans., 27/6.
HENRY'S, 5, Harrow Rd., Edgware Rd., W.2.

QUALITY.—We offer you a receiver combining all the features of local quality reception and the communications receiver sensitivity, something new, it will be worth while investigating.—2½d. stamp for descriptive brochure from the Moreton Cheyney Company, BCM/REME, London, W.C.1. [4832

5-VALVE 3-wave superhets complete; kits for W.W. amplifiers, or built to order; communication receivers available, mains ht eliminators, ht units, work that battery set off 2volt accumulator only; details on request. —R.E.S., Marfrebel, Maurice Rd., Canvey, Ex.

AMPLIFIERS. — Complete equipment for P.A. industrial, dance and stage installations and portable apparatus from 15 to 150w; early deliveries; illustrations and spec. on request.—Broadcast and Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [2903

ANELOY RADIO offer set of components for making M.W. semi-midget 4-valve ac/dc t.r.f. receiver, including cabinet, valves, drilled chassis, 6½in speaker, screws, etc.; nothing more to buy; complete with circuit, £8, packing and post 5/-.—Aneloy Radio, 36, Hindmans Rd., E. Dulwich, S.E.22. [4663

BAKER'S.—New 7-valve "Wireless World" Quality amplifier with tone control stage, 8 watts push-pull triode output, price includes super Quality triple cone, 12in permanent magnet speaker, with large output transformer and all valves; also as above but with 15 watts tetrode output, ideal for realistic reproduction for public address; 2½d. stamp for particulars, prices, etc.—Bakers Selhurst Radio. Tel. Croydon 4226. [3680

NOW ready, the Model P.A.3 7-valve amplifier; order now, immediate deliveries.
MAINS transformers, output transformers, chokes, specially designed for the "Wireless World," 4, 8 and 12 watt Quality amplifiers.
READY soon, the "Wireless World" 8 watt Quality amplifier with pre-amplifier and variable record compensation; write now for full details and lists.—Chadderton Radio & Television Co., Ltd., Peel St., Chadderton, Lancs. Special terms to factors and export agents.

RECEIVERS, AMPLIFIERS—SECOND-HAND

SOUND Sales W.W. 3-wave super six tuner; £20.—Box 5674. [4840

7-VALVE ac wireless, walnut, foreign make, pre-war £150; what offer?—Box 5773.

AMATEUR-Built 8v s.w. superhet; £18.—Godier, 9, Warner Rd., N.8. Mou. 3044.

SOUND Sales tri-channel amplifier, complete with speakers; offers.—Box 5761.

RADIOGRAM, H.M.V. and automatic record change; £60 (no offers).—Box 5766.

TROPHY Six communication receiver, very little used, perfect cond.; £16.—Box 5017.

TWO B.T.H. cinema amplifiers, each weighing 140lb, P.X.25's in output; £22 each. —Myers, 222, Jack Lane, Leeds, 10. [4872

5-VALVE receiver, battery operated with tuner, type C.H. less coils, made by Marconi Scientific Inst. Co.; offers?—Box 5492.

HOME-Constructed superhet communications set, 230v a.c., 9-valve, 13-60 meters coils, B.F.O., A.V.C., etc.; £40.—Box 5765.

H.R.O. with 230volts ac power pack, coils for 50c/s to 430kc/s, and 900 kc/s to 30mc/s in 7 bands.—Offers to Box 4949. [4702

HALLICRAFTERS SX25 communications receiver, 7 watts P.P. output; £39/10; advise collection.—Dean, 35, High St., Hailsham. Tel. 102. [4771

MIDWEST 7 valve 5 waveband AC Console, beautiful condition throughout, better than new, specially polished, fine performance; £35; carriage paid.—Box 4867. [4676

HALLICRAFTERS' Skyrider Defiant SX24, 545kc-43.5mc, bandspread, crystal filter, variable selectivity, noise limiter, perfect; £40 or nearest offer.—Box 5018. [4717

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All these will benefit by the experience we have gained during the last six years when the reliability and performance of our products were vital.

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This is now ready and illustrates various styles of mounting. We shall be pleased to send you a copy upon request together with a comprehensive list of components available from stock.

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Transformers manufactured to your specification can now be delivered in 28 days.

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A.C.S. RADIO, 44, Widmore Rd., Bromley, Kent, offer small selection com. sets, radio receivers, amp. and televisors; list free.

AMATEUR transmitter, giving up, all to be sold, incl. meters, high voltage transfs., conds., etc.; offers for part or lot, s.a.e. or call. —38, Church Lane, N. Featherstone, Yorks.

RADIOGRAM ac Pilot 8-valve, beautiful walnut cabinet, perfect order, £80; also rotary converter, in. 230v dc, out. 230v ac, 50 cycles 0.25hp, £16.—58, Eccles Rd., S.W.11.

WESTERN Electric 7-valve super heterodyne receiver, complete with frame aerial, battery box and Western Electric 2-valve amplifier and loud speaker; offers?—Box 5491. [4812

4-VALVE battery operated Gecophone complete with mahogany cabinet, Wayfarer Major portable receiver, and Osram Music Magnet 2-valve receiver; offers the lot?—Box 5494.

SUPERB His Master's Voice, 11 valve, 5 waveband AC autoradiogram, magnificent appearance, performance, special model, cost £356; accept £130; carriage paid.—Box 4866.

BURNDEPT all-wave super heterodyne 7-valve receiver, complete with coils in mahogany cabinet, and 4-valve battery operated Britphone No. 4a receiver, less valves; what offers for the lot?—Box 5493. [4814

THE output stage of a 500watt amplifier, comprising a pair of Standard Telephones, type 212E, 250watt valves (listed at £30 each), ESU40 rectifier, with special holders, h.t. transformer, filament transformer, output and smoothing chokes and condensers; £35 the lot.—Harris, Strouds, Bradfield, Berks.

COMPONENTS—SECOND-HAND, SURPLUS

SPECIAL offer for this month.
WHILE existing stock lasts.
SPEAKERS.—Celestion P.M. 6½in. L/Trans., 16/6; 6½in. P.M. W/Multi ratio trans., 26/6; 8in. M. energised (1,500 coil), 18/11.
CENTRALAB v/controls L/S, 2/6; w/s, 3/6.
CONDENSERS, .1, .01, .05, .002; 6/- doz.
STANELCO & Solon soldering irons; 13/6 ea.
TWO- and three-gang condensers, .0005, 2-gang, 11/6; 2-gang s/motion, 13/6; 3-g. 14/6.
ROTHERMEL crystal p/ups de luxe; £3/18/9.
LINE cord, .3amp (60ohms p.ft) 2-way, 1/6 per yard; 3-way, 2/6 per yard.
T.R. cable, 1/044 asstd. lengths; 7d. per yard.
EIRE resis, ½watt, ¼meg., 1 mag., 4,700, etc.; 4/6 doz.
ALL goods are new; many other lines in stock; large assortment B.V.A. and U.S. valves.
MATT RADIO SERVICE, 152, Richmond Rd., Kingston-on-Thames. [4728

SOUTHERN RADIO'S wireless bargains:—
LATEST radio publications:
"RADIO Valve Manual," equivalent and alternative American and British types with all data, 3/6; "Radio Circuits," fully illustrated receivers, power packs, etc., 2/-; "Amplifiers," fully descriptive circuits, 2/-; "Radio Coil and Transformer Manual," 2/-; "Short Wave Handbook," 2/-; "Manual of Direct Disc Home Recording," 2/-; "Test Gear Construction Manual," 1/6; "Radio Pocket Book," formulas, tables, colour-code, etc., 1/-; "10 Hows for Radio Constructor," 1/-. Just published, "Radio Reference Handbook," comprehensive and up-to-date, covering all branches of radio, 10/6.
PAPER condensers Post Office type, upright, 2mfd, high working (used but guaranteed perfect), 2/6 each. Brand new 2mfd mains-bridge, 3/6, 1mfd 3/-, 1.-1.-1. 2/6; 4 C.C. electrolytic reversible 4-4mfd 70v, 3/6, multicon mica condensers, 28 capacities in one, 4/-. ACE "P.O." microphones, complete with transformer, usable with any receiver, 7/6. Permanent crystal detectors, 2/6. Crystals 6d., with cat's-whisker 1/-. Insulated pushback wire, 25 yards, 5/-. Insulated sleeving, assorted sizes and colours, 3/6 per dozen yard lengths. Single screened wire, 10/- per doz. yards. Twin screened wire, 17/- per dozen yards. Power rheostats cutler harmer, 30 ohms and 10 ohms, 4/6 each. Press button switches, 3 way 4/-, 8-way 6/- (all complete with knobs). Escutcheons for 8-way switches, 1/6. Yaxley type rotary switches, 11-way single bank, 6/6. Hundreds more bargain lines.
SOUTHERN RADIO SUPPLY Co., 46, Lisle St., London, W.C. Gerrard 6653. [4234

COLPAK tuning unit G10, 11, 12, 14; 4G condsr.; as new.—Offers to Pursell, 16, Goldwell Rd., Thornton Heath. [4730

BIG stocks of radio valves, all types, list prices; 8in Field energised speakers, 35/-; c.o.d. or pro-forma—David Robinson, Ltd., 100, High St. Bedford. [4577

B. & H RADIO offer all sizes of electrolytics, 2- and 3-core line cord, transformers, chokes, volume controls, etc; everything for the service man; competitive prices; trade only; send for list.—Victoria Garage, Hargreave Terrace, Darlington. [4690

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LARGE STOCKS OF ELECTROLYTIC CONDENSERS ALL NEW AND GUARANTEED BY WELL-KNOWN MANUFACTURERS

8 mfd., 450 v.w. tub **3/6.** 8 mfd., 500 v.w. tub can **5/6.** 8 mfd., 500 v.w. **4/-.** 16 mfd., 440 v.w. wet can **7/6.** 8×8 mfd., 150 v.w. tub **3/6.** 8×8 mfd., 450 v.w. tub **5/9.** 16×16 mfd., 450 v.w. tub **7/9.** 16×16 m.f.d., 350 v.w. block **7/-.** 4 mfd., 650 v.w. block **5/9** 2 mfd., 250 v.w. tub **2/-.** 8 mfd., 200 v.w. tub **2/3.** 4 mfd., 200 v.w. tub **2/-.**

ELECTROLYTIC BIAS CONDENSERS.—25 mfd., 25 v.w. tub **1/9,** micropack **2/6.** 50 mfd., 12 v.w. tub **1/6,** micropack **2/6.** 75 mfd., 12 v.w. tub **1/6,** micropack **2/9.** 12 mfd., 50 v.w. **3/-,** 50 mfd., 50 v.w. **3/6.**

TUB CONDENSERS.—.1, .01, .001, .05, .02, .003, etc., mfd., 400 v.w. **8½d.** each, **8/-** doz. These are only a few examples of our extensive stocks.

THIS MONTH'S SPECIAL OFFER—SUPER SERVICE KIT.—48 assorted condensers, including: one of 8 mfd. 500 v.w., 8 mfd. 450 v.w., 16 mfd. 440 v.w., 16×16 mfd. 350 v.w., 8×8 mfd. 450 v.w., 4 mfd. 650 v.w., 2 mfd. 250 v.w., 25 mfd. 25 v.w., 75 mfd. 12 v.w., 50 mfd. 12 v.w., and 36 assorted resistances. **£3 19s. 6d. POSTAGE AND PACKING FREE.**

MIDGET YAXLEY TYPE WAVECHANGE SWITCHES—5-way 2-pole, **2/9**; 2-way 3-pole, **2/6.**

MIDGET COILS AERIAL AND H.F.—Medium wave high gain, **5/9** matched pair. Medium wave high gain, **6/9** with circuit. M. and L. wave with circuit, **8/6**; with reaction, **10/6.**

VALVES.—6,000 mains and battery types in stock, B.V.A. or Tungsram. Most types of American glass, metal, G.T. and UX and Octal at B.O.T. prices. Send us your queries.

LOUD SPEAKERS P.M.	**ENERGISED**
2½" to 12" all sizes.	6½", 8" and 10".

SPEAKER TRANSFORMERS.—Midget Pentode, **5/9.** Multi ratio universal, **7/6.**

MIDGET SMOOTHING CHOKES, 500Ω, **6/6.**

LINE CORD.—**2/6** per yd., 2- and 3-way.

MAINS VOLTAGE DROPPERS.—.3 amp. 800Ω, **5/9.** .2 amp. 1,000 , **5/9.**

MAINS TRANS.—350-0-350 v., 6.3 v. and 5 v., or 4 v. and 4 v., **29/6.**

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NEW receivers; Airmaster 5-valve superhet chassis and 8in R. and A. energised speaker, all British product with valves, 14½in long, 8in wide, 3½in high, cream cellulose finish, large illuminated dial 8in×5½in, four wavebands 13-2,000m, factory built product of the highest standard, sockets for P.U. and ext. L.S., ac mains, 200-250v, £16/10; Alba 1946 5v all-wave superhet, £18/4/6; K.B. 6v all-wave superhet super model, £32/3/11; Grampian 1946 Ensa amplifier, mike and two speakers, 12w portable outfit, £36; Philip's 15w amplifier, mike and two horn speakers, 12v dc or 110-250v ac, £58/10; 5w ac/dc amplifier, neat chassis with valves, £6/10.

LOUDSPEAKERS; 5in Rola, 18/6; Rola 8in, 19/6; Celestion 8in with trans, 25/-; Celestion 8in energised, 2,000ohms field, with transformer, 36/-; R. and A. 10in with trans, 45/-; Vitavox 10w 12in, £7.

BOOKS; "Radio Circuits," 2/-; "Radio Manual," 1/-; "Amplifier Manual," 2/-; "Modern Radio Test Gear Construction," 1/6; "Radio Inside Out," 4/6; "Manual of Disc Recording," 2/-; "Radio Valve Manual," 3/6; "Short Wave Handbook," 2/-; all new goods, prompt dispatch, satisfaction guaranteed; postage extra under £4.

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THE return of post mail order service, cod or cwo, exclusively mail order.

NEW goods only, no surplus, all orders over 5/- post free; compare these prices; special quantity discounts.

LINE cord, .3 amp 60 ohm, 2-way 1/6 yd., 3-way 1/9.

MAINS transformers, wax impregnated, primaries for 200-250 volts; 300-0-300 60ma, 4 or 6v, 17/6; 350-350 100ma, 4 or 6v, 24/-; bobbins as last model, 15/6; 450-450 200ma, 4v 8a, 4v 4a, 4v 4a, or 6.3v 4a, 6.3v 4a, 5v 3a, 42/6.

SMOOTHING chokes, 40ma, 4/6; 60ma, 6/-; 90ma, 7/-; 100ma, 12/6; 200ma, 21/6; fluorescent lighting chokes, 80 watt, 25/-.

SPEAKERS, Magnavox, Rola, Plessey, Celestion, P.M., less transf., 2½in, 24/-; 3½in, 27/6; 5in, 19/6; 6½in, 20/-; 8in, 21/-; 10in, 30/-; with transf., 6½in, 24/-; 8in, 25/-; 10in, 36/-; energised with trans. 8in 1.200 or 2.000 field, 32/6.

SUPERHET coil packs, S/M/L wave, completely wired with 5-valve circuit, 465kc/s, 32/6; I.F. transf., iron cored, 465 matched, 13/6 pr.

MAINS droppers, feet, 2 sliders, 0.2amp, 4/3; 0.3amp, 4/6.

OUTPUT transformers, Midget pen, 4/6; mid. power/pen, 5/-; std. size Univ. with C.T., 6/-; 8 watt Univ., 10/6; 15 watt, 21/-; 30 watt, 37/6.

COLLARO radiogram equipment, rotational deliveries begin March; motors, £4/13/6, with pick-up, £7/9/8. [4861

FOR sale, National M.F. and L.F. coils for H.R.O.—Box 5450. [4806

MAINS transformers, first grade, brand new, 350-0-350v 80ma, 4v 4a and 4v 2.5a, or 6.3v 3a and 5v 2a, 20/- ea; post 1/-.

ELECTROLYTICS, 8mfd 500v, 3/-; 8×8mfd 550v, 5/-; 16×8mfd 350v cans, 6/6; 16×8mfd 450v, 6/6; 25v 25mfd, 1/9; 50mfd 12v, 1/4; 8in P.M., with trans., 25/-; s.a.e. for list of other bargains.

ANELOY RADIO, 36, Hindmans Rd., E. Dulwich, London, S.E.22. [4865

HENRY'S offer.—Philips wet electrolytics, small cans, 8mfd, 450v wkg, 8mfd 320v wkg, midget, 25mfd 320v wkg, at 6/6; also 8×8 450v wkg, 6/9; 8mfd 350v wkg, 2/3; 8mfd, 450v wkg, 4/-; 16×16 block, 350v wkg, 8/-; 4mfd, 200v wkg, 2/-; 2mfd, 1,200v wkg, 7/6.

T.R.F. m and l wave coils with reaction, 8/6 pr, with circuit; T.R.F. med wave midget coils, 6/6 pr, with circuit; 3-bank 3-way, 3-pole, with screen, 4/6; toggle switches, 2/-.

GOODMANS 3in P.M. 3 or 15ohms, 35/-, with trans; 2-gang 0.0005 midget condensers with trimmers and feet, 12/6; and 2-gang 0.0005 ceramic ins with feet drum and drive spindle, 14/-; 3-gang 0.0005 ceramic ins, 12/6; Litz wire wound h.f chokes, 2/-; midget strong steel chassis, size 9½×4½×1½, with cut-out for 5in speaker, holes for 5-valves and drilled for components, 4/6; s.a.e. for latest price list, 4-page

HENRY'S, 5, Harrow Rd., Edgware Rd., W.2. Pad 2194 [4426

TOGGLE press by Stanelco, suitable for radio chassis work; sheet metal bender by A.A. Tools for chassis, transformer clamps, etc.; 2 Avo capacity bridges; all unused.—C. T. Kennedy & Co., 555, Sauchiehall St., Glasgow, C.2. [4799

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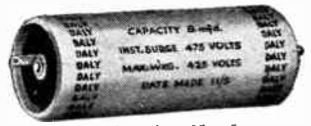

Tube—size 2¼" × 1"

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Block—size 4 3/16" × 1½"

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Allowance made on old models

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CHARLES BRITAIN RADIO offers several new and interesting lines this month. T.R.F. ac/dc midget chassis, long and medium waveband, wired up, tested and complete with 4 valves and speaker, £7/10; short-wave coil pack T.R.F. covering 917-24m, 19.3-45m, 39.5-95m, 85.4-208m, with diagram and instructions, 30/-; all-wave superhet coil pack with all padders, trimmers and switch, etc., and diagram, 30/-; midget I.F. trans., 465 k/c, iron cored, 22/6 pair; standard type with trims, 12/- pair; all-wave coils with diagram, superhet, 14/-; dual-range T.R.F. coils, H.F. and Ae, 7/- pair.

3- and 4-gang .0005 tuning condensers, ceremic insulated, 10/- ea; 2-gang midget type, short spindle, with feet, 8/6 ea; 2-gang with feet, trimmers and tapped spindle for pointer, 12/-; complete dial assembly, comprising all-wave dial escutcheon, drum drive, pointer and spring, 5/6; small dials for midgets, 8/- doz; all-wave ivorine dials, 2/6 ea; dual-band clock-faced dials, 2/6 ea; Bulgin panel light, chromium finish, red glass, to take standard bulb, 2/6 ea.

SPECIAL offers: Philco mains, energised speakers with new cones and transformers, field 1,200ohm, £1; L.F. chokes, 360ohm, 100ma, ex Ekco, 4/6 ea; band-pass aerial coils with dia., 2/6 ea; oscillator coils, 110k/c, with dia, 2/6; I.F. trans with trims in ali cans, 110k/c, 3/6 pair; wavechange switches, suitable for coils, 2/6 ea; three-gang condensers, one section tracked for 110k/c, 3/6 ea; 0.2 mains droppers, ex Ekco, 2/6 ea; parcel of assorted tubular condensers, incl. 0-1s and bias types and block smoothing condensers, 6/- ea; mains trans for C.R. tubes, ex Ekco television, 35/- ea; send for list "W" terms, cash or c.o.d. over £1.—Charles Britain Radio, Radio House, 2, Wilson St., London, E.C.2. Tel. Bis. 5985, ext. 7. [4884

CHOKES, output, and mains transformers; lowest prices; s.a.e. particulars.—Ponder, 8b, Kew Green, Kew, Surrey. [4800

VALVE panel, 250ac, as new, charts, books, etc., stock resistances, condensers, etc.; suit beginner; bargain price lot; no separation.—Gee, Essendon, Herts. [4768

SERVICEMEN.—The following products are well designed and of high quality; volume controls, carbon type, all values, with or less switch, wire-wound resistors, 1 to 60watts; dropper resistors, 0.2 and 0.3 amp; line cords and razor resistors; terms and quotations on req.—Dagole, Ltd., 5, Torrens St., London, E.C.1

WIRE-WOUND non-inductive resistances, 2 watt, ideal for meter shunts, resistance boxes, etc, 2½% accuracy, wound on bakelite bobbins, ⅞in×¼in, one of each of the following ratings, 25, 100, 200, 400, 600, 1,000 and 2,000 ohms; 5/6 per lot, postage paid; quantities available.

ELECTRO-MAGNETS, 200-250 volts, ac resistance 320 ohms, 1¾×1½in; 3/6 ea.

MOVING coil headphones, p.m., energised by Alni magnets, 45 ohms, ½in coil, ideal for mikes, miniature loudspkrs, 1½in overall in bakelite cases with 3in front flange, 7/6 ea.

MOVING coil microphones, fitted as hand mic., with switch in handle, 45 ohms speech coil; 12/6 each.

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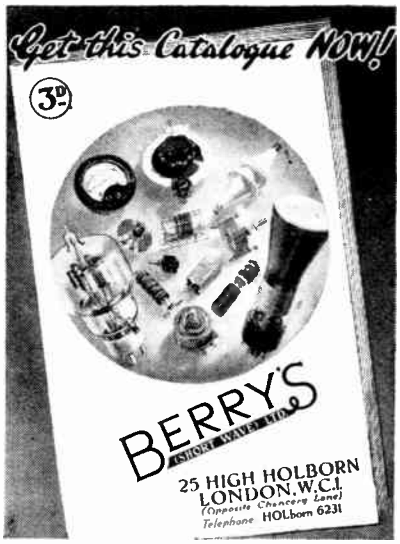

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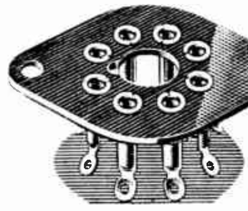

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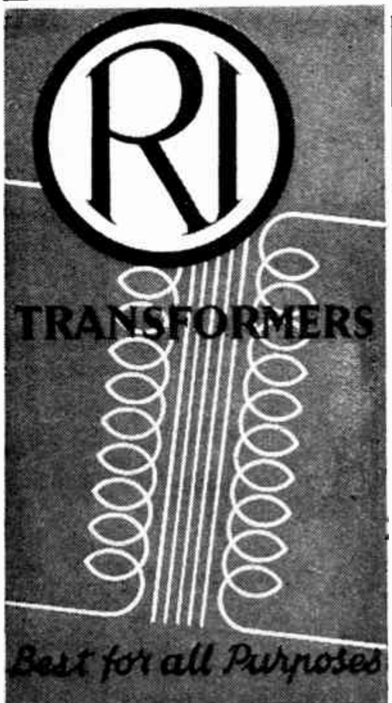

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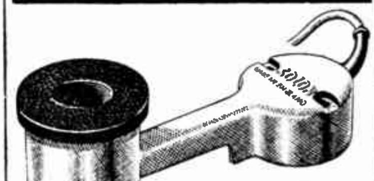

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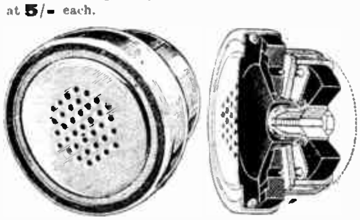

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J. G. DREW,
Town Clerk

31st January, 1946
Town Hall,
BRIGHTON, 1

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PRE-WAR QUALITY

HIGH TIN CONTENT

ERSIN Multicore Solder in 60/40 tin/lead alloy may now be purchased without restriction. For many years 45/55 tin/lead alloy has, by Government regulation, been the standard for radio and while it gives excellent results the higher tin content alloy is usually preferred for high quality work. 60/40 has a 37° C lower melting point, it "sets" quicker and the solder joints look brighter. Because there is more tin in 60/40 alloy than 45/55, it costs more. Consequently except for work where the lowest melting point alloy is essential it must be a matter of personal preference which alloy is used.

60/40 alloy Ersin Multicore Solder is available for radio manufacturers in gauges from 10-22 S.W.G. at bulk rates. For service engineers the following standard specification on nominal 1-lb. reels will soon be held in stock by most factors.

CATALOGUE REFERENCE NO.	ALLOY TIN/LEAD.	S.W.G.	APPROX. LENGTH PER NOMINAL 1-LB. REEL.	PRICE PER NOMINAL 1-LB. REEL (SUBJECT TO USUAL DISCOUNT)
16014	**60/40**	**14**	**64 feet**	**6/-**
16018	**60/40**	**13**	**178 feet**	**6/9**
14513	45/55	13	45 feet	4/10
14516	45/55	16	94 feet	5/3

Labels on 45/55 reels are crimson on buff.
Labels on 60/40 reels are red and white on black.

Manufacturers, Factors and Service Engineers are invited to write for technical information and free sample of Ersin Multicore Solder 60/40 alloy.

MULTICORE SOLDERS LIMITED

MELLIER HOUSE, ALBEMARLE ST., LONDON, W.1. Tel.: (REGENT 1411 P.B.X. 4 lines)