Wireless World

RADIO AND ELECTRONICS

OCT. 1949

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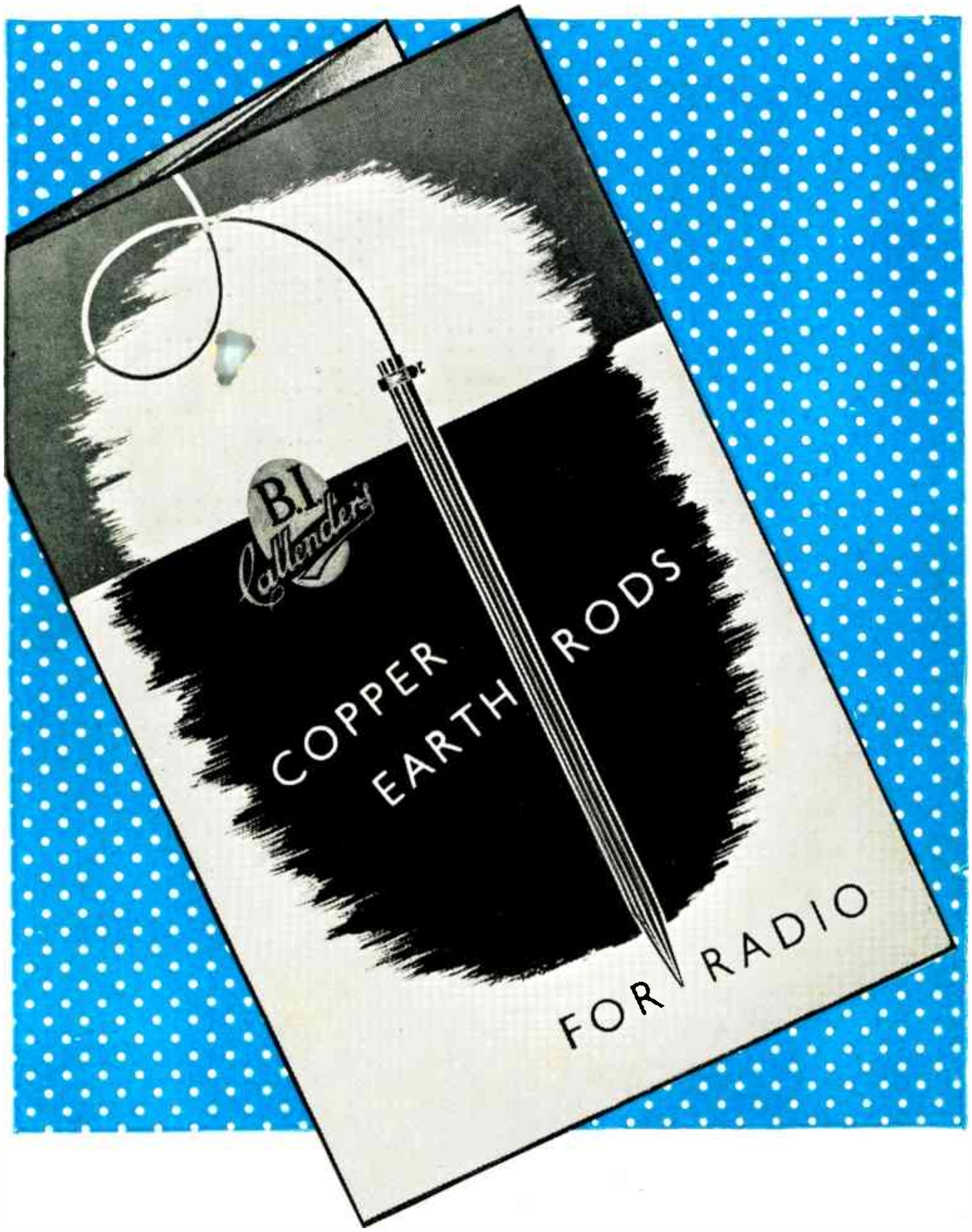
Vol. LV. No. 10

IN THIS ISSUE: RADIOLYMPIA SHOW GUIDE

World Radio History



Made from solid-drawn high-conductivity copper, B I C C earthing rods are specially designed for use with radio and television receivers. Further information, including sizes and construction, is contained in this Publication (No. 243 T). Send for a copy to-day.

BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

World Radio History

Important ANNOUNCEMENT to users of the AVO VALVE TESTER

REGD TRADE MARK

RADIOLYMPIA
See our Exhibit at
Stand No. 85
Sept. 28—Oct. 8

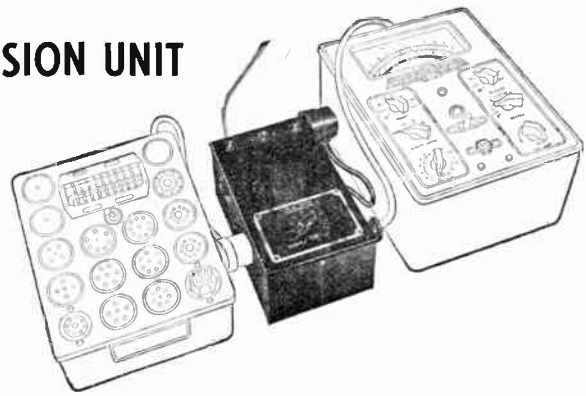
In response to popular request, we are pleased to announce the availability of the following accessories, which provide an inexpensive means of bringing the "Avo" Valve Tester completely up-to-date. Possession of these accessories will, furthermore, render it a simple matter to maintain the "Avo" Valve Tester in a condition capable of testing any new types of valves that may be produced in the future.

ACCESSORIES for the 'AVO' VALVE TESTER

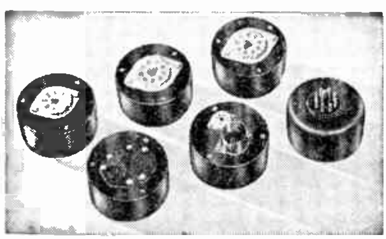
FILAMENT VOLTAGE EXTENSION UNIT

For providing filament voltages of 1.4 to 117 volts for testing valves recently introduced into general use and which are not covered by the original "Avo" Valve Tester.

This unit is plugged in between the Meter panel and the S.S. panel, where it may be left permanently in position regardless of whether the original or the additional heater voltages are being used.



VALVE BASE ADAPTORS



These Adaptors have been specially designed for plugging into the international octal socket of any "Avo" Valve Tester Panel which is fitted with a rotary selector switch. The following types, covering recently introduced valve bases not provided for on the existing Valve Panel, are now available:—

Type No. 1......B7G and B8A.
Type No. 2......B9G (EF50, etc.).
Type No. 3......B8B (American Loctal).
Type No. 4......Hivac Midget 4 and 5-pin and Midget Diode.
Type No. 5......Blank.

Other types will be made available as required, and Adaptors can also be supplied for any special valve base.

Sole Proprietors and Manufacturers:

The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON • S.W.1 *Telephone: VICTORIA 3404/9*

V.T.E.I

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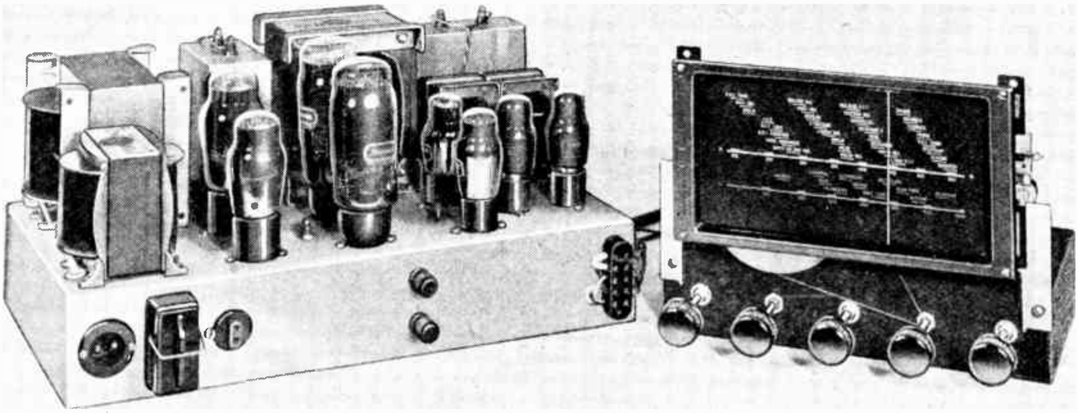


GOODSELL

15-WATT HI-FIDELITY AMPLIFIERS ARE UNSURPASSED IN PERFORMANCE

AS DESCRIBED BY T. D. N. WILLIAMSON IN "*Wireless World*" AUG, 1949.

The fidelity of reproduction given by the Williamson Amplifier is now an accepted standard throughout the world. This high standard is made possible by the following important features.

- Specially designed output transformer.
- Low phase shift.
- Heavy feedback, which includes the output transformer and all the valves.

These features make possible :

- Low linear distortion, with less than 0.1 per cent. harmonic content.
- Low intermodulation distortion.

Our amplifiers are built to strict specification and incorporate only the finest components. After assembly and adjustment by experts they are severely tested to ensure the highest possible standard of performance.

PRICES :

Amplifiers	from	£19 19 0	No tax.
Pre-Amplifiers	from	£8 0 0	
Tuners with Pre-Amplifiers		£10 10 0	plus tax.

Send for free illustrated brochure.

The illustration shows a High Fidelity Feeder for radio and record reproduction. This model has a high gain single R.F. amplifier, infinite impedance detector, tone control and L.F. stage, and gives high quality reproduction from local stations.
A special pre-amplifier, not used on radio, is incorporated for use with modern low gain pickups and this embodies a 6dB per octave bass lift to correct for recording deficiencies.
Modern valves are used, including EF.42, EBC.41, EF.40, and ECC.40.
A pre-set version and high quality super-het are also available.
Please send for leaflet.

Manufactured by **GOODSELL LTD, 40 GARDNER ST, BRIGHTON, SUSSEX** *Telephone: 6735*

Easy Terms from LONDON RADIO SUPPLY CO, Balcombe, Sussex.

World Radio History

We Proudly Present

the latest, the loveliest, the teeniest weeniest, our own, our very own Baby Power Screwdriver—M.60. Not much bigger than a fountain pen but what a bundle of energy! There's going to be a great rush to be godfather to little M.60 and we shall give preference to electrical engineers, watchmakers, chaps now working overtime in optics or indeed anyone who will give him the sort of work he loves. We'll send you a leaflet about M.60 if you like. And then perhaps you too will be a godfather. Goody goody!

Call up the little TEENY-WEENY horse

THE DESOUTTER MINIATURE SCREWDRIVER weighs 8 ounces. Size: $5\frac{1}{2}''$ long by $\frac{7}{8}''$ diameter. Capacity: Screws, No. 3 to 10 BA, and equivalent nuts. Operation: The air is automatically switched on when the tool is applied to the head of the screw and pressed on to the work. The tool can quickly be reversed by turning the ring switch fitted in the head of the tool. The impact clutch of new design gives perfect torque selection when used with pressure regulator on the air line.

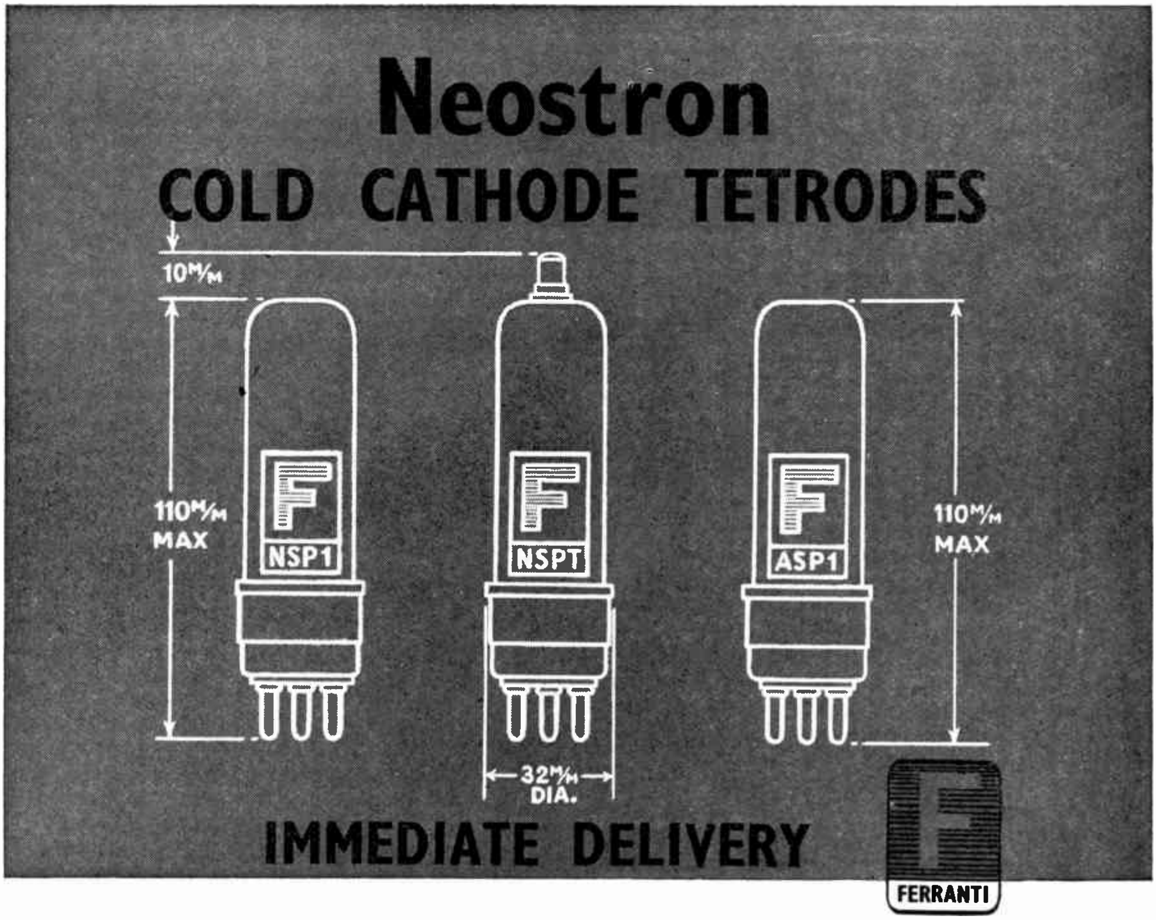
Write for literature giving much more information.

DESOUTTER

Specialists in Lightweight Pneumatic and Electric Portable Tools.

DESOUTTER BROS. LTD., THE HYDE, HENDON, LONDON, N.W.9. TELEPHONE: COLINDALE 6346-7-8-9. TELEGRAMS: DESPNUCO, HYDE, LONDON

CRC 201



The Ferranti Neostron is a cold cathode tetrode filled with neon, designed for use as a stroboscopic light source, a flashing indicator, or an electronic relay.

The discharge in the anode is started by initiating a glow discharge between the screen and grid electrodes, the screen being at a fixed positive bias, a negative impulse being applied to the grid.

Operating Characteristics	NSP1	NSPT	ASP1
Max. Anode Voltage	400	650	400
Normal Anode Voltage	300	600	300
Mean Anode Current	40-100* mA	40-100* mA	40-100* mA
Peak Anode Current	250 Amps.	250 Amps.	250 Amps.
Max. Operating Frequency	250 c.p.s.	250 c.p.s.	300 c.p.s.
Anode Connection	in base	Top cap	in base
Gas Filling	Neon	Neon	Argon

**Dependent upon frequency of operation*

All types can be supplied with English 4 pin or American 4 pin bases.

FERRANTI LTD ELECTRONICS DEPT. MOSTON MANCHESTER 10

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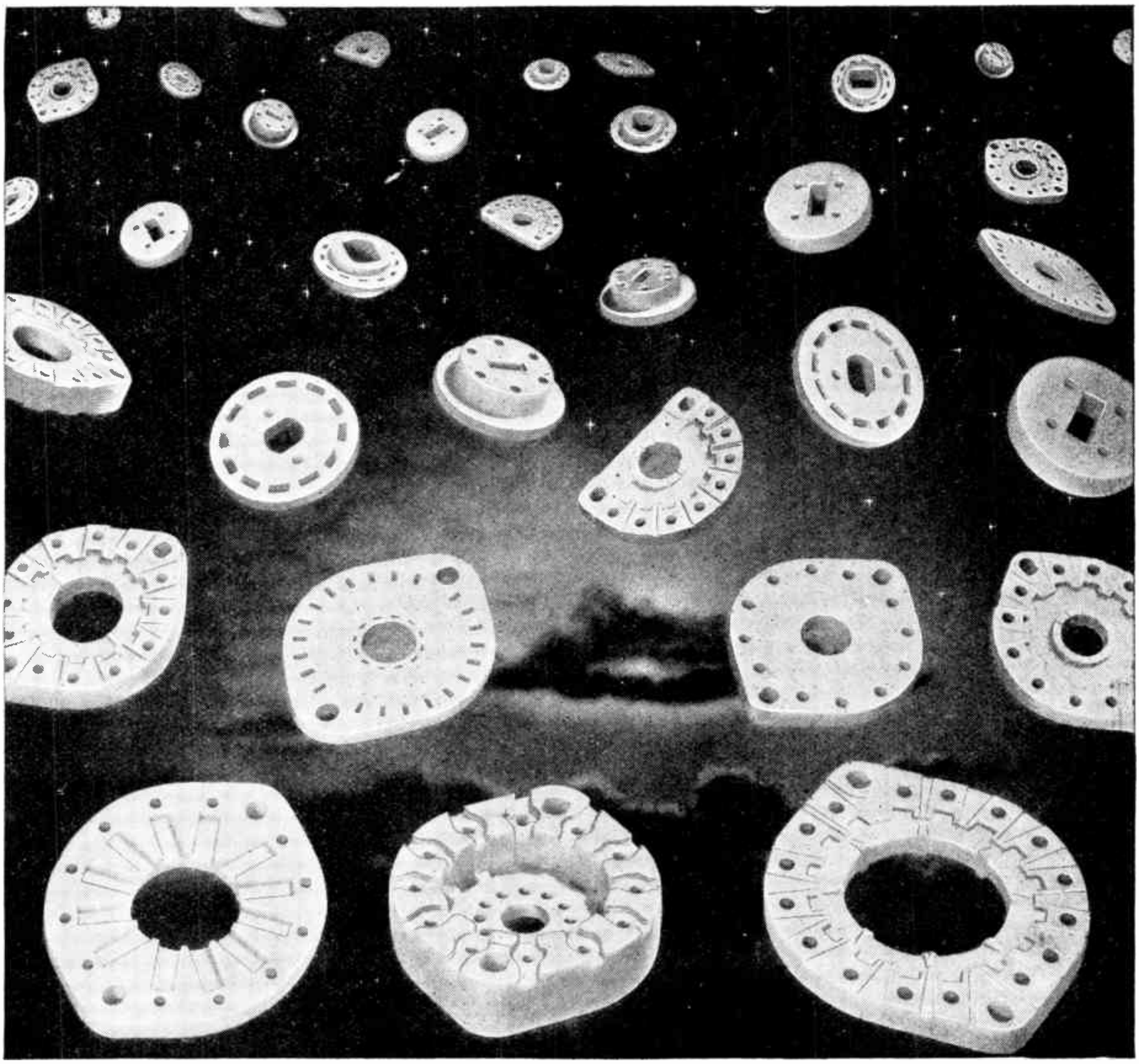


CERAMICS FOR SWITCHES

and all radio components

FREQUENTITE-FARADEX-TEMPRADEX

STEATITE & PORCELAIN PRODUCTS LTD.

Stourport on Severn, Worcester Telephone: Stourport 111 Telegrams: Steatain, Stourport

S.P. 54

— and more service behind the sales.

The G.E.C. Osram Valve Book O.V.2 deals fully and authoritatively with the Octal range of valves used in standard radio receivers designed for AC operation. Data, characteristics, circuit diagrams and component values are included.

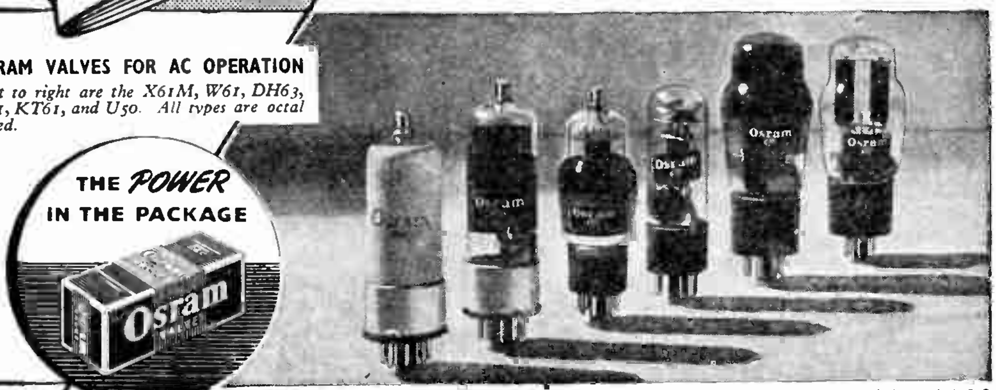
COPIES FOR FREE DISTRIBUTION

BE FIRST and benefit *most*. Supplies are limited so send for yours TODAY to Osram Valve Technical Dept., Magnet House, Kingsway, London, W.C.2.

Osram VALVES

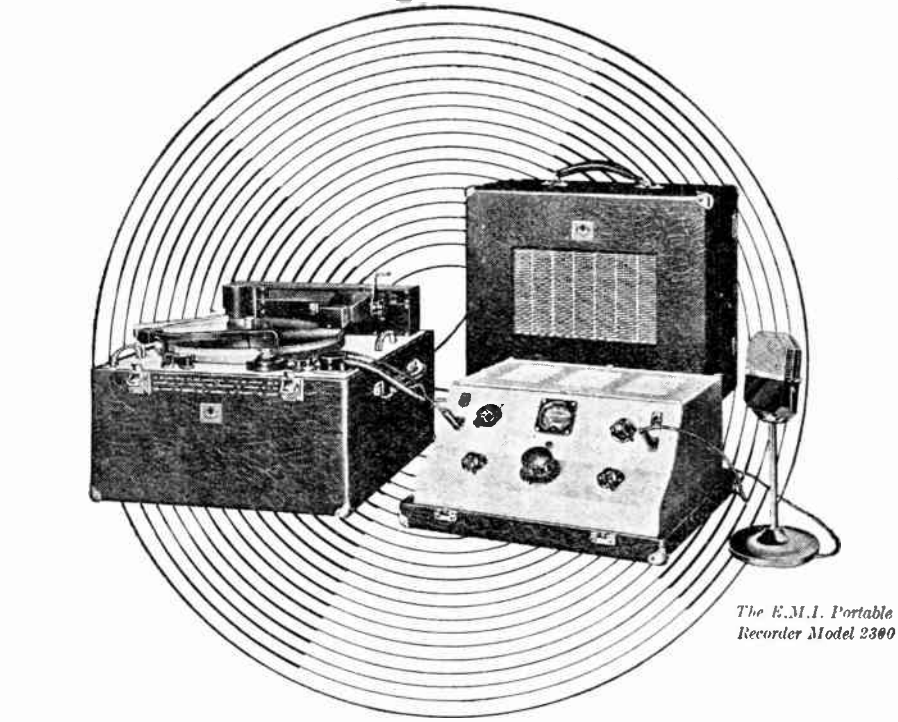
OSRAM VALVES FOR AC OPERATION

Left to right are the X61M, W61, DH63, Y61, KT61, and U50. All types are octal based.



THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, W.C.2

World Radio History



The E.M.I. Portable Recorder Model 2300

PUT THEM ON RECORD SPEECHES · LECTURES MEETINGS · SOCIAL FUNCTIONS · CONCERTS

WITH THE E.M.I. PORTABLE RECORDER

Produced by E.M.I. technicians with 50 years' experience in recording equipment this new E.M.I. Portable Recorder is a remarkable technical achievement. Here in transportable form is a complete recording and play-back equipment designed to produce high quality recordings on lacquer blanks without demanding expert knowledge of recording technique. Operation is extremely easy and the equipment which is contained in three transportable cases will operate on 200/250 volts 50 cycle A.C. mains supply or from a Car Battery and convertor.

The lacquer recording blanks from 6″ to 13″ diameter are ready for play-back immediately after cutting.

Facilities for play-back and for sound amplification form an integral part of the Recorder.

Microphone. High performance ribbon type designed to exacting professional standards and having a frequency response uniform within ± 2½ d b from 30-10,000 c.p.s. It is free from distortion even at extremely high levels of sound. The matching impedance is 20 ohms.

4 Stage Amplifier. Flat response from 50-10,000 c.p.s. with " push-pull " output of 8 watts.

Turntable. Band driven 18 lbs. balanced turntable powered by 1/20 h.p. motor specially mounted to give freedom from vibration. Speed 78 r.p.m.

Recording Head. Moving Iron type used in conjunction with a specially matched equaliser. The depth of cut can be adjusted for various types of lacquer blanks and cutting styli.

Loudspeaker Unit. Houses the Microphone and connecting cables. The Loudspeaker is of the 10″ elliptical permanent magnet, wide range, high quality type. Impedance 5 ohms at 1,000 cycles.

A descriptive leaflet giving full details of the equipment and Recording Blanks is available on request.

E.M.I. SALES & SERVICE LTD. HEAD OFFICE · HAYES · MIDDLESEX

(Distributing Organisation for The Gramophone Co. Ltd. ('His Master's Voice'), H.M.V. Household Appliances, The Marconiphone Co. Ltd., Columbia Graphophone Co. Ltd., Regal-Zonophone, The Parlophone Co. Ltd., M.G.M. Records)

S.S.2.

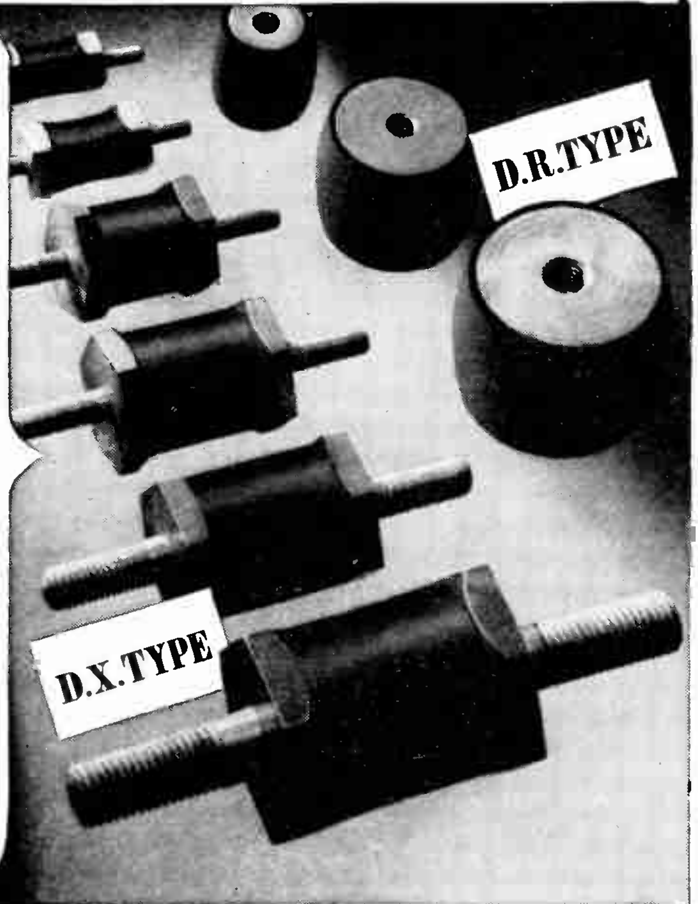
World Radio History

NINE EXAMPLES

from the
"FLEXILANT"
(RUBBER BONDED TO METAL)
RANGE
of
MOUNTINGS

•

OBTAINABLE FROM STOCK



OUR TECHNICAL STAFF investigates all mounting problems May it investigate yours?

RUBBER BONDERS LIMITED

ENGINEERS IN RUBBER BONDED TO METAL

FLEXILANT WORKS

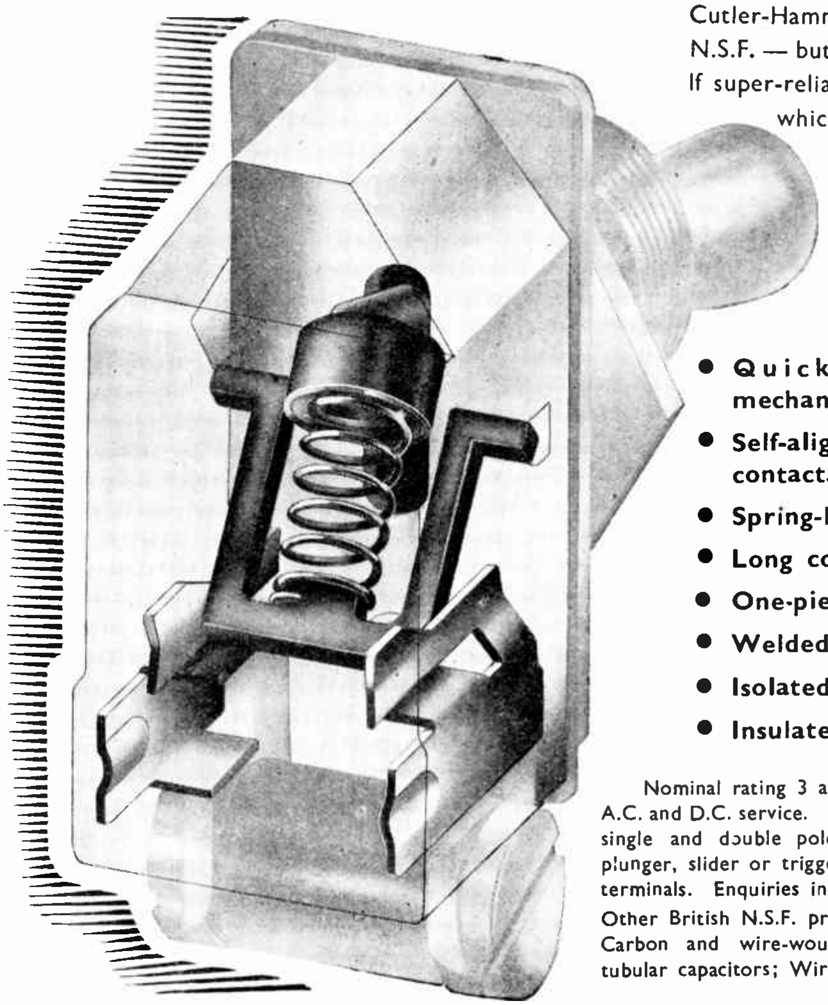
DUNSTABLE · BEDS.

TELEPHONE DUNSTABLE 803-4-5

R.B.37

INSIDE INFORMATION

about the switch that is superior



We agree that there are cheaper 3 amp. toggle switches than the Cutler-Hammer types made by British N.S.F. — but there are none better. If super-reliability is the yardstick by which you choose a switch then this is the switch for you.

NOTE THESE C-H FEATURES

- **Quick make and break mechanism.**
- **Self-aligning "wiping" moving contact.**
- **Spring-leaf fixed contacts.**
- **Long coil spring.**
- **One-piece moulded case.**
- **Welded terminal plates.**
- **Isolated toggle lever.**
- **Insulated terminal bridge.**

Nominal rating 3 amps. 250 volts —suitable for A.C. and D.C. service. Available in a wide range of single and double pole types operated by lever, plunger, slider or trigger, with screw or solder-lug terminals. Enquiries invited.

Other British N.S.F. products include :
Carbon and wire-wound potentiometers; Paper tubular capacitors; Wire-wound resistors.

NSF

CUTLER-HAMMER
APPLIANCE SWITCHES
C-H

BRITISH N·S·F CO. LTD
KEIGHLEY · YORKS

Phone : Keighley 4221/5. Grams : ENESEF, Keighley.
LONDON OFFICE : 9 Stratford Place, W.1. Phone : Mayfair 4234.
Licensees of Igranic Electric Co. Ltd. for the above products of Cutler-Hammer Inc. Milwaukee, U.S.A.

World Radio History

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD

THE NEW PREMIER TABLEGRAM A modern Tablegram, incorporating many new features. Covers Medium and Long wavebands. Operates on 200-250 v. A.C. Mains. A high-fidelity pick-up and the latest Collaro electric gramo. motor ensure excellent record reproduction, **£19/19-**, including Purchase Tax.

METAL RECTIFIERS

230 v. 30 m/A.	2/6
260 v. 30 m/A.	3/-
300 c. 75 m/A.	4/-

MINE DETECTOR PANELS, include three 1T4 valves, 12-1 Midget Trans., three ceramic valveholders, 18 condensers and resistors, etc., **20/-**. Without valves, **5/-**

A NEW PREMIER PRODUCTION
A 5in. Moving Coil PM Loudspeaker in an attractive plastic cabinet. Fitted with Volume Control. A fine extension speaker for **30/-**.

WE HAVE PURCHASED THE ENTIRE STOCK OF A TELEVISION LENS MANUFACTURER AND ARE OFFERING 9in. AND 12in. LENSES AT LESS THAN HALF PRICE.

These are of the highest quality and are distortionless.
9in. Lens. List Price £5 17 6. OUR PRICE: **39/6**.
12in. Lens. List Price £7 17 6. OUR PRICE: **70/-**.
TELEVISION MAGNIFYING LENS. Suit any 5in., 6in., or 7in. tube. Increase picture size considerably. **25/-**.

METER KIT
A FERRANTI 500 MICROAMP M C METER, with separate High Stability, High Accuracy, Resistors to measure, 15, 60, 150 and 600 volts D.C. Scale length 1½in., diameter 2¼in. **10/-** the complete kit.

SECTIONAL WHIP AERIAL. Seven sections which plug into each other making an aerial 14ft. long. Thinnest section ⅛in. diam., thickest section ⅜in. diam. Weather proof enamel. **3/6** each complete.
INSULATED BASE for above, **2/6** each.

LOUDSPEAKERS BY FAMOUS MAKER

3in. P.M. 2-3 ohms	9/-
5in. „ 2-3 „	10/-
6in. „ 2-3 „	16/6
8in. „ 2-3 „	17/6
10in. „ 2-3 „	23/6

C.R. TUBES. E.M.I. 4/1 Cathode Ray Tubes. 3½in. in diameter. 4 v. 1.3 a. Heater. 800 v. H.T. complete with Socket. Short Persistance. Complete operating data is supplied with each tube.
Cat. No. CRT746 .. .. 17/6 each

C.R. TUBES V.C.R. 138 (equivalent to E.C.R. 35)
3½in. in diameter. Green Screen. 4 v. 1a Heater. 1200 v. H.T. Complete with Socket. Short persistance. Complete operating data is supplied with each tube.
Cat. No. CRT747 .. .. 19/6 each
We can supply a mu-metal screen to fit the VCR.138 Tube .. .. 4/6 each

A NEW A.C. ALL-WAVE SUPERHET RECEIVER

7 Valves (plus metal Rectifiers) for 200/250 volts, 40/60 cycle A.C. mains. 4 wavebands, 13.6-52, 51-200, 200-550 and 900-2,100 metres. Pick-up input. Uses 6K7, 6K8, 6K7, 6B8, 6J7 and 2-6V6 in push-pull, giving an output of 10 watts. Specially designed OP Transformer to match 6V6's to 3 and 15 ohm Speakers. Negative feedback is applied over 3 stages giving a high fidelity output. Completely wired and tested, **£15/17/9**. Our Universal model is still available at **£15** built; or **£13/8/-** in kit form. All prices include Pur. Tax.

PREMIER MIDGET RADIO RECEIVER. Due to greatly increased production we are now able to offer this receiver at a greatly reduced price. The Receiver is housed in an attractive Bakelite case, 12in. long × 5in. wide × 6in. high. The valve line-up is 6K7, 6J7, 6V6 and a Selenium Rectifier in the A.C. model; and 6K7, 6J7, 25A6 and Selenium Rectifier in the A.C./D.C. model. Both are for use on 200 to 250 volt mains. The dial is illuminated, and the receiver presents a very attractive appearance. Coverage is for the medium and long wavebands. PRICE **£6/15/-**.

Complete kit of parts with diagrams, **£6/6/-** inc. Purchase Tax.

PREMIER MIDGET SUPERHET RECEIVER. This powerful Midget Superhet Receiver is designed to cover the short-wave bands between 16 and 50 metres and the medium wavebands between 200 and 557 metres. Two models are produced, one for 200-250 volt A.C. mains, and the other for 200-250 volts A.C. or D.C. mains. Both are supplied in the same plastic cabinet as the TRF Receiver. The A.C. valve line-up is 6K8, 6K7, 6Q7, 6V6 and a selenium rectifier. The A.C./D.C. line-up is the same, with the exception of the output valve, which is a 25A6. The dial is illuminated, making a very attractive receiver. PRICE: **£8/19/6**.

Complete kit of parts with diagrams, **£8/8/-**, inc. Purchase Tax.

PLASTIC CABINETS, as illustrated above. In Brown, **17/6**. In ivory, **22/6**.

METERS

Full Scale Deflection	Scale Marking	Scale Length	Movement	Price
1 mA	0—100	2½in.	M/C D.C.	15/11
1 mA	0—1	2in.	M C D.C.	7/6
5 mA	0—5	2in.	M C D.C	5/-
25 mA	0—25	1¼in.	M I D.C.	12/6
30 mA	0—30	2in.	M C D.C	10/6
50 mA	0—50	1¼in.	M I D.C.	12/6
50 mA	0—50	2in.	M C D.C.	8/6
100 mA	0—100	1¼in.	M I D.C	12/6
150 mA	0—150	2in.	M C D.C.	6/-
200 mA	0—200	2½in.	M C D.C.	8/6
2.5 Amp.	0—2.5	2in.	Thermo	5/-
3 Amp.	0—3	1¼in.	Thermo	5/-
3.5 Amp.	0—3.5	1¼in.	Thermo	5/-
20 Amp.	0—20	2in.	M C D.C.	7/6
25 Amp.	0—25	2½in.	M I D.C.	2/11
40 Amp.	0—40	2in.	M C D.C.	7/6
20 v.	0—20	2in.	M C D.C.	5/9
40 v.	0—40	2in.	M C D.C.	5/9
300 v.	0—300	1¼in.	M C D.C.	10/-
5,000 v.	0—5,000	3½in.	Elect	50/-
500 u.a.	0—15 0—600	2in.	M C D.C.	5/-
500 u.a.	0—500	2in.	M C D.C.	7/6
500 u.a.	0—500	2½in.	M C D.C.	19/6

ALUMINIUM CHASSIS, 16 SWG. Substantially made of bright aluminium with four sides.

	Price
7in. × 3½in. × 2in.	3/3
9½in. × 4½in. × 2in.	4/-
10in. × 8in. × 2½in.	5/6
12in. × 9in. × 2½in.	6/8
14in. × 9in. × 2½in.	6/11
16in. × 8in. × 2½in.	7/3
20in. × 8in. × 2½in.	7/11
22in. × 10in. × 2½in.	10/-
10in. × 9in. × 3in.	6/3
12in. × 10in. × 3in.	6/10
14in. × 10in. × 3in.	7/11
16in. × 10in. × 3in.	8/6
20in. × 10in. × 3in.	10/-

ROTARY TRANSFORMERS. Type 103. Normal rating is 19 v. D.C. Input. Output 300 v. 30 mA and 6.5 v. 3 A. D.C. By applying between 230 and 250 v. D.C. to the H.T. output side the two Low-tension windings may be used to charge Accumulators. The 19 v. side will charge a 6-volt Accumulator at 2-3 amps., the 6.5 side a 2-volt Accumulator at 1-2 A. With a 12-volt input to the 19 v side 180 v. at 30 mA and 4 v. at 3a may be obtained. With a 6 v. Input to the 6.5 side 160 v. at 30 mA may be obtained. By extending the spindle which is flush with the frame and applying 200 to 250 v. D.C. Mains to the 300 v. side, the Unit becomes a powerful high-speed electric Motor, suitable for small drilling machines, etc. Similarly it may be used with 6 or 12 v. input to the 6.5 v. or 19 v. side. In conjunction with the 325 v. 65 mA Rectifier which can be supplied at **4/-**, this Unit may be driven off 200/250 v. A.C. Mains **5/-** each.

R28 ARC5 RECEIVERS. Cover 100/150 Mc/s **BRAND NEW COMPLETE WITH TUBES AND CIRCUIT.** Ten Valves, including four 717A, **42/6**.

ELECTRON MULTIPLIER PHOTO CELL TUBES. Type 931A. Brand New. Guaranteed, **30/-**.

CRYSTAL DIODES, Type CV102, **3/6** each.

DOUBLE HEADPHONES complete with Headband and Cord. 4,000 ohms resistance, **5/-** per pair.

TELEPHONES. We can now offer a Kit of Parts for a real Post Office type telephone that will enable you to communicate over any distance up to several miles. The Kit comprises two army type carbon microphones with switch in handle, two single earphones, two switches two buzzers, two matching transformers. Price **15/-**. All you require to complete the kit are two small dry batteries between 3 and 4 volts, two wooden bases for mounting components, sufficient twin bell wire or flex.

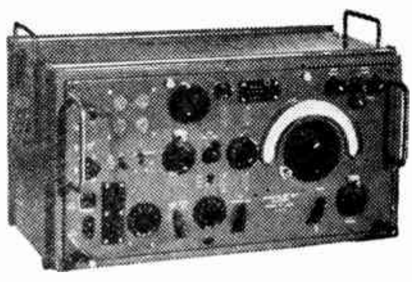
GOVERNMENT SURPLUS MAINS TRANSFORMERS
All are for use on 230 volt 50 cycle Mains.

Type		
42	500-0-500 v. 170 mA. 4 v. 4 a.	25/-
44	10 v. 5 a., 10 v. 5 a., 10v. 5 a.	35/-
51	350 + 350 v. 60 mA 6.3 v. 1 a., 6.3 v. 3-5 a.	12/6
53	250-0-250 v. 60 mA. 5 v. 2 a., 6.3 v. 2-3 a.	15/-
54	275-0-275 v. 60 mA, 5 v. 2 a., 6.3 v. 2-3 a.	15/-
55	250-0-250 v. 100 mA, 5 v. 2 a., 6.3 v. 3-5 a.	17/6

SUPER MOVING COIL MIKE AND STAND. We have purchased the entire stock of a famous Manufacturer of PA Equipment at a very low price, and are offering a £5 5/- Super Moving Coil Mike, with a chromium plated folding stand to match. The list price of the stand was £3/3/-.

WE OFFER THE PAIR AT 79/6. LESS THAN HALF THE USUAL PRICE.

R107. ONE OF THE ARMY'S FINEST COMMUNICATIONS RECEIVERS. (See "W.W." August, 1945.)



9 valves, R.F. amp. osc. Frequency Changer, 2 I.F.'s. (465 kc.), 2nd Detector, A.V.C. Af. amp. B.F.O. A.C. mains, 100-250 v. or 12 v. accum. Frequency range 17.5 to 7 mc/s, 7.35 mc/s to 2.9 mc/s, 3.0 to 1.2 mc/s Monitor L.S. built in. Complete. Write for full details. **£16/16/-**. Carriage paid.

500-WATT GENERATOR. These heavy-duty generators are engine driven and give an output of 12 volts D.C., watts. They can also be driven by wind or water power. Offered at a fraction of original cost. Cat. No. G.500 Price **30/-**.
Carriage and Packing, **5/-**.

BRANCHES AND AT—

207, EDGWARE ROAD, W.2 Phone : AMBassador 4033

All **POST ORDERS** to 167, LOWER CLAPTON ROAD, LONDON, E.5. *Phone : AMHerst 4723*

Terms of Business : Cash with order or C.O.D. over £1. Send 2d. Stamp for list

EDGWARE ROAD IS OPEN UNTIL 6 p.m. ON SATURDAYS

World Radio History

PREMIER RADIO COMPANY

MORRIS & CO. (RADIO) LTD

You can build a commercial looking and working

TELEVISOR WITH PREMIER KITS FOR

—£17.17.0—

This Receiver consists of 4 units :

The Sound Receiver, Vision Receiver, Time Base and Power Pack. As is usual in all Premier Kits, every single item down to the last bolt and nut is supplied. All chassis are punched and layout diagrams and theoretical circuits are included.

The cost of the Kits of Parts is as follows :

Vision Receiver with valves	£3	13	6
Carriage 2 6.			
Sound Receiver with valves	£2	14	6
Carriage		2	6
Time Base with valves	£2	7	6
Carriage		2	6
Power Supply Unit with valves	£6	3	0
Carriage		5	0
In Addition you will need :			
VCR97 Cathode Ray Tube	£1	15	0
Carriage		1	6
Set of Tube Fittings and Socket		7	0
Carriage			6d.
6in. PM Moving Coil Speaker		16	6
Carriage			6d.

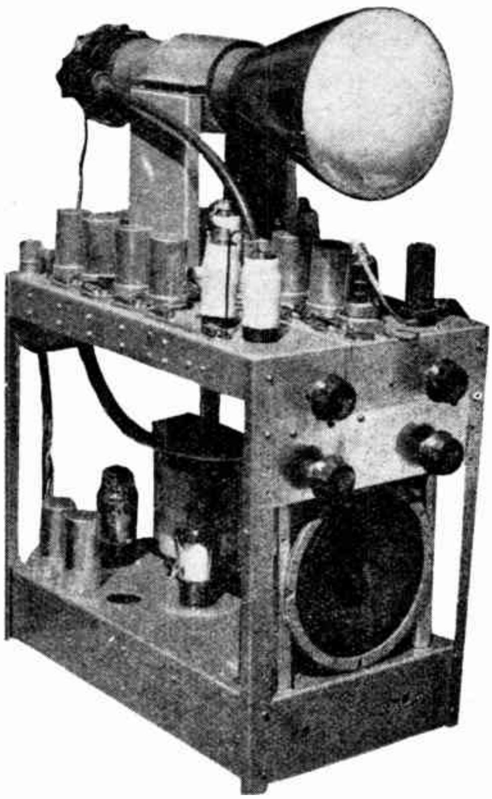
A well-made pedestal cabinet in walnut is available at £5 10 - plus 10 - packing and carriage.

The Instruction Book costs 2 6, but is credited if a Kit for the Complete Televisor is Purchased.

Any of these Kits may be purchased separately ; in fact any single part can be supplied. A complete priced list of all parts will be found in the Instruction Book.

20 valves are used, the coils are all wound and every part is tested. All you need to build a complete Television Receiver is a screwdriver, a pair of pliers, a soldering iron and the ability to read a theoretical diagram.

Modification Details for the Midland transmitter will be available a few days after the commencement of full power transmissions. For those wishing to commence construction the time base and power pack which are identical may be purchased immediately and an order placed for the balance to insure prompt delivery.



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FOR FIELD OR FACTORY

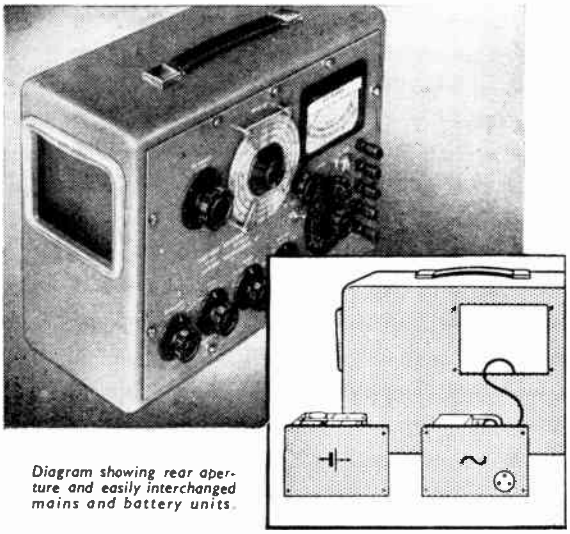

Diagram showing rear aperture and easily interchanged mains and battery units.

Originally styled for service in the front line, this mobile Marconi Signal Generator has proved itself supremely adaptable. Light and compact as an attaché case it is mains operated ordinarily but independent of power supplies when fitted with its special battery unit. Technically a triumph of ingenuity, it combines in so small a compass a SIGNAL GENERATOR with wide frequency coverage—70 kc/s to 70 Mc/s—OUTPUT POWER METER, up to 1 W with impedance matching — and CRYSTAL CALIBRATOR accuracy 2 parts in 10^4. Accuracy of output and frequency calibration is above the average for so moderately priced an instrument. Please ask for further particulars of:

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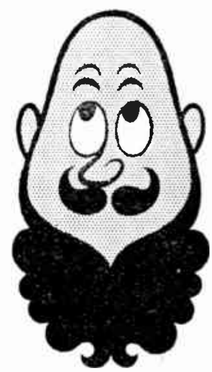

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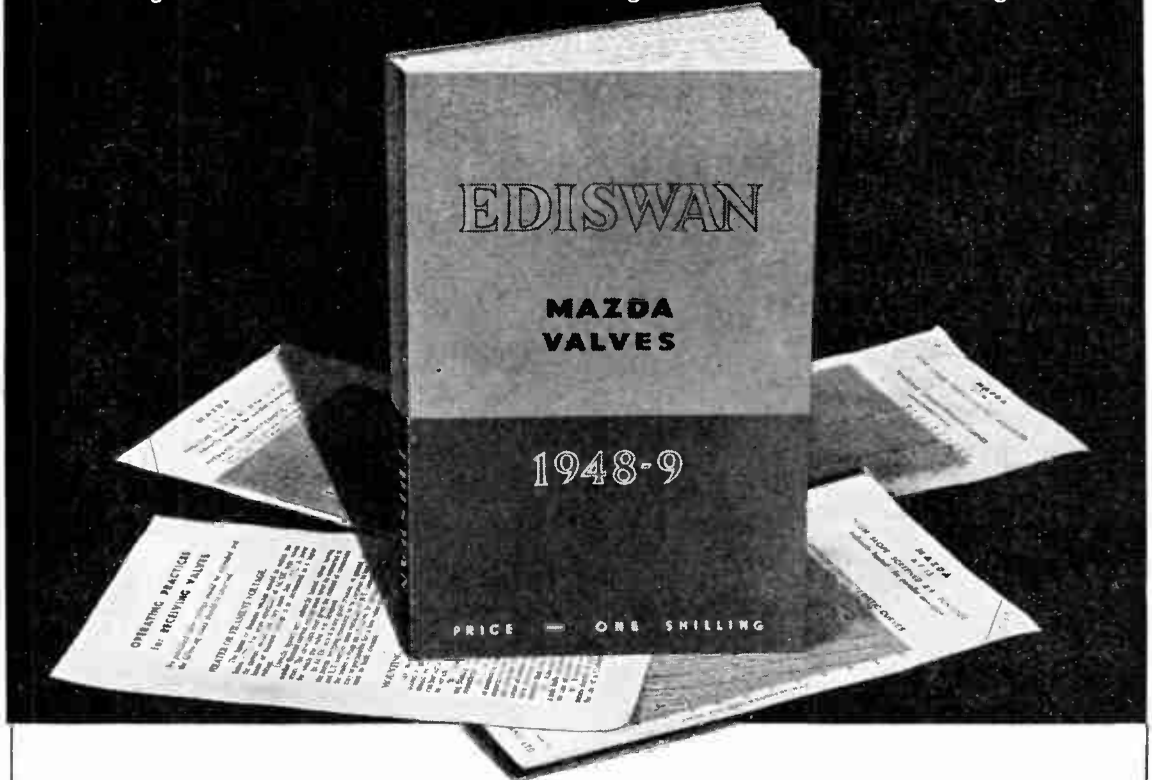

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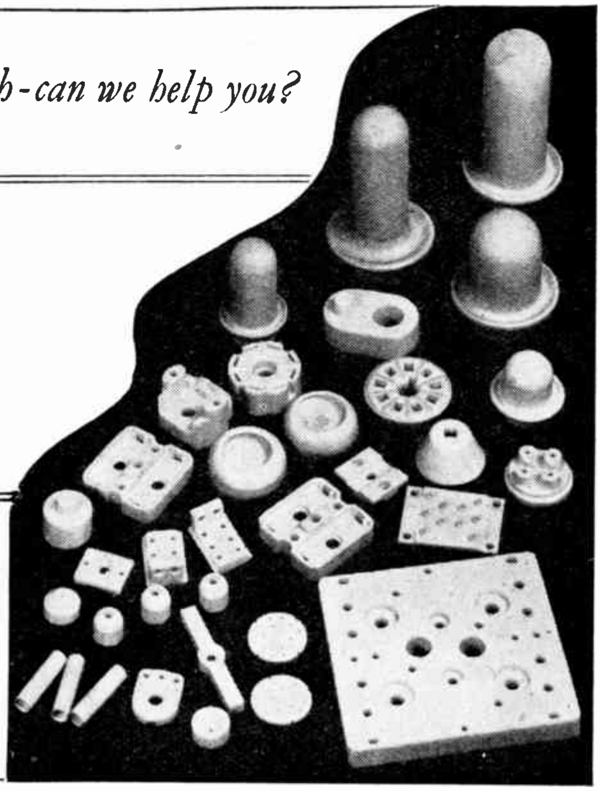

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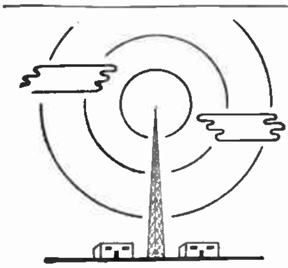

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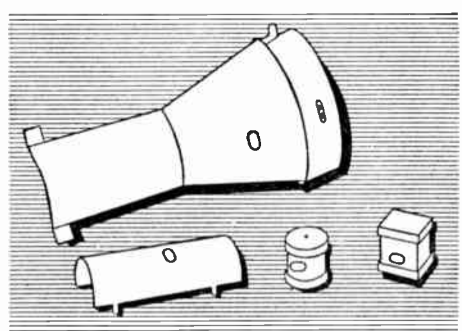

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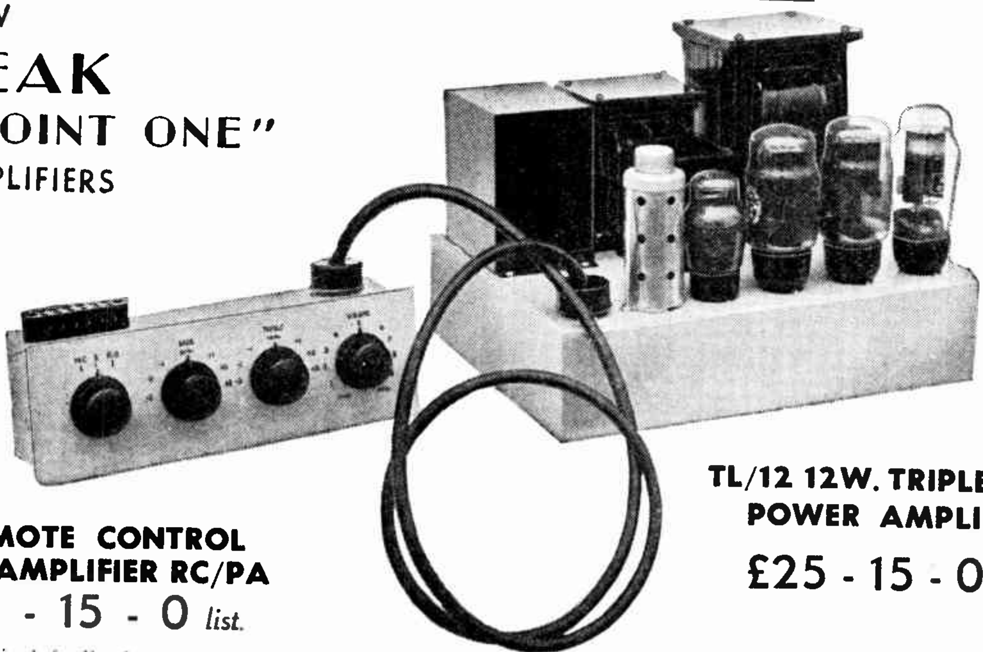

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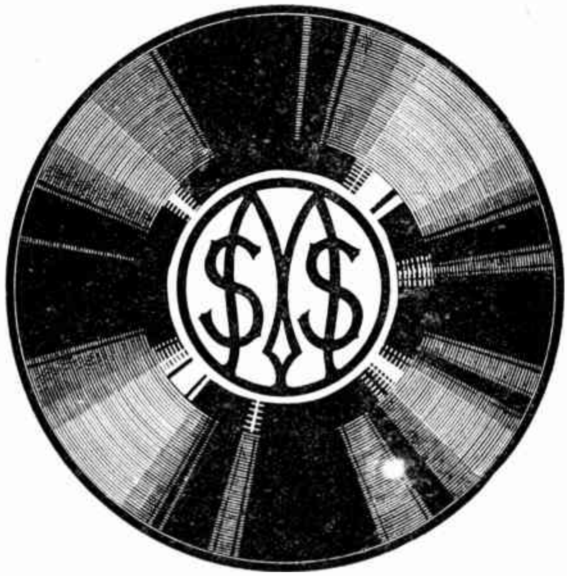

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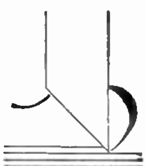

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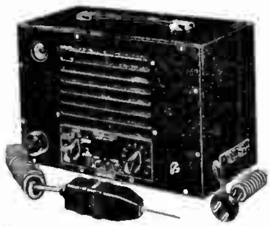

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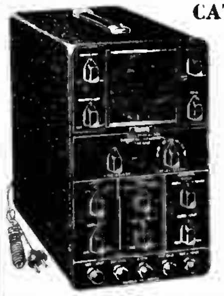

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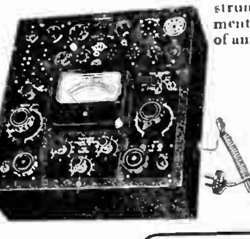

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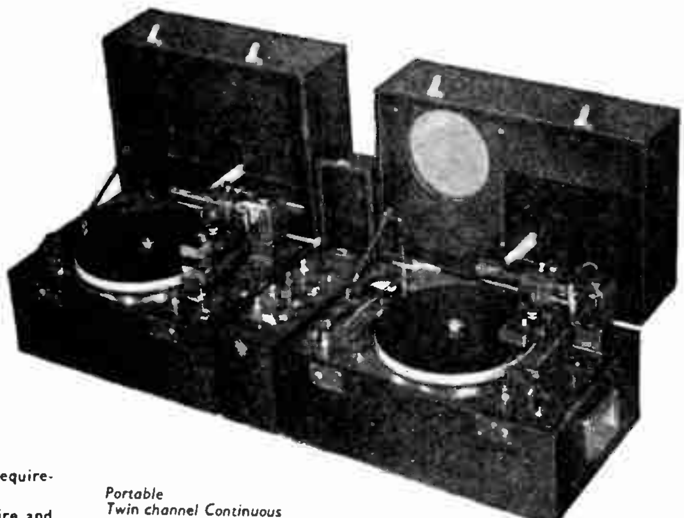

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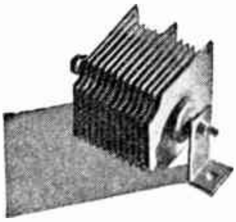

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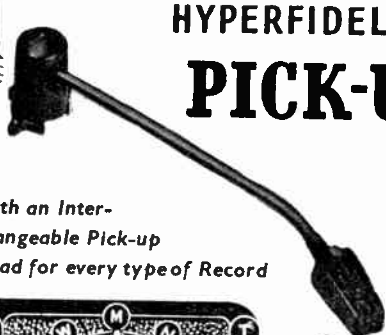

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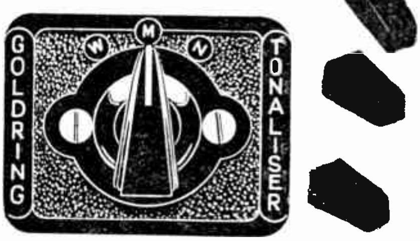

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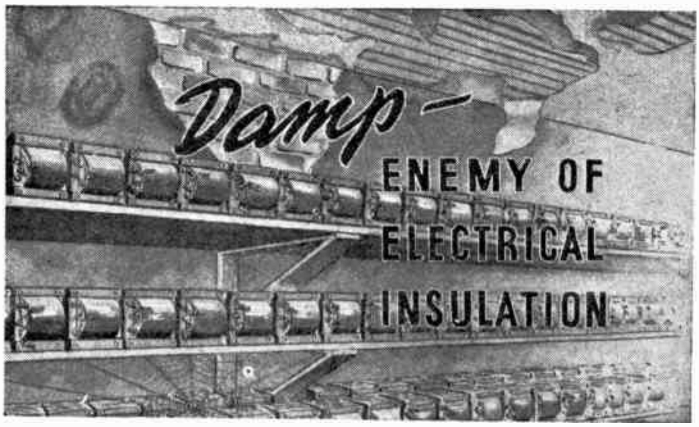

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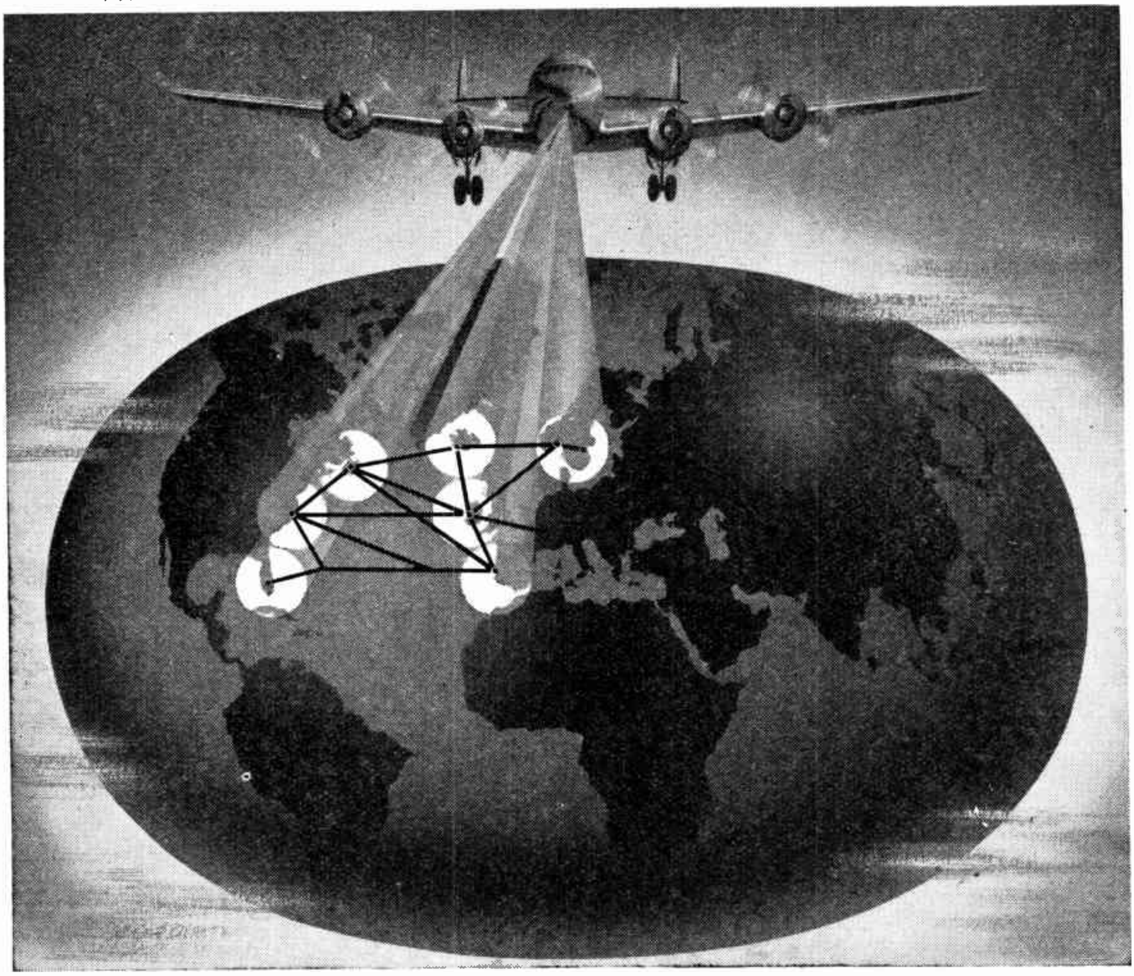

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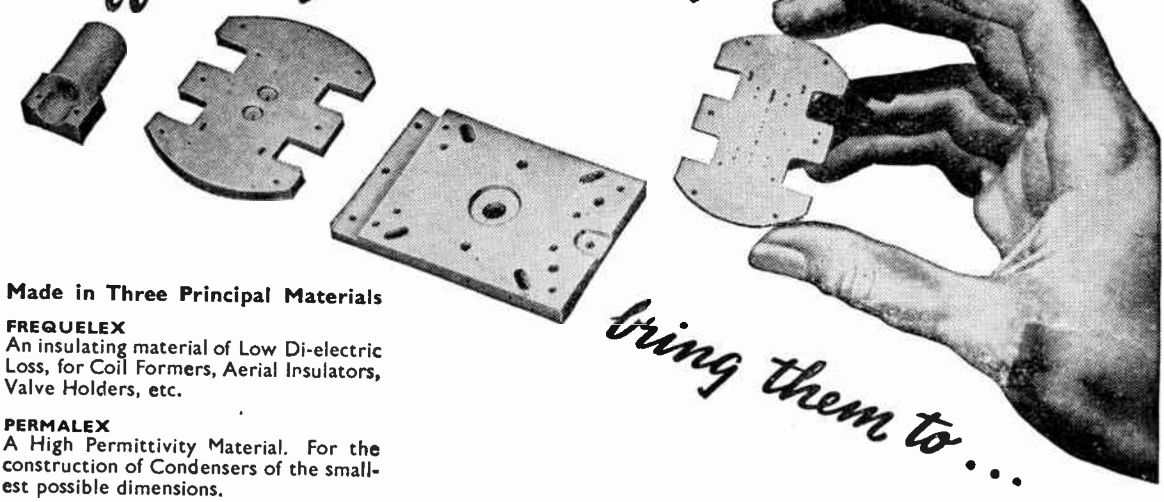

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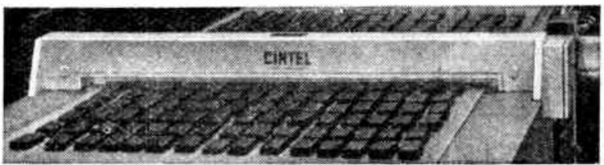

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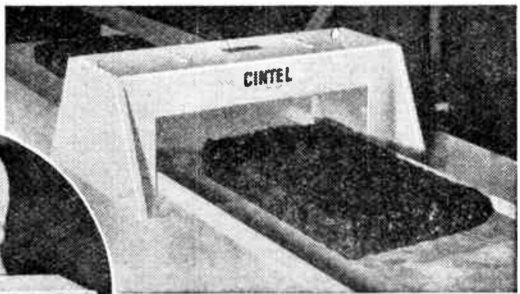

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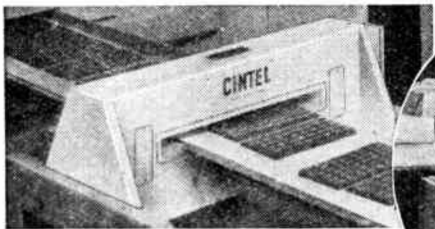

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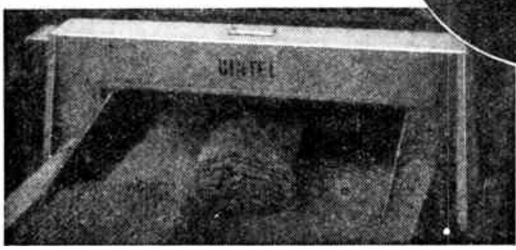

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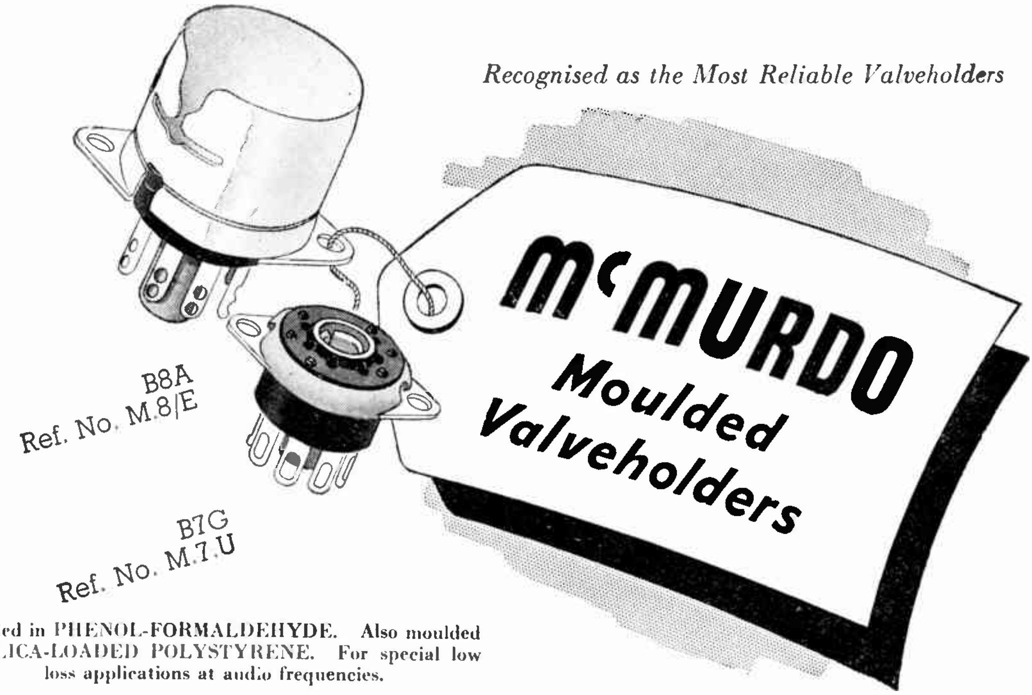

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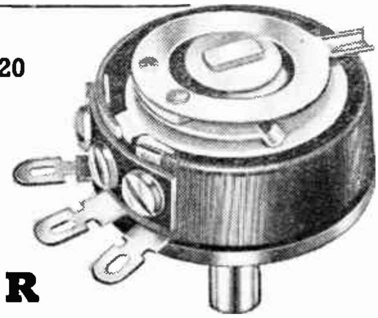

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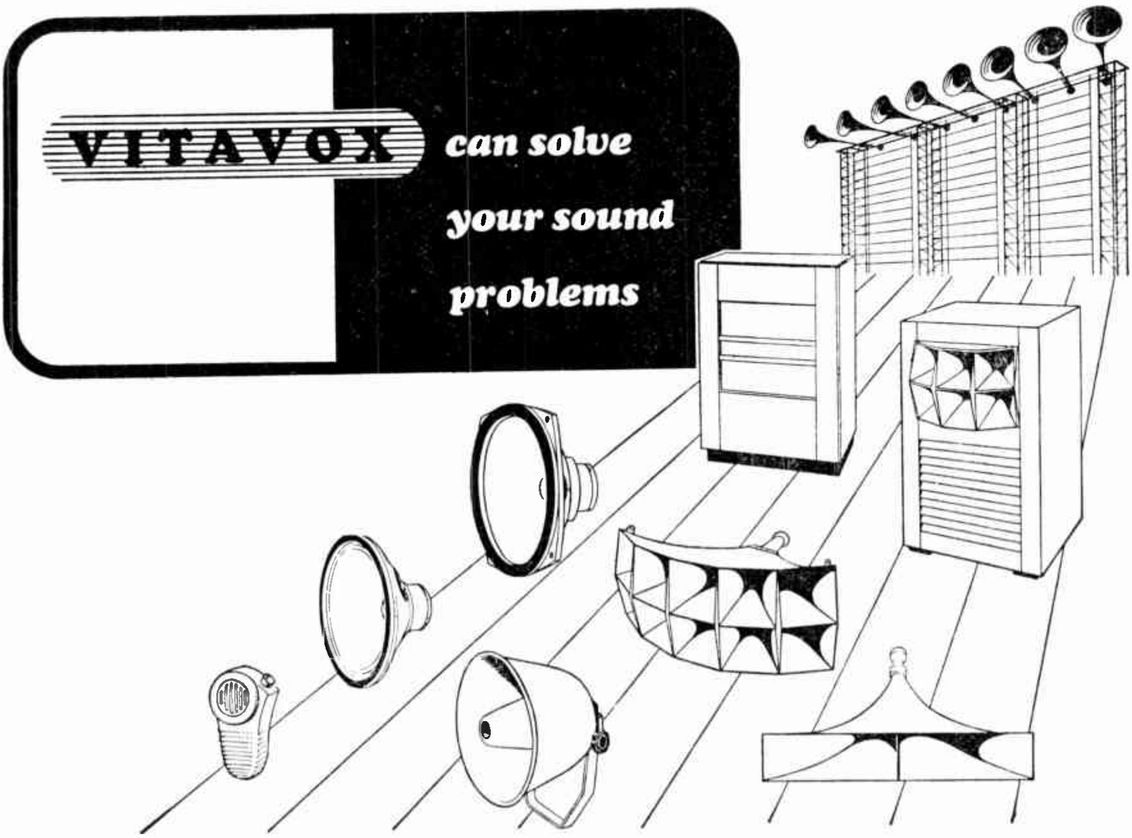

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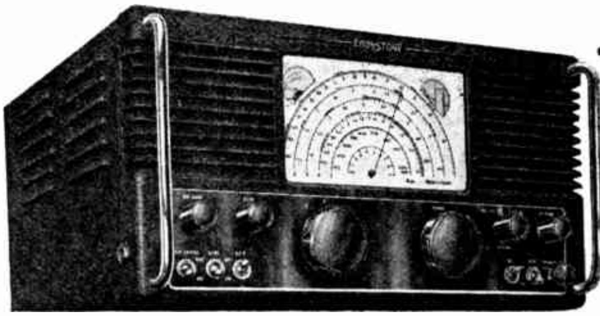

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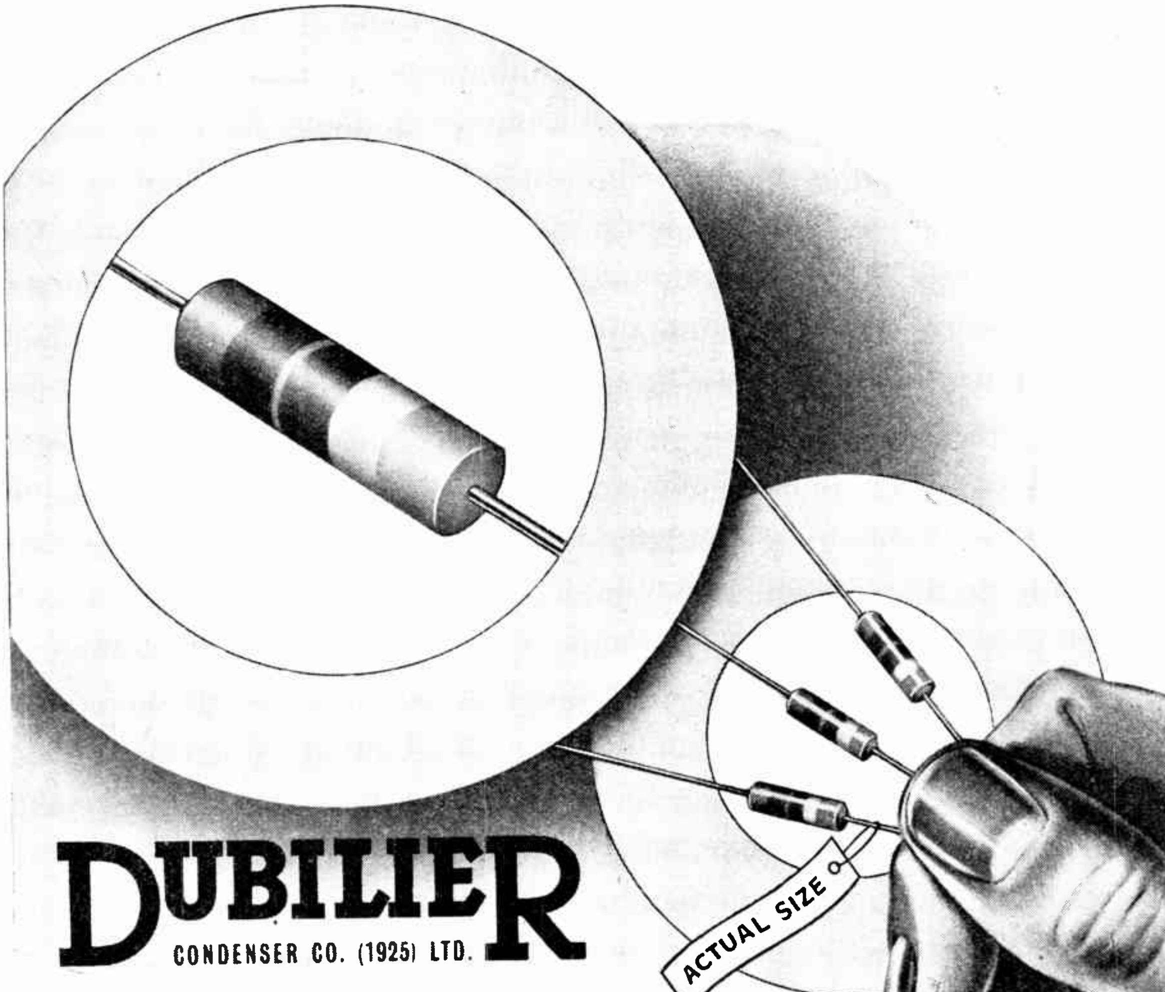

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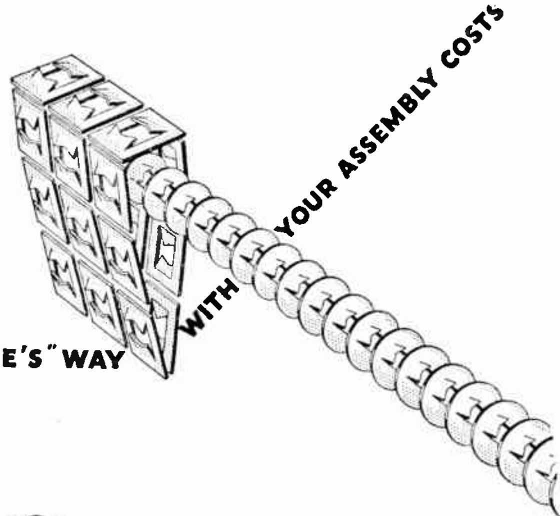

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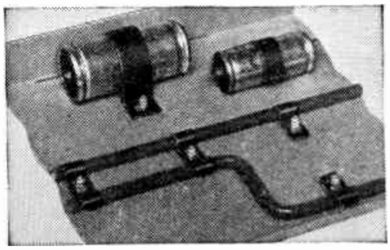

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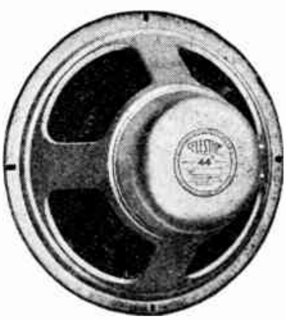

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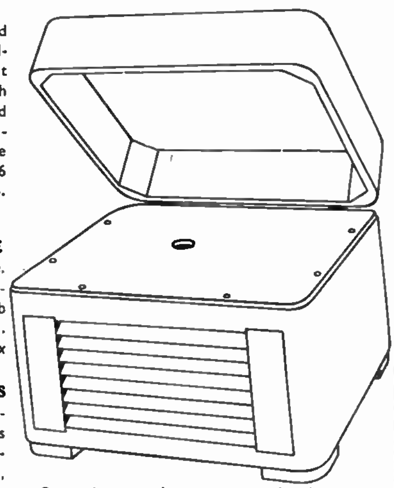

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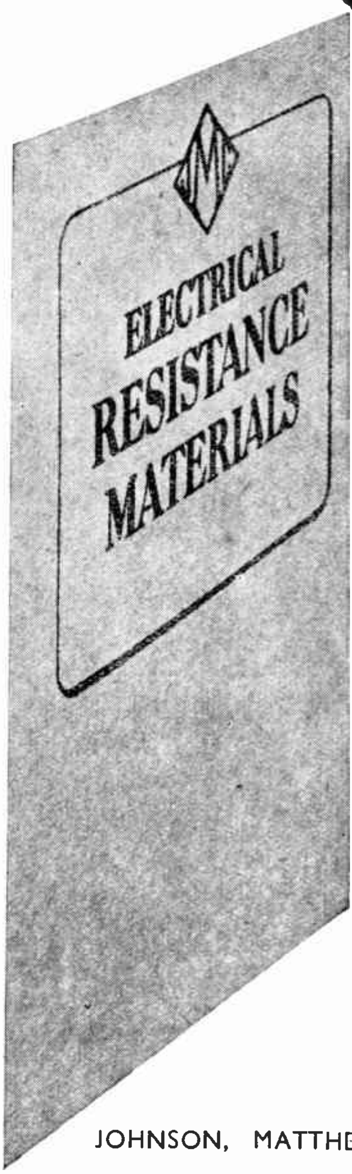

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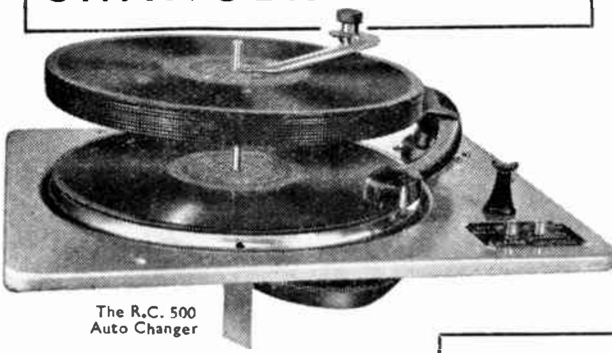

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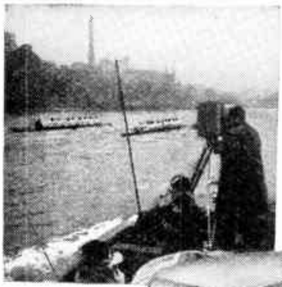

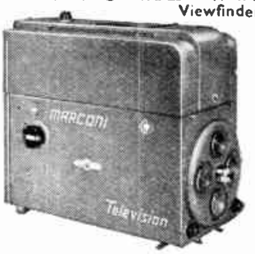

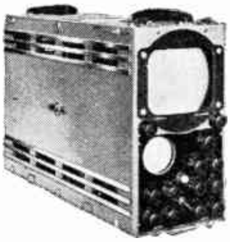

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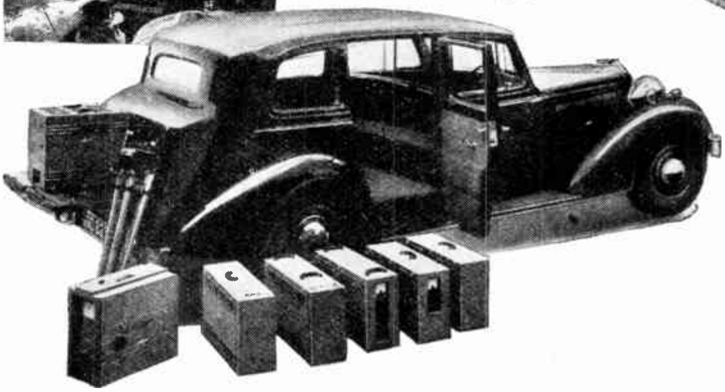

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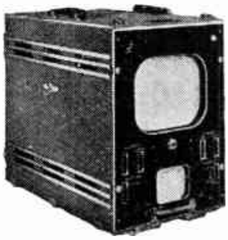
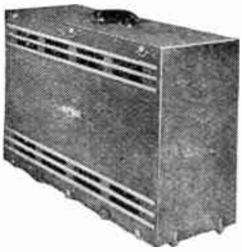


5. MASTER MONITOR
Weight: 68 lbs.
Dimensions: 20" x 13" x 18".



6 & 7. WAVE FORM GENERATOR (in two units)
Weight: 70 lbs. and 55 lbs.
Dimensions: 26" x 8½" x 16" and 26" x 8½" x 16".

These seven lightweight "suitcase" units provide a complete mobile television system. Easily transportable, adaptable and flexible, their exceptional mobility widens the horizon of television. For outside broadcasts or for the specialised applications of television in hospitals, in film studios, or for general application in industry, Marconi television equipment is the finest in the world.

Ask for descriptive brochure SP14.

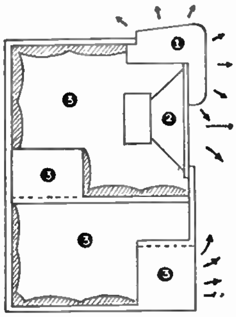
DEMONSTRATION ON STAND NO. 174
NATIONAL HALL, RADIOLYMPIA

Marconi
Television

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, CHELMSFORD.

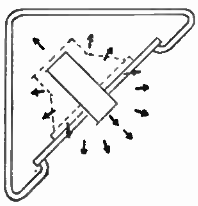
A new development in Loudspeakers

1. Multidirectional Ribbon Unit.
2. Low Frequency Unit.
3. Elements of Acoustic Filter.



Side view sectional diagram showing arrangements of units and vertical dispersion.

Top diagram view showing horizontal dispersion.



The Corner Ribbon

We have now completed our work in the development of a new type of loudspeaker aimed to give the highest possible quality of sound reproduction.

The new loudspeaker incorporates a freely suspended ribbon for the mid-high and high frequencies, this being loaded front and back and arranged to radiate in all directions (including the rear). A cone unit is used for the lower frequencies, the back being coupled to the air through a two-section acoustic filter.

During the last three years, the development of this loudspeaker has entailed some physiological research and a vast number of conventional measurements. It has also brought to light some new methods for assessing the goodness of a loudspeaker. Full details of the loudspeaker itself and some of the methods used in its development will shortly be available.

A special listening lounge will be provided at Radiolympia this year solely for the demonstration of this loudspeaker—fed from a QA12 P amplifier with radio and records. We strongly recommend that you take advantage of this demonstration. We should also like to see you on our stand (No. 91), where we shall be pleased to give you further information.

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Telephone : HUNTINGDON 361

CO-AX AIR-SPACED ARTICULATED R.F. CABLES

BASICALLY BETTER

IMMEDIATE DELIVERIES
FOR HOME & EXPORT

FOR RADIO FREQUENCIES

	LOW ATTEN. TYPES	IMPED. OHMS	ATTEN. db 100 ft. at 100 Mc/s	LOADING Kw	O.D."
	A.1	74	1.7	0.11	0.36
	A.2	74	1.3	0.24	0.44
HIGH POWER FLEXIBLE	A.34	73	0.6	1.5	0.85

FOR VIDEO and SPECIAL APPLICATIONS

	LOW CAPAC. TYPES	CAPAC. mmf/ft	IMPED. OHMS	ATTEN. db 100 ft. 100 Mc/s.	O.D."
	C 1	7.3	150	2.5	0.36
PHOTOCELL CABLE	P.C.1	10.2	132	3.1	0.36
	C.11	6.3	173	3.2	0.36
	C.2	6.3	171	2.15	0.44
	C.22	5.5	184	2.8	0.44
	C.3	5.4	197	1.9	0.64
VERY LOW CAPACITANCE CABLES	C.33	4.8	220	2.4	0.64
VERY LOW CAPACITANCE CABLES	C.44	4.1	252	2.1	1.03

Write for data sheets to the originators of air-spaced R.F. Cables.

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CONTRACTORS TO H.M. GOVERNMENT.

Slashed Prices to clear EX-GOVERNMENT SURPLUS!

TR3152 Special Purpose Tx. and Rx. (U.H.F.). Containing 2 EC52 1 EF50, 1 6V6G, 1 5Z4G, 1 SP61 and 1 6H6G. All brand new and boxed. Carriage 5/-. 40/-, **NOW** 30/-.

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TRANSMITTING VALVES. Brand new Westinghouse latest 1.5V type 1299A (QRP Tx. loctal base pentode). 7/6, **NOW** 5/-. UX210 (Continental). The famous transmitting 10. 4/6, **NOW** 2/6. *VR135 (U.H.F. Triode). 3/6. **NOW** 2/6. *SP41. 3/-, **NOW** 2/-. *EF50. 7/6, **NOW** 5/-. * All out of Government surplus equipment but O.K. Brand new and boxed R.C.A. 866A and 866. 25/-, **NOW** 18/6. Eimac 250TH 45/-, 100TH 35/-, 830B, 832, 832A, 25/- ea., **NOW** 20/-. 307, 8/6, **NOW** 7/6. 813, 60/-, **NOW** 50/-.

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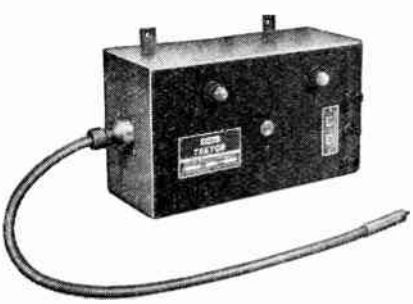
IN MICRO-MEASUREMENT AND CONTROL

FOR ANY INDUSTRIAL OR RESEARCH PROBLEM RESOLVABLE INTO MINUTE ELECTRICAL CAPACITANCE CHANGE

ACTUATION by PROXIMITY of solid or liquid conductors or insulators to an electrode terminating a co-axial cable

THE FIELDEN PROXIMITY METER—SENSITIVITY 0.01 mmf—indicates minute capacitance changes, whether caused by very small mechanical displacement or dielectric change. It measures, for instance, strains in structures, it gauges components to less than 0.00001", monitors sheet, foil and wire sizes, measures liquid and other levels precisely, monitors dimensions and compositions, compares dielectric properties of non-conducting liquids etc. It does what is impossible mechanically and, in many fields, surpasses all other micro-measurement methods.



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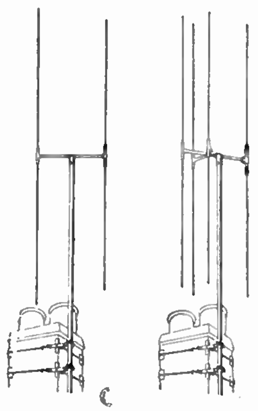
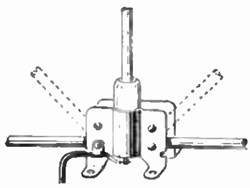
STAND NO. **13** GRAND HALL

I t's easy to remember our Stand No.! Don't miss the opportunity of seeing the full range of WOLSEY T.V. Aerials for the London and Birmingham areas. Examine them — observe their many special features and quality construction —the result of many years' specialisation. Brochures on WOLSEY T.V. Aerials and Installation Service free on request.





Eight types of WOLSEY Outdoor Aerials for London and Birmingham, including a new 'field-tested" In-line 3-element Folded Dipole Array, giving a gain of 7.5 DB's. Also a new low priced All-Flexible Indoor Aerial.

WOLSEY **INDOOR** AERIAL Designed for use where an outdoor aerial is impracticable. A special polythene V.H.F. insulator ensures maximum signals possible with an indoor aerial Easily adjusted to various positions.

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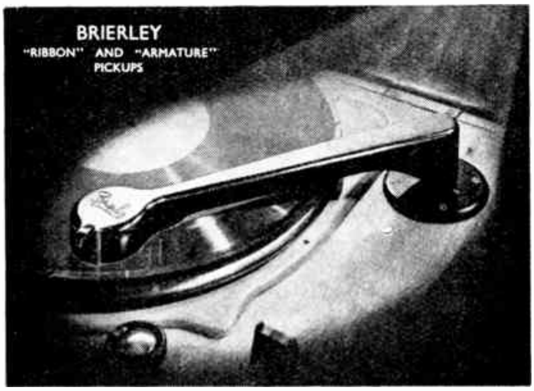
Ribbon, type JB/P/R/2

Microarmature, type JB/P/A/1



These two pickups are individually made instruments for those who take a pride and obtain pleasure in reproduction that is as nearly perfect as present technical development permits.
We regret that our best efforts fail to meet the present demand, and we have still to ask for patience.

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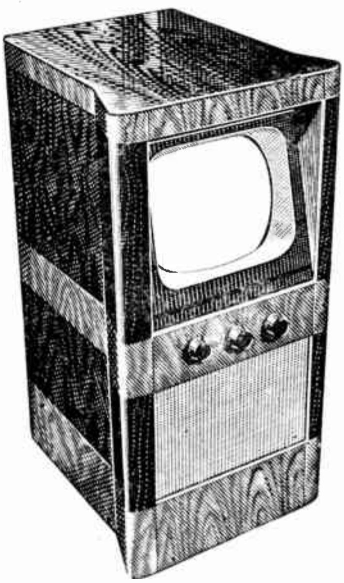
Spatial Distribution of Sound
Echoes in the Listening Room
Limitations of Single Channel
Limitations of the Human Ear
Distortions and Faults caused by Apparatus
The Radio Link
Frequency Response
Non-linearity
The Signal Rectifier
The A.V.C. Rectifier



APOLOGIA

We may as well admit it. The only reason why this space is not filled with our usual "informative" article on radio is that our author slipped away on holiday; and what with one thing and another we forgot to ask him for the next instalment. So let's forget negative feedback, non-linearity, QPP and Uncle Tom Cobley and all, and get down to a little honest to goodness advertising for a change.

Here is our latest Television Set—the Murphy V 120. From every point of view, including that of the "experts", it's a pretty good set. It has a large size screen (12″ C.R.T.) and yet costs only £71.10s.8d. including Purchase Tax. The illustration here gives you some idea of the set but it's the quality of picture and sound that count of course. So you'll go along and see it working at the nearest Murphy Television Dealer, won't you?

murphy radio limited

WELWYN GARDEN CITY · HERTS

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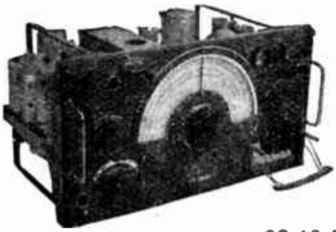
CRC9

LONDON CENTRAL RADIO STORES

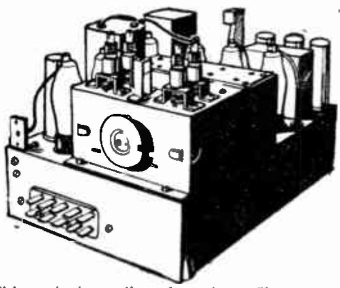
Government Surplus—from Stock

The FAMOUS R1155 10-VALVE COMMUNICATION RECEIVER.



Thoroughly Overhauled **£8.10.0**
Complete with Power Pack and Speaker. (Carr. & pkg. 10/6 extra) **£14.10.0**
FREE with each receiver! Complete circuit description and modifications for civil use, reprinted from "W.W.," July 1946.

R.A.F. 6-VALVE SUPERHET RECEIVER UNIT No. 25



This unit is easily adapted to Short-wave reception for home use. In addition to two EF36, two EF39, one EK32 and one EBC33 valves, it contains 1 pr. 460 Kc/s iron dust I.F. Transformers, Mic. and phone output transformers, a number of resistances and fixed condensers of useful values, two 1 mfd. 500 v. wkg. and four .1 tubular condensers, pot'meters, Int. Octal Valveholders. Tuning Coil, etc. mounted on steel chassis 8¼ × 6¼ × 2¼in. FREE circuit diagram 9in. × 19in. showing all components, supplied with each set **25/-**

NEW MILNE'S H.T. UNITS (Everlasting)

120v. 600 mA. Will charge from 6 v. accumulator.................................. **67/6**

MAGNETO RINGING TELEPHONE SET. Complete with hand generator. Self-energising, with Indicator Lamp and Howler. Can be used for distances up to one mile. No current needed. Weight 16 lbs. Overall dimensions 9¼ × 6 × 7in., **45/-**

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VISION UNITS, Model 6A. Consisting of 6in. VCR97 Electrostatic C.R. tube, 7 valves, including four EF50, potentiometers, resistances and other associated components. In metal cabinet 18 × 8 × 7¼in. These units are in perfect condition. Ideal for Television. Carriage Paid **67 6**

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The R.F. Unit Type 25 suitable for use with the above and for other television purposes is **12/6** extra.

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Including full constructional data

MODEL A70. 6 valve all-wave modern superhet chassis with tuning indicator, tone control and radiogram switch. The ideal replacement chassis £12 12 0d. including Tax, plus valves, £3 3 0d.
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Mainstransformer 425–0–425 volts 200 mA., 6.3 v. 4 a.; 6.3 v. 2 a., 5 v. 3 a. Pri. 210, 230, 250 volts 50 c.p.s. Size 4 × 4½ × 4¾ high. (Postage 1/6.) **£2/17/6.**
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An attractive light weight pick-up requiring no transformer. Price, complete with Sapphire point (inc. P.T.) **£3/5/-.** Price, complete without Sapphire point (inc. P.T.) **£2/10/6.** (Postage 1/-.)

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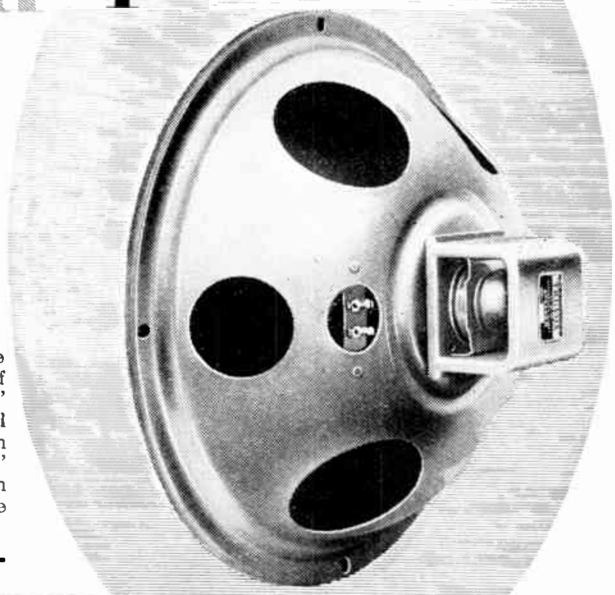
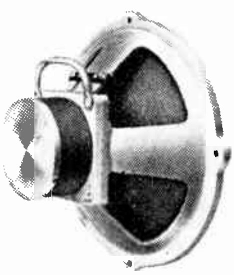


fidelity of response speaks for itself to the discriminating ear. Precision manufacture is no less eloquent to the trained engineer. These qualities make TRUVOX speakers famous.

C.P.M. 12″ SPEAKER. The outcome of intensive development by specialist engineers, the method of construction employed in the Truvox "C.P.M." series offers a notable economy in size, weight and cost. Ranging from "midgets" to auditorium speakers, each model in the TRUVOX "C.P.M." series is precision-designed to combine maximum flux density with the widest frequency coverage for its size.

Model BXII (12″ C.P.M.) LIST PRICE **45/-**



12″ HEAVY DUTY. Rigid die-cast chassis; square casting for the magnet seating, secured with large hexagon head bolts; centre pole and bottom plate all in one forging; ring-clamped cone; die-cast centring ring; practical construction matched by excellent response and high sensitivity—all made for HEAVY DUTY.

Response 55-11,000 C.P.S; flux density 13,000 Gauss; powerhandling capacity 10 watts (A.C.)

Model SS10A LIST PRICE **£6.17.6**

6½″ WAFER. Wherever the requirements call for minimum space, minimum weight, robustness and normal sensitivity and response, Truvox "Wafer" speakers are the answer. Designed by specialists with twenty years' pioneering experience in loudspeaker manufacture, they are the outcome of a completely fresh approach to the problems of speaker weight and size in relation to efficiency.

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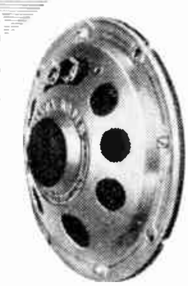

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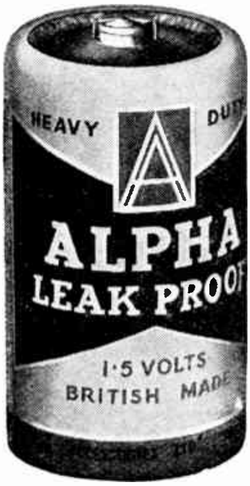

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★ *Covered by British Patent No. 531237*

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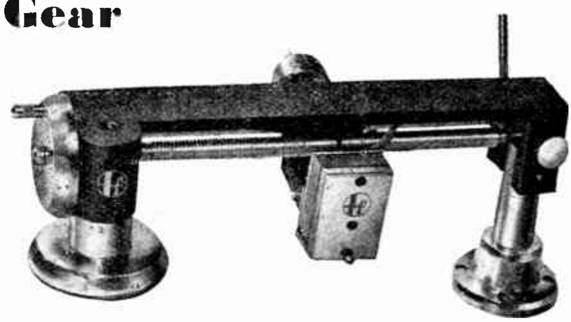

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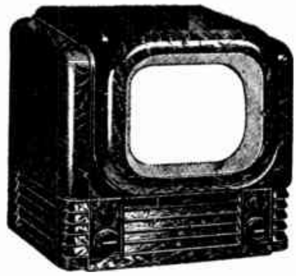

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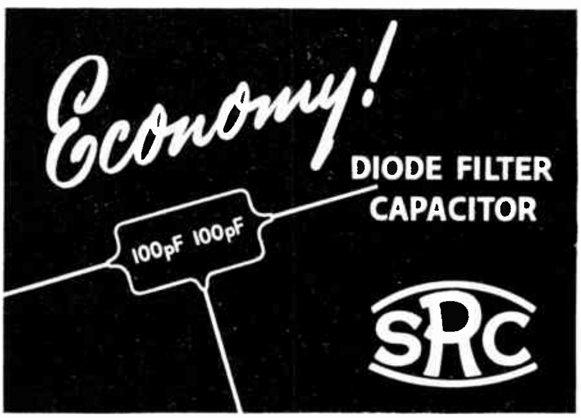

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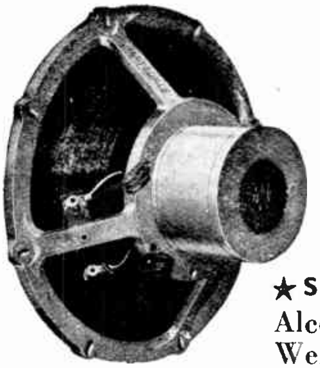

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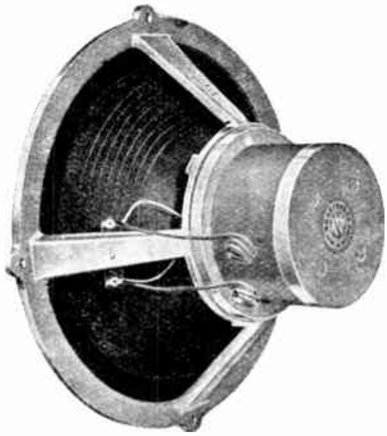

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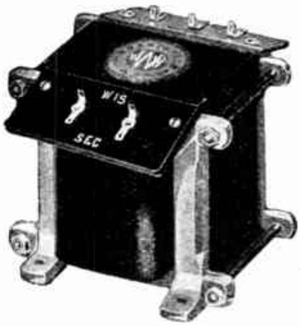
Alcomax III Magnet. 17,000 lines. Weight $18\frac{1}{4}$ lbs. Maximum efficiency. Wide response without the usual "twelve inch peak" between 3,000 and 5,000 cycles.



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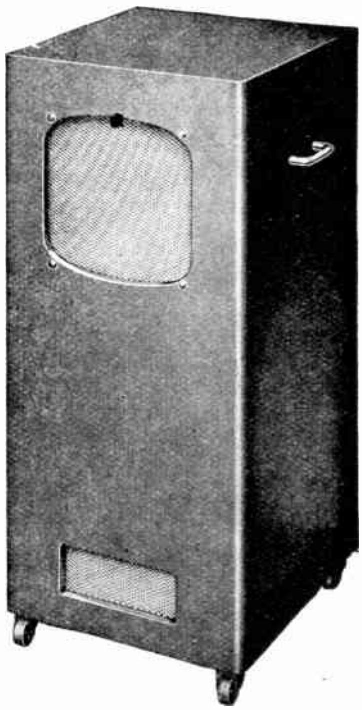
Weight $4\frac{1}{2}$ lbs. For wide response circuits up to 20 watts. Sectioned Windings. Inductance 70 Henrys. Leakage Inductance .1 Henry.



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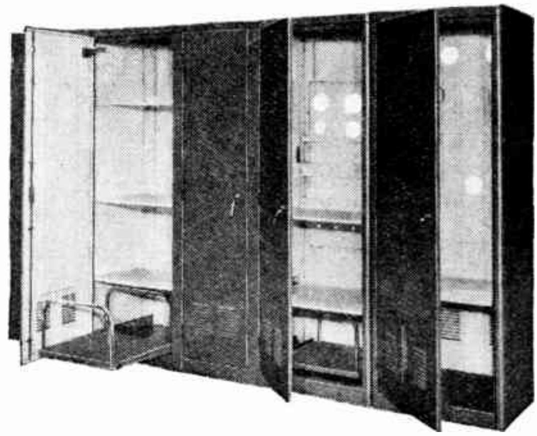

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Woden super 60-watt amplifiers with valves. As new, cost £47/10 £27 10 0

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Wharfedale W10/CSB10 Units, as new £5 0 0

1938 Murphy, pre war 15-v. All Wave Console, band spread S.W., a really superb job, P.P. output, 12in. speaker, a job for the connoisseur. ONE only, in perfect condition, would cost to-day £120. Owner deceased, as new £39 0 0

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H.R.O. and Eddystone Coils in stock.

One H.R.O. senior less cabinet and coils, but with valves. Perfect £9 0 0

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M.S.S. Disc Recording Unit in portable case less amplifier, as new £35 0 0

Heavy Duty Recording Motor and Turntable, as new, AC 200/50 v. £9 0 0

We have other types of equipment arriving daily. We take your used gear in part exchange for new. Balance by Cash or Deferred Terms. We urgently need good used equipment, and will buy for spot cash. Bring, send or phone for offer.

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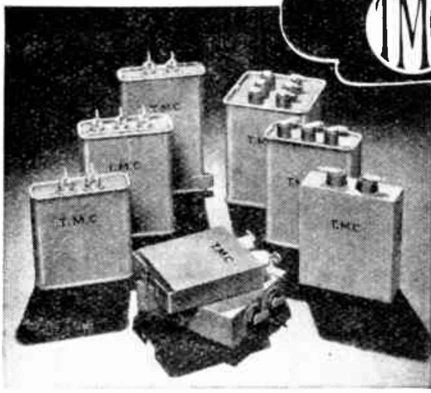
Phone GERrard 4447 and 8582. Hours 9 to 6. Thursdays 9 to 1.

B 17

World Radio History

TMC PRECISION CAPACITORS



Engineers speak with no small pride when they say that their apparatus is to "Communications Standards."

We feel equal pride in the ever-increasing number of Engineers who specify their requirements from our comprehensive range of high grade "Precision" capacitors.

To Designers who must have the best we offer:—

T.M.C. Capacitors for general use in Radio and Television, Electronic, Telecommunications, and Public Address equipment are made in a wide range of capacitances. Working voltages up to 10,000 D.C.

PAPER DIELECTRIC TYPES
for the not so exacting conditions.

CLAMPED MICA DIELECTRIC TYPES—
for heavy current duty.

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for use where small size and weight are important.

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TELEPHONE MANUFACTURING COMPANY LIMITED

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Why you should use . . .

Superspeed SPECIAL
Activated
ROSIN CORED SOLDER

1 Maximum "Wetting" Capacity
2 Accelerated Fluidity
3 Moderate soldering bit temperatures
4 Mechanical bonding and perfect Electrical conductivity ensured.
5 Minimum amount of solder used per joint.
6 Residue sets hard, is non-corrosive, and of high dielectric strength.
7 No harmful fume deposits.
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9 Even distribution of activator in core.
10 Approved by Air Ministry and General Post Office.

Supplied in a wide range of Gauges and Alloys on 1 lb and 7 lb reels, works coils or as required. Prices on application.

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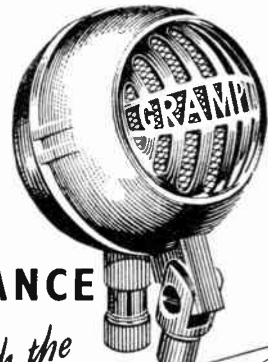

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Here is a wide range high fidelity moving coil type Microphone which combines good sensitivity with a level response curve. Equally suitable for Auditorium or Outdoor Work, and its use can confidently be advised for Amateur as well as Professional use. Housed in modern streamlined die cast alloy case of great strength and finished in hammered metallic lacquer with chromium plated grille. Delivery from stock. List price £8.8.0

Dimensions 3" diam. 3⅜" back to front, Net weight 2 lb. Frequency response 60-9,000 c.p.s. Output impedance 15 ohms. Fitting 5/16" B.S.F. Connection 2-pin plug.

GRAMPIAN P.A EQUIPMENT

Grampian Reproducers Ltd., Hampton Road, Hanworth, Middx.
'Phone: Feltham 2657.

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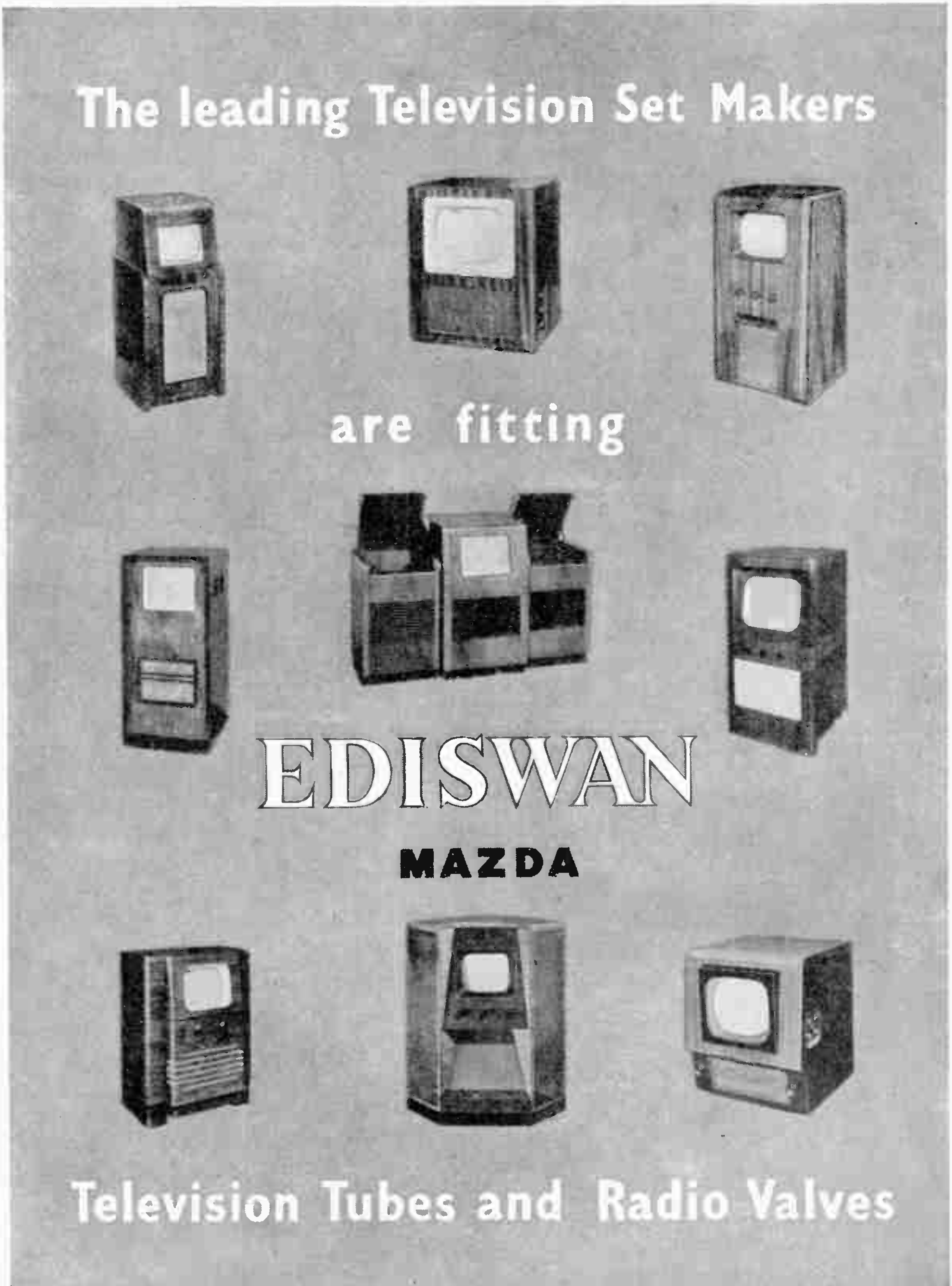

THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2.

B 19

World Radio History

just what we keep on saying—

is drained.—*P. G. E.*

Women's Voices

ELIZABETH CHRISTINE BROWN suggests that the reception of women's voices is worse than that of men's because they are pitched higher. Surely this is a reflection on the inability of most commercial wireless receivers to reproduce the top frequencies, on which the clarity of voices depends. Given a wireless of adequate performance, I can assure her that women's voices are received as well as men's. It does seem to be the habit of many manufacturers to spend a disproportionately small amount of the cost of a set on the loudspeaker. After all it does make the noise.—*R. C. Headington, Oxford.*

Letter to
RADIO TIMES
Aug. 12th 1949

its the Loudspeaker that COUNTS!

REPRODUCERS AND AMPLIFIERS LIMITED
FREDERICK STREET WOLVERHAMPTON ENGLAND
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Dependable Di-electrics

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—for insulating, filling, impregnating, waterproofing, sealing and finishing radio and electrical components, cables, etc.

ALL GRADES ARE DESIGNED TO MEET DEFINITE CHEMICAL, PHYSICAL AND ELECTRICAL STANDARDS.

For technical advice and samples, phone TEMPLE BAR 5927.

Sales Department
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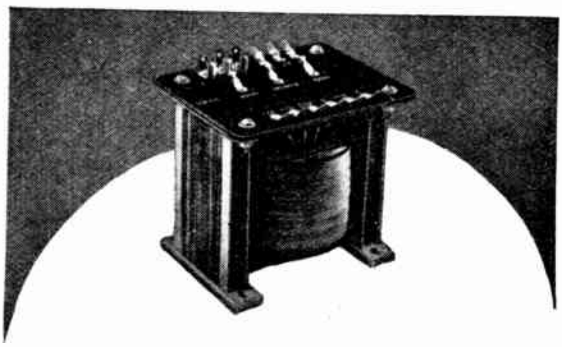

When an unusual Specification is required

We can give you the benefit of 20 years' experience in transformer construction and design. We do NOT mass produce. Every instrument is built to suit your most exacting individual specification.

Send your enquiries for the personal attention of our Mr. W. Bryan Savage.

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SAVAGE OF DEVIZES
LIMITED

SAVAGE TRANSFORMERS LTD. · NURSTEED ROAD, DEVIZES, WILTS.

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TELEVISION

for £15. 5s. 0d.

(SOUND and VISION)

BY USING OUR EX-RADAR UNITS FOR YOUR HOME-BUILT TELEVISOR YOU ARE LETTING THE BEST OF BRITISH BRAINS AND INDUSTRY SAVE YOU MONEY, TIME AND TROUBLE. For instance the vision receiver is practically built for you, and after all the vision receiver is the stumbling block of many constructors, because in this unit even the spacing of each component is important. To have one of these almost ready made, obviously is a tremendous advantage. Again the Indicator supplied for our Mark II Televisor is a double decker type, so that it accommodates the time base, sound receiver, power pack and tube in a very professional manner. In fact the whole receiver assembles into a compact table model, size approximately 16in. wide, 12in. high and 19in. deep as illustrated. Of course, if you want to make up a console, you can spread the units about as you wish.

TRIED AND APPROVED CIRCUIT. Our Mark II has already been built by over 1,000 people (men and women), and many have remarked "that it worked first time," and we have even had letters from people claiming results from places as far off as Birmingham, Liverpool and York. A few, of course, get into difficulties, but this is inevitable with any set using 20 or so valves. Nevertheless, we have a technical information service to help you in these cases.

SOME QUESTIONS ANSWERED.

QUESTION 1. Is technical knowledge necessary?
ANSWER. You need not know anything about television, but you must be able to work from and understand a theory circuit diagram.

QUESTION 2. What is the total cost?
ANSWER. £15 5s. 0d. if you collect the goods yourself, otherwise £1 extra for the packing cases and carriage. (All items may be bought separately, detailed price list is enclosed with our 7/6 data, or will be sent on request.)

QUESTION 3. Does £15 5s. 0d. include everything?
ANSWER. It includes a new VCR.97 Picture tube, 6½in. Loud-speaker and everything else which goes into the cabinet, but it doesn't include the cabinet nor the aerial and lead in. (Aerial kits can be supplied, indoor type 15/-, outdoor type 25/-, lead in at 3d. per ft.)

QUESTION 4. How much is the data?
ANSWER. Our data contains 26 pages of instructions, wiring diagrams and photographs and was very costly to produce, and for this we charge 7/6 per copy, but this will be credited to you if you buy the bulk of the components and the units, and also this price includes free technical advice.

DEMONSTRATIONS DAILY. Why not call to see our demonstration model, we are open until 6 p.m. weekdays and until 5 p.m. Saturdays, when a made-up receiver can be seen working if a programme is being transmitted.

If you can't call, however, we shall be able to send the outfit carefully packed in wooden crates for £1 extra.

BIRMINGHAM CONSTRUCTORS. You can make most of your set now, but certain modifications will, of course, be necessary, details of this will be available later.

THE ITEMS BELOW ARE OF SPECIAL INTEREST TO CONSTRUCTORS OF TELEVISORS USING ELECTROSTATIC TUBES (VCR97, etc.).

"50 PITFALLS FOR TELEVISION CONSTRUCTORS." If you are having difficulty in getting a perfect picture, then this publication may solve your problem. The price is only 2/6 post free.

WHITE PLASTIC MASK. Designed to fit a 6in. electrostatic tube, VCR97, etc. This will give a professional look to your home-built Televisor. If yours is a bigger than usual picture, the size of the opening can be enlarged to suit your own needs. The price is 7/6 post free.

MAGNIFYING LENS. De Luxe type. The lens which is really designed to give optical perfection. First-class quality and workmanship throughout. Guaranteed against any discoloration of the special oil content. Price 39/6, postage, packing and insurance 5/-.

AERIALS. Indoor type—for fitting in loft. Very simple in installation. Full instructions and fixing clips, etc., supplied with every one. Order "SNAPPY AERIAL KIT," price 15/-.

VCR97 CATHODE RAY TUBES. Brand new in original cartons. Price 35/-, carriage and insurance paid. Buy a spare now while they are still available at this silly price.

PRE-AMPLIFIER FOR TELEVISION. Complete conversion details for using RF26 or RF27 ex-R.A.F. units, 2/3 post free. Brand new RF26 units, 35/- post free. Nothing else needed. Suitable for sound or vision.

E.H.T. CONDENSERS. .1 mfd. 2,500 v., 2/6; .02 mfd. 8 kV can type at 3/9; .1 mfd. 4 kV at 3/9; .02 mfd. 5,000 v. at 1/6; .1 mfd. 5 kV, 3/9.

OCTOBER SALE OF RADIO SPARES

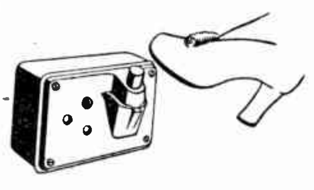
Bin No.
035 **OUTPUT TRANSFORMER**, standard pentode matching, 3/3 each.
036 **OUTPUT TRANSFORMER**, push-pull matching, 3/9 each.
049 **CO-AXIAL** 80 ohm T.V. feeder, 9d. per yard.
038 **DOUBLE TRACKER** as above, one section 220 pf. other section 100 p.f., 8d. each.
040 **INSULATED TOP CAPS** for high voltage rectifiers, 2/3 each.
050 6½in. **ENERGIZED SPEAKER**, 700 ohm field with output transformer, "Rola" 11/6.
PB15 **PAXOLIN VALVE HOLDERS**, international octal, solid leg type, 4d. each.
042 **L.F. TRANSFORMERS**, 465 KC dust-covers, very high "Q," 6/9 per pair.
044 2½in. **P.M. SPEAKER**, just right for intercoms, 8/6 each.
PF14 ½ **MEG. VOLUME CONTROL** with switch, extra long spindle, 3/9 each.
046 6½in. **P.M. SPEAKER "TRUVOX"** with pent. output transformer. 12/6.
047 **.25 MFD. 500V. METAL CASED CONDENSER**, 6/6 per dozen.
021 **TOGGLE SWITCH**—double pole ON/OFF metal body, 1/9 each.
PD14 **DRIVES** fast and slow speed, the type which is slow motion for three quarters of a rev. of the knob, and then engages the main spindle to become direct drive, 1/3 ea.
PD15 **SELF ADHESIVE PURE RUBBER TAPE**, large coil in carton, 1/6.
01 **MAINS TRANSFORMER**, made for the AR.88, potted, fully shrouded and impregnated. Fitted primary screen, 280-0-280 at 150 ma., 6.3 v. at 10 amp., 5 v. at 3 amp. Primary 110-250 v. 50 C.P.S., 27/6.
05 **SCREWS**, 1in. 4 B.A., cheese-head cadmium plated, 1/9 per gross.
06 **TUNING CONDENSER**, 2-gang .0005 standard size, extra long spindle, undoubtedly a very good job, 3/6 each.
07 **P.M. SPEAKER**, 10in. "Rola" new and perfect, 19/6.
08 **SMOOTHING CONDENSER**, E.H.T. .1 mfd. 4 kv., these are recent manufacture but casing is slightly soiled, 3/- each.
PF3 **MAINS TRANSFORMER**, 260-0-260 at 70 mA., 6.3 v. at 3 amps., 5 v. at 2 amps., 13/9 each.
PF4 **MAINS TRANSFORMER**, 260-0-260 at 60-70 mA, 4 v. at 4 amp. 4 v. at 2 amp. 13/9 each.
B86 **P.V.C.** Insulated Copper Connecting Wire, really fine for chassis wiring or as throw-out aerials, etc., 250 yd. coil £1.

ELECTROLYTIC CONDENSERS. (Only new stock from best manufacturers).

2 mfd. 450 v.	1/-	8 mfd. 350 v.	1/6
4 mfd. 450 v.	1/3	16 mfd. 350 v.	1/11
8 mfd. 450 v.	1/11	32 mfd. 350 v.	1/11
16 mfd. 450 v.	2/8	25 × 25 mfd. 200 v.	3/11
8 × 8 mfd. 450 v.	3/4	8 mfd. 150 v.	1/3
8 × 16 mfd. 450 v.	3/4	25 mfd. 25 v.	1/-
16 × 16 mfd. 450 v.	3/9	25 mfd. 50 v.	1/6
16 × 8 × 24 mfd.	4/9	50 mfd. 12 v.	10d.
8 mfd. 500 v. BR850	2/6	10 mfd. 25 v.	10d.
16 mfd. 500 v. BR1650	3/6		

Bin No
PD3 **TRIMMER**, postage stamp compression type 50 p.f. ceramic, extremely nice job, 4d. each.
PE10 **AMPHENOL INTERNATIONAL** octal valve holder, 6d. each.
PF6 **MIDGET TUNING CONDENSERS**, 2-gang .00035, fitted with trimmers and complete with perspex dust cover. These condensers are of the type used for tuning personnel receivers, 6/6 plus 8d. postage.
PF7 **4-GANG TUNING CONDENSERS**, .0005 each section—fitted trimmers—ceramic insulation. These are complete in a very useful chassis, and are fitted with a drive. Government Surplus equipment but new and perfect, 2/9, plus 1/3 postage. Case of 6 units, 17/6 carriage paid.
BS8 **12in. P.M. SPEAKER, "TRUVOX,"** 42/6.
PB11 **SYSTOFLEX SLEEVING**, 1 mm. assorted colours, 1/9 per dozen.
PD4 **CROCODILE CLIPS**, small instrument type, very well made by "Bulgin." 3/6 per doz.

THIS MONTH'S SNIP



This month's "snip" is:
15 amp. shuttered switch plug, bakelite moulded surface mounting type, made by very famous maker, made to B.S.S.

Only 6/- each, 2 for 11/-

Send cash with order or request C.O.D. Orders over £2 are post free—we are open until 5 p.m. Sats. List available on request—it helps us if you can quote our Bin No.

ELECTRONIC PRECISION EQUIPMENT (2) ELECTRON HOUSE, Windmill Hill, RUISLIP MANOR, MIDDLESEX

Maximum sensitivity with uniform frequency response from a more compact speaker, appreciably reduced in weight—that is what Rola technicians have achieved with the new G.12. Special features include dust-proof suspension completely protecting coil and magnet gap and the powerful Alcomax II magnet. Write for details and also for particulars of Rola 3" and 4" P.M. models, dust-proofed and equipped with Alcomax II magnets.

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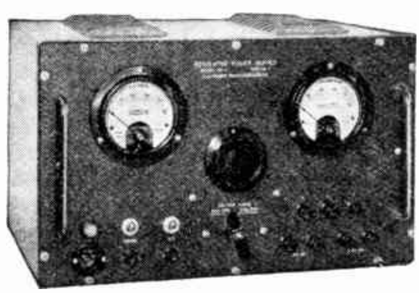
NEW SERIES 101

Our new Laboratory Power Supplies, Series 101, are based on our well-known Model 101-A, but incorporate a number of improvements and refinements



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For details on the SOUND MAGNET write now for brochure

Two models **£35** and **£47 10 0.**

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GENERAL LAMINATION PRODUCTS LTD.
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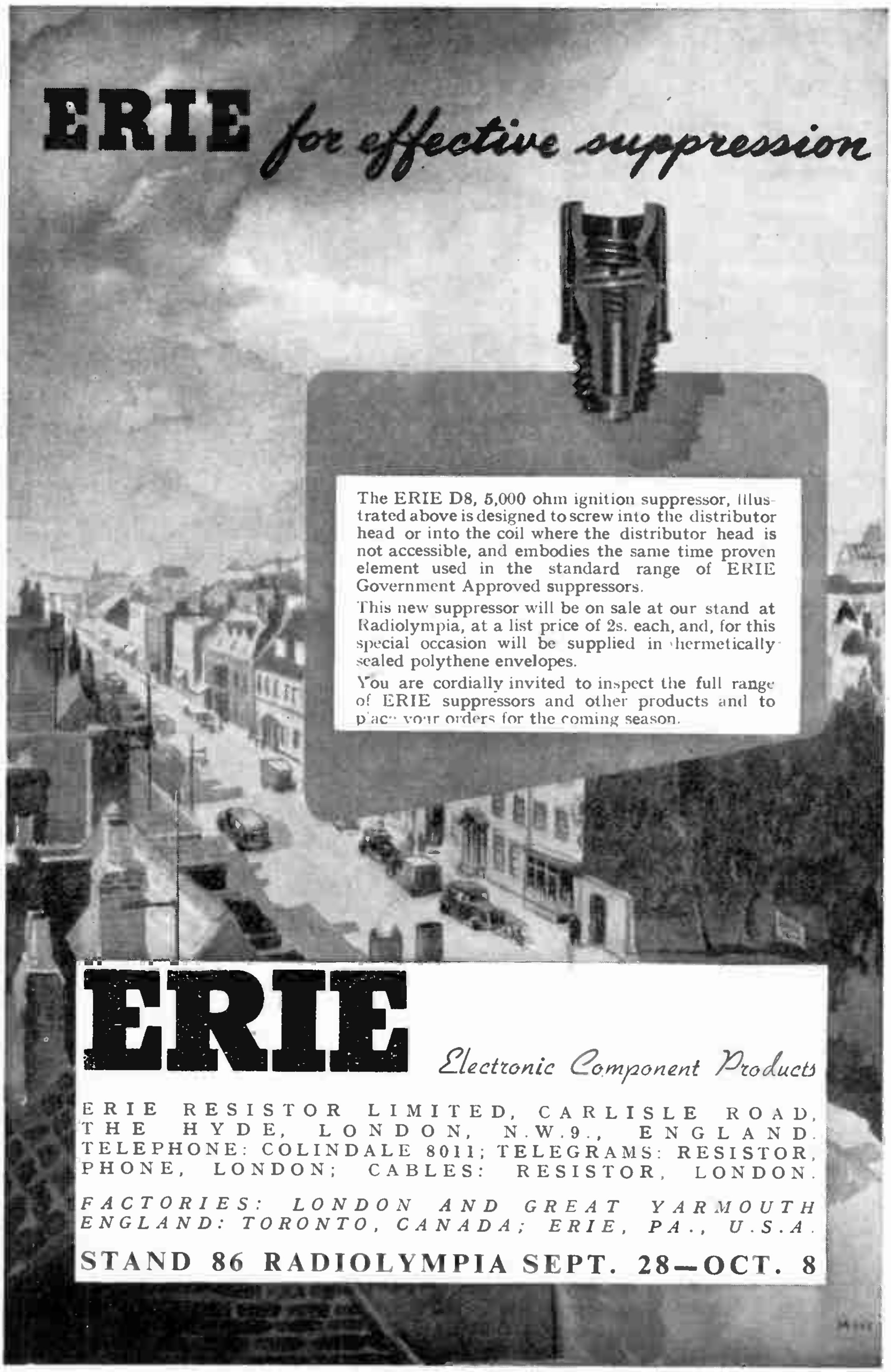
ERIE for effective suppression
The ERIE D8, 5,000 ohm ignition suppressor, illustrated above is designed to screw into the distributor head or into the coil where the distributor head is not accessible, and embodies the same time proven element used in the standard range of ERIE Government Approved suppressors.
This new suppressor will be on sale at our stand at Radiolympia, at a list price of 2s. each, and, for this special occasion will be supplied in hermetically sealed polythene envelopes.
You are cordially invited to inspect the full range of ERIE suppressors and other products and to place your orders for the coming season.
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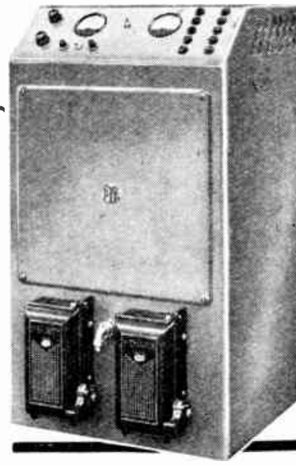
FACTORIES: LONDON AND GREAT YARMOUTH ENGLAND: TORONTO, CANADA; ERIE, PA., U.S.A.
STAND 86 RADIOLYMPIA SEPT. 28—OCT. 8

THE PYE *Automatic* VOLTAGE REGULATOR FOR A.C. MAINS



FOR efficient operation, modern radio and electronic devices demand a constant input voltage.

The Pye Automatic Voltage Regulator not only ensures such a constant input but also gives a waveform free from distortion, a characteristic not found in other types of stabilizer.

Directors of Research laboratories, of educational institutions, e.g. universities and technical colleges; makers and users of laboratory testing equipment, radio transmitters and radar equipment, facsimile telegraphy apparatus, cinema projectors and sound equipment, telephone apparatus, electronic calibrators, electro-chemical analysis equipment, will find this voltage stabilizer indispensable. It is fully automatic and of special value wherever equipment is installed on unattended sites since it prevents large and sudden changes in the input voltage from causing momentary overloads to equipment.

The regulator is robust, fully tropicalised, and requires little maintenance. It gives constant output voltage of 230 volts or any required voltage within ½% despite an input variation of up to 90 volts, e.g.

Voltage Required. 230 Volts.
Output Voltage from Pye Automatic Voltage Regulator. 230 ± 1.15 volts.
Although the mains may vary from 170 — 260 volts.

The regulator is designed for a maximum power output of 4.8 Kilowatts.

PYE Telecommunications
CAMBRIDGE ENGLAND

PYE LIMITED · TELECOMMUNICATIONS DIVISION · CAMBRIDGE · ENGLAND

THE WILLIAMSON AMPLIFIER

Our version of this well-known amplifier built by craftsmen to laboratory standards, and incorporating recent improvements, is now available from stock.

Only the finest quality components are used in its construction, and the layout has been carefully designed to produce the best possible performance.

Standard Model " A " with 150 m/A H.T. supply **£27/10/-. Model " B "** with 200 m/A H.T. supply, **£29/10/-.**

Various pre-amplifiers are available including a pre-tuned high fidelity radio unit. Full details will be forwarded on request.

For constructors, drawings and detailed lists of compoponents are available at **7/6** per set.

SPECIAL :

The experimental B.B.C. V.H.F. A.M. transmissions may now be heard (when operating) at our demonstration room.

ROGERS DEVELOPMENTS Co.,

106, Heath Street, Hampstead, London, N.W.3
HAMpstead 6901.

BARKER'S 148a SPEAKER IS NOT AT RADIOLYMPIA

Not because we have any prejudice, but due to present preoccupations with building up a stock to meet what we believe is to be a record season for the 148a. Summer has been no holiday this year, the traditional doldrums of July and August being as lively as last autumn, and our forward delivery order book is pretty full. We believe the patented Barker cone and coil system is the basically correct way to achieve NATURAL REPRODUCTION, and our latest methods of manufacture do full justice to this ideal, within a very reasonable price limit. The high percentage of 148a users who write to tell us of their pleasure is proof enough. So whatever may be seen and heard at Olympia, those who seek truth in sound reproduction will come back to listen to the 148a before deciding they have found the nearest approach to their ideal. Many good retailers, especially those particularly concerned with high quality reproduction, sell Barker Speakers; they include famous names like Webbs Radio, Rogers Developments, Goodsells, E.M.G., Lowther, Gramophone Exchange, Brierley and a number of music and radio dealers spread over Great Britain.
If you live near one of these, see him ; if not, ask your dealer or write direct to

BCM/AADU LONDON, W.C.1.

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Largest stocks, Best selection

CLYDESDALE

and Bargains in Ex-Service Radio and Electronic Equipment

RACK MOUNTING
R1481 V.H.F. R/T Receiver Unit.

Frequency 65-86 mcs.
A 10 valve superhet with 4/VR53 (EF39) VR54 (EF34) VR57 (EK32) 2/VR65 (SP61) VR65 (P61) VR67 (6J5G) plus stabiliser VS70 (7475) "5" meter, screened R.F. section, B.P.O. etc., etc., in enclosed chassis, size 19 x 10½ x 11in., finish dark grey. Circuit supplied.

CLYDESDALE'S PRICE ONLY £4.19.6 each CARRIAGE PAID

Also a few R1132 Rcvrs. (freq. 100-124 mcs.) finish light grey. Dimensions etc., as R1481, available at the same price.

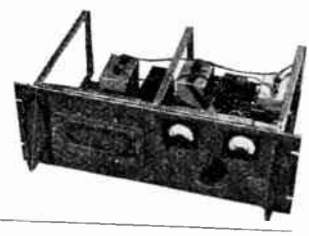
New, Unused Rack mtg. A.C. Mains Power Unit, Type 3.

For R1481 and R1132.
Input 0-200-210-220-240-250 v., complete with 0/300 voltmeter, 0/150 H.T. milliameter, 5Z4 rectifier, fully smoothed. Output 200 v., 40 ma., 6.3 v., 3A., 4 v., 1.5A. enclosed chassis.

CLYDESDALE'S PRICE ONLY £4.10.0 each CARRIAGE PAID

Special Offer. Receiver and Power Unit.

CLYDESDALE'S PRICE ONLY £8.19.6 each CARRIAGE PAID



Ex. British Army.
Telesonic Xmtr/Rcvr. YA4911-YA4915.

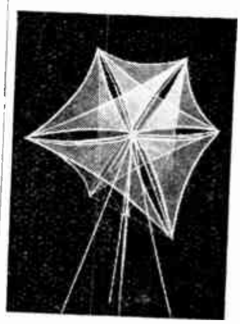
Designed for the Transmission and Reception of audio frequencies No. R.F. is employed. The Transmitter unit YA4911 with valves 2/ARP12's (VP23) 2/ATP4's (V248A) (loop aerial not supplied) H.T. V1. 60 volts, V2. 120 v. V3 and 4. 180 v. L.T. 2 volts. Space for batteries is provided inside, size 14½ x 11 x 8in., fitted with handles, Khaki finish.

The receiver unit YA4915 with valves 3/XH1.5V (HIVAC) 1/XP1.5V. (HIVAC) which are in series parallel for 3 v. fil. supply. H.T. 67.5 v. Space for batteries is provided inside the unit. Dimensions : 7 x 6 x 2in., finish Khaki, with pick up coil.

CLYDESDALE'S PRICE ONLY £3.0.0 CARRIAGE PAID

For both units with rcvr. (PU) Coil only.

Receiver and PU Coil, 34/6.

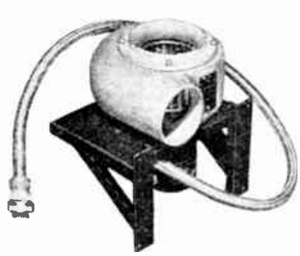


Brand New.
Reflector Aerial (MX-137/A).

E.175. A first-class Transmitting and Receiving Omnidirectional Antenna, in original moisture proof carton with assembly instructions, size ass'd approx. Ht. 6ft. Wd. 4ft

CLYDESDALE'S PRICE ONLY 5/6 each POST PAID

Circuits for Ex-Services Equipment available, full list on application.



Ex.-U.S.A.A.F.
Brand New, in maker's carton.
SCR-720 BLOWER, WITH SHUNT MOTOR

Made by I.L.G. Electric Ventilating Co./Western Electric, etc. 27 volts D.C., 1.5A., 1/50 h.p., 3,000 r.p.m., continuous running, multi-bladed an, outlet dia., 2¼in. Size overall 7 x 5 x 6in., mnt. size 7½ x 5 x 4½in., with fixing screws, aluminium construction.

CLYDESDALE'S PRICE ONLY 17/6 each POST PAID

RELAY

E449. (H1011C). 200 ohms coil, DP-Changeover Contacts.

CLYDESDALE'S PRICE ONLY 3/11 each or 42/- per doz. POST PAID

★ **SPECIAL BARGAIN LIST** ★

Prices slashed to clear stocks.

★Radar repeater Amp. AN/APA—1 Now only......... 69/9
★Master Oscillator type M1-19467-A Now only......... 79/6
★Crystal Multiplier type M1-19468 Now only......... 39/6
★Mobile U.H.F. Receiver R28/ARC5 Now only......... 37/6
All New in sealed maker's packing.
★C.R. Indicator Unit A.S.B. series Now only......... 69/6
New, but not in maker's packing.

Brand New.
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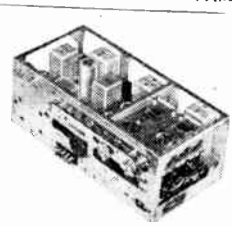

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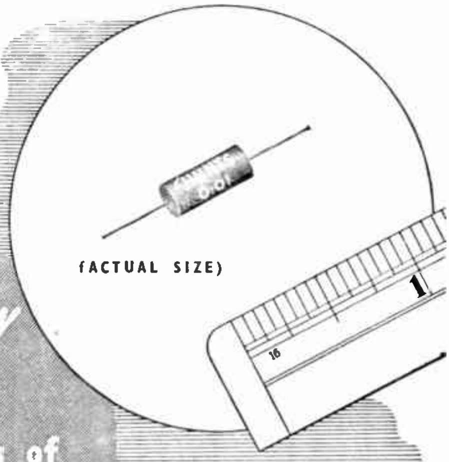

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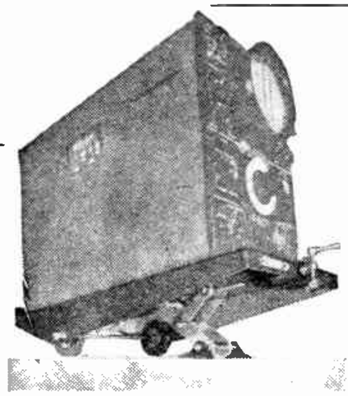

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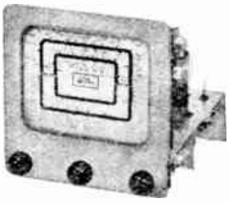

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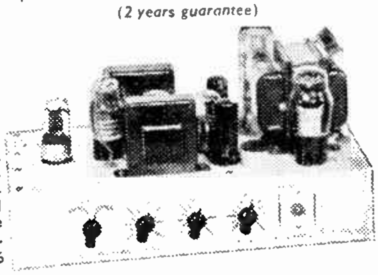

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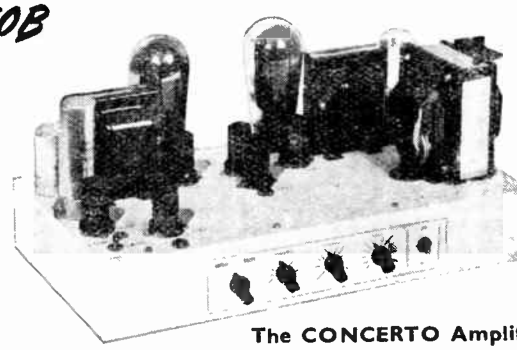

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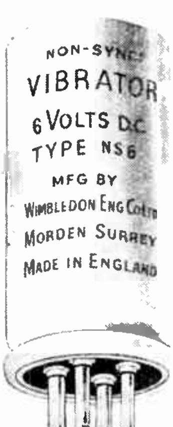

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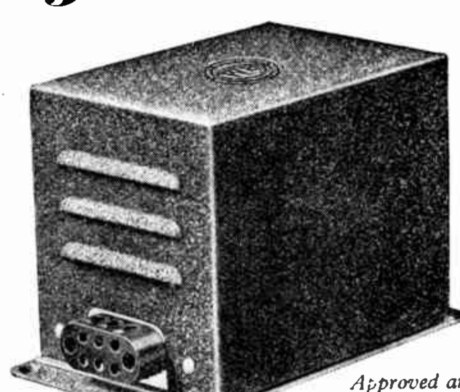

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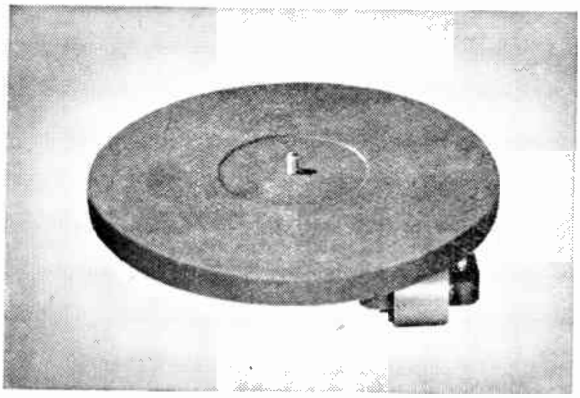

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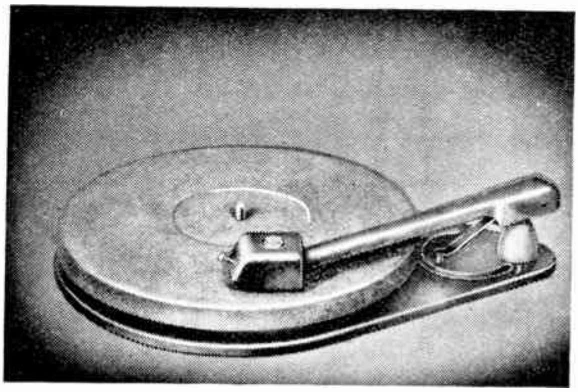

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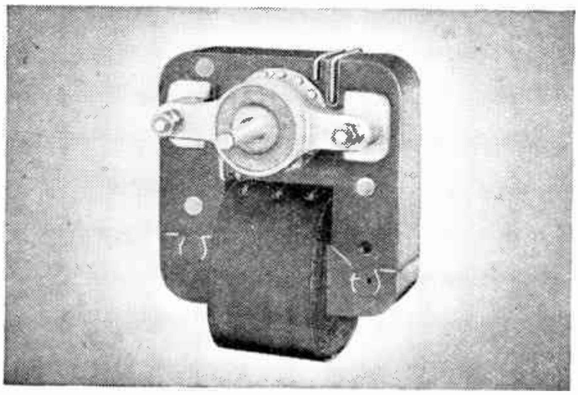

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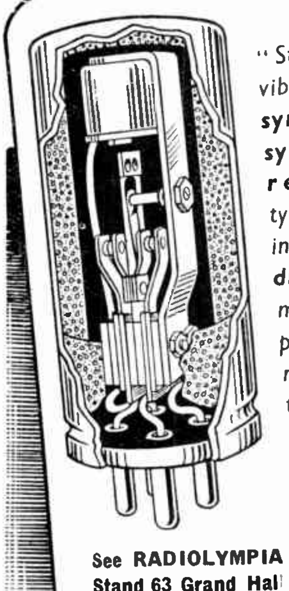

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Valves and their applications

TELEVISION SYNCHRONIZING & TIME BASE CIRCUIT USING EF42, ECC34 & EL38. No. 1.

Previous articles have, in general, been concerned with one valve or one circuit stage; it frequently happens that more complex problems are encountered in combining a number of valves and stages to make a complete equipment and this article and the next three deal with television receiver synchronizing and time base circuits. A practical circuit with complete operating and constructional details is given as an illustration of the solution of this type of problem. The circuit, though employing only five valves for all the functions of synchronizing, scanning, and E.H.T. derivation, and being economical in components, will be found to give excellent stability of synchronization under conditions of interference and will also give good linearity.

A block schematic diagram in Fig. 1 gives the valve and stage arrangement. It will be seen that the functions of frame output amplifier and line blocking oscillator are carried

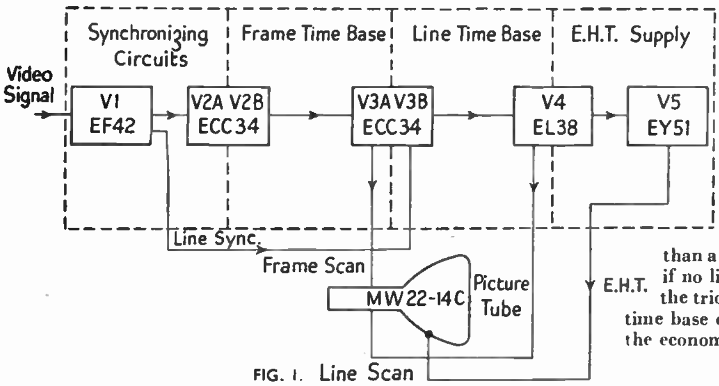

FIG. 1.

out in one valve envelope. This avoids the risk of non-interlace which would attend the combination of the line blocking oscillator with the frame blocking oscillator or frame synchronizing pulse separator. The triode used for frame synchronizing pulse separation gives an amplified pulse and a very steady hold as a result. Thus, this arrangement gives a better performance than one using a diode or double diode for separating the frame synchronizing pulse and a separate valve for the line time base oscillator, and is more economical in valves and components.

The frame output valve is transformer coupled to the deflector coils. As with all frame output transformers it is not possible to make the magnetizing current negligible compared with the load current without using a core and windings of prohibitive size. A circuit and valve must, therefore, be provided which supply this magnetizing current of parabolic form and the load current of linear form.

If the output valve has a high output impedance (e.g. a pentode) the grid potential waveform will be substantially the same shape as the anode current waveform. On the other hand, if the output valve has a low output impedance (e.g. a triode) the grid potential waveform will be substantially the same shape as the anode potential waveform, which is linear during the scan.

The potential waveform obtained from most time base oscillators has an exponential form such that the slope decreases during the scan while the waveform of the total valve current should increase in slope during the scan. It is evident that the correction needed to produce the correct grid potential waveform will be easier when a triode or low impedance valve is used. Conversely, when a given degree of correction is available a triode valve will allow a greater proportion of the current to be parabolic in form and a smaller transformer can then be employed. Furthermore, one of the most convenient and effective methods of waveform correction uses potential negative feedback which reduces the effective output impedance of the valve in addition to conferring the other advantages of negative feedback. Negative feedback of approximately 5:1 should be used with all frame time bases to reduce the effects of microphony in the output valve which otherwise would need to be more rigidly constructed and its cost would be greater. From the point of view of microphony a low μ triode is also better than a high slope pentode as a blocking oscillator. Hence, if no limitation such as a low value H.T. line is imposed, the triodes of the ECC34 have great advantages for frame time base circuits, and the use of double-triodes has enabled the economical arrangement of Fig. 1 to be employed.

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Reprints of this report from the Mullard Laboratories, together with full transformer and coil winding data can be obtained from the address below. The complete circuit will be given in the next issue of the "Wireless World".

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World Radio History

VOL. LV. NO. 10

Wireless World

RADIO AND ELECTRONICS

OCTOBER, 1949

MONTHLY COMMENTARY:

Radiolympia, 1949

THE more obvious purpose of a radio exhibition is strictly commercial; it acts as a convenient shop window, and the commercial exhibitor hopes to recoup himself for a considerable expenditure—of time, effort and money—by an immediate increase in sales. Taking the long-term view, the aim should be to encourage the widest possible section of the public to take an intelligent and serious interest in all branches of radio. And to those already "in the game" an annual exhibition should be a kind of focal point of the year.

IN our view, pre-war exhibitions failed lamentably in all these respects. They were too specialized, and concentrated mainly on "selling" broadcasting—which was already sold—rather than on selling equipment, or, on the broader issue, showing the year's progress in all branches of the industry. True, there were some signs of improvement in 1939; the fiasco of the exhibition of that year was in no way the fault of the organizers, but was due to the fact that it coincided with the outbreak of war. Broadly speaking, however, it was not until the first post-war exhibition of 1947, which came under the wing of the Radio Industry Council (itself a war-time creation) that the exhibition took on what we think to be the right shape. It proved a great success, and did much to re-establish in the eyes of the world the prestige of the British radio industry, and to offset much of the harm that had been done by ill-advised delays in permitting the publication of detailed technical information on war-time developments. Attendances at the 1947 exhibition reached record figures; true, some of that attendance comprised "exhibition addicts" and so was not of any great value, but we know from our own observation that there was a very high proportion of deeply interested and serious visitors, including users and would-be users of every kind of radio and radio-like equipment.

Radiolympia, 1949, follows the essential pattern of its immediate predecessor of 1947. In spite of one or two regrettable defaults, the show which will have opened when this appears in print should be adequately representative of all branches of radio and its offshoots, and there is little to criticize in its general plan. Though it may be urged that television is given undue prominence, the organizers could hardly do otherwise at a time when our national service is in process, at long last, of being extended, and with further extensions in prospect.

So far as can be judged at present, there is a lack of the more serious kind of educational exhibit which, we suggest, would be a highly desirable feature. Developments in our field are still so rapid that there is small wonder that the layman, even of the best informed type, can hardly be expected to know what radio can (and cannot) do for him. To some small extent the exhibits of the various non-commercial bodies and Government departments fill this gap, but the kind of thing we have in mind would be of a rather more detailed nature, and might well be presented by the various industrial organizations.

ELSEWHERE in this issue we present information which, it is hoped, will serve as a convenient guide to the visitor to Olympia, and, at the same time, will be of some value to readers, including those overseas, who are unable to go to the show. In addition to a plan of the exhibition, with lists of exhibitors, we give in tabular and graphical form a quick-reference index to the stands on which the various classes and types of radio and electronic equipment are to be seen. This information is as complete as possible up to the time of going to press. In our next issue we hope to give a detailed review of the show.

World Radio History

MAGNETIC RECORDING

THE general theory of magnetic recording has already been covered in this journal,* and it is the purpose of the present article to cover the more practical aspects and to draw attention to some of the finer points of technique, now that tape

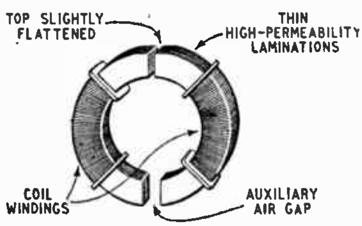


Fig. 1. Essential features of a magnetic recording head

and wire are available, e.g., from E.M.I. Factories, Ltd., Hayes, Middlesex, and Wirek (Electronics), Deansbrook Road, Edgware.

Heads (General) : Modern magnetic heads are made in ring or toroidal form. Usually the rings are cut in half and each half fitted with a coil (Fig. 1). The halves are then clamped together with non-magnetic spacing shims to give two accurately dimensioned gaps. The magnetic recording medium is arranged to lie in contact with the outer face of the core for about $\frac{1}{16}$th of an inch on either side of one of the gaps. Different gap widths are used for the erase, record and playback heads, typical values being 20 mil, 1 mil and $\frac{1}{2}$ mil respectively (1 mil = 0.001 in).

Heads for use with tape are generally made from a stack of 5 mil ring laminations, the thin gauge being necessary to reduce eddy-current losses at high frequencies. Heads vary from $\frac{1}{2}$in to 1in outside diameter, with about $\frac{1}{8}$in wall. High-permeability nickel-iron alloy, such as Mu-metal or Permalloy-C, is used, as it is essential to have the lowest possible reluctance at the pole-piece tips for a sharply defined magnetic field. Laminations are clamped together and the gap edges ground straight and square. The tape contact area is also smoothed. Finally the laminations are annealed to restore maximum permeability and then cemented solidly together. A hard material, such as beryllium-copper, is used for the shims to prevent rounding of the gap edges.

Less efficient tape heads may be made by bending two $\frac{1}{4}$in wide strips of 15-mil material into semi-circular shape. The loss in efficiency occurs mainly at low frequencies owing to the low iron/copper ratio, so that these heads are more suitable for use at low tape speeds, where, as will be seen, the bass response is relatively greater. These heads work quite well un-annealed, but there is a comparative treble loss of about an octave.

A head for wire recording is very similar, but consists of a single-ring lamination, about 10 mil thick, clamped between non-magnetic side pieces. These side pieces are bevelled so as to form a V slot leading down to the edge of the lamination. The wire runs on the edge of the lamination and a shallow groove is usually provided to keep the wire central and to give better magnetic contact with the round surface. It is not necessary for a head to be of perfect ring form. Rectangular laminations may be used, with a curved edge or a felt pad to keep the medium in contact with the gap. But it is important to keep the head symmetrical and the coils identical; an astatic head picks up much less hum, which is a very real problem in magnetic recording.

Coils may be of high or low impedance according to circuit requirements. Low impedances have the advantage that self-supporting coils of thicker wire may be used. The playback head, however, must be of high impedance, or used with a step-up transformer, for maximum voltage output to be developed.

Erase Head.—A fairly wide gap is used in the erase head so that the erasing field spreads sufficiently for each point of the passing wire or tape to be subjected to a hundred or so gradually decreasing demagnetizing cycles. But the gap must not be too large or the maximum value of the field will not be enough to saturate the medium, and previous recordings will not be erased completely. To obtain sufficient erase current the inductance of the erase head is

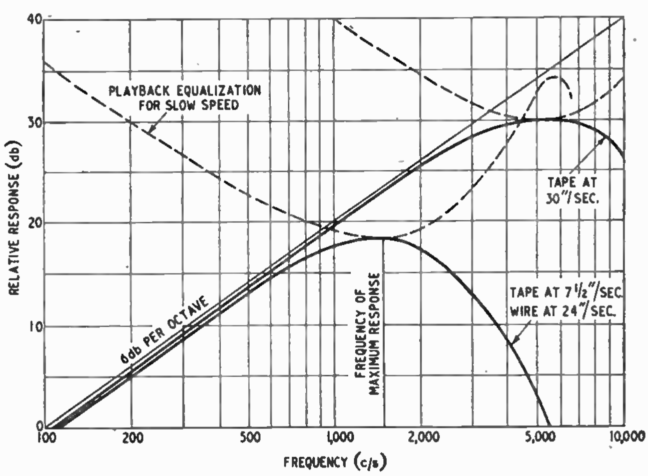


Fig. 2. Typical constant-current response curves with playback equalization for two different tape speeds.

* "Magnetic Recording," G. L. Ashman, Aug. 1944, p. 226.
"The German Magnetophon," R. A. Power, June 1946, p. 195.

TECHNIQUE

Practical Notes for the Experimenter

By DESMOND ROE (*Birmingham Sound Reproducers*)

often tuned to the frequency of the ultrasonic oscillator by means of a series condenser. It is quite common for an erase head to run warm. 100 ampere-turns is a typical energizing value. Radiometal is better than Mumetal for erase heads.

Recording Head.—In recording with modern "ultrasonic bias," the actual flux density recorded depends on the instantaneous value of the magnetizing field at the moment the medium leaves the gap and passes into the relatively field-free region of the rear pole-piece. Hence the actual gap width is of less importance than the rapidity of the decay of the magnetic field at the rear gap edge. It is important, therefore, that the rear edge be sharp and square, and the material fully annealed for lowest reluctance if the maximum high frequency response is to be recorded.

Playback Head.—For good treble response on playback, "scanning" loss must be a minimum, so the playback gap is made very narrow, about ¼ to ½ mil. The gap should not be too narrow or else efficiency will be lowered due to the magnetic flux from the medium leaking back across the gap instead of going through the pick-up coils. Pole-pieces are slightly tapered to the point where they meet the medium, so that the actual amount of parallel gap is small. In the case of wire heads, it is usual to clamp the two pole-pieces, remove the spacer and soft solder the pole tips in position.

Frequency Response.—In any sound recording system, to obtain the maximum signal-to-noise ratio, there should be equal likelihood of overload at all frequencies. In magnetic recording the overload point is set by the saturation level of the magnetic medium. Saturation is independent of frequency, and depends only on the magnetizing field of the recording head; that is, on the recording ampere-turns. Constant recording current, therefore, produces constant peak flux.

On playback the voltage induced in the playback head is proportional to the rate of change of flux, and as the flux reversal is clearly more rapid at higher frequencies, owing to the shorter wavelength, the playback output rises with frequency at a rate of 6 db per octave. However, at very high frequencies the minute magnets representing individual cycles become very short and of a size comparable with the thickness of the wire or tape. Consequently the well-known demagnetization of short magnets occurs, resulting in considerable high-frequency attenuation. A typical playback response curve of a constant current recording is shown in Fig. 2. It should be noted that this curve is more or less constant in shape for a given wire or tape, and with changes in recording speed merely shifts proportionately, parallel to the 6 db per octave line.

Constant current in the recording head is obtained by feeding it from a constant-voltage high-resistance source, or through a series resistance from a source of low resistance. Magnetic recording requires a power of only about 10 mW, so the resulting power transfer loss is not important. In recording, some treble boost and a little bass boost may be used without risk of frequency-selective overload. However, most of the equilization has to be applied during playback. Between 18 db and 30 db of bass boost at 100 c/s is required, according to the recording speed. Treble boost is usually obtained by means of a damped tuned circuit, which more closely complements the recording curve.

A typical playback equalizer circuit is shown in Fig. 3. Owing to the large amount of bass boost used on playback, great care has to be taken to shield the playback head from magnetic hum pick-up. One or more screening cans of high-permeability alloy may be needed, and the head should be spaced as far as possible from drive motors and mains transformers.

Distortion.—Superimposition of a steady high-frequency tone upon the audio signal while recording on a completely unmagnetized medium has been found to produce a linear magnetic recording characteristic of greater volume range than previous methods, together with much less background noise. The frequency of this "ultrasonic bias" is not important, but it is usual to choose a value at least five times the highest audio frequency, to prevent audible beat notes with the signal. The optimum amplitude of the bias varies with different wires, tapes and recording heads. Fortunately, it is easily found by experiment and is not very critical.

Using music as a test signal, as the "bias" is increased from zero, distortion rapidly diminishes, while the volume output rises to a maximum. Above this point, any

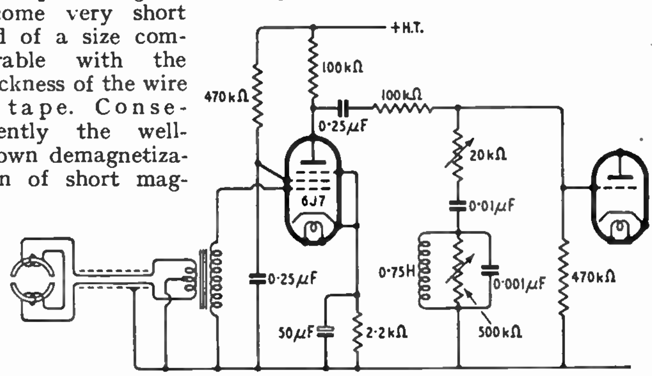
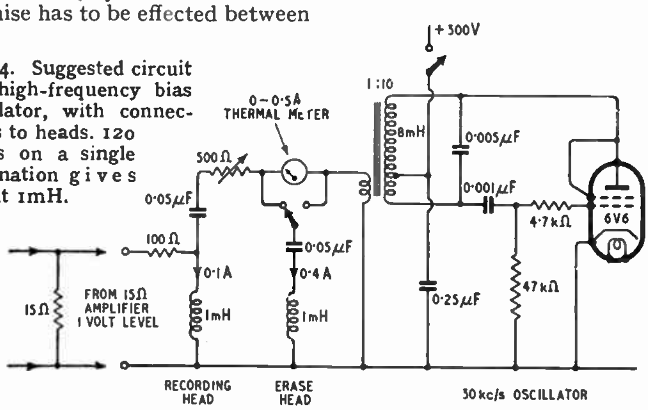


Fig. 3. Playback equalizer circuit for low-speed recording.

World Radio History

Magnetic Recording Technique— further increase in "bias" begins to reduce the volume level, and especially the high frequencies, although some further reduction in distortion may occur. A compromise has to be effected between good high-frequency response and low distortion. Too high "bias" also makes erasure more difficult. Care must be taken during these tests to keep the recording level well below the overload point. Fig. 4 shows a typical oscillator circuit and connections.

Fig. 4. Suggested circuit for high-frequency bias oscillator, with connections to heads. 120 turns on a single lamination gives about 1mH.



Noise.—If a demagnetized wire or tape is run over a demagnetized playback head, clearly no signal voltages can be induced. If, however, the medium is first passed over, say, a permanent magnet, then every discrete magnetic particle becomes magnetized and capable of inducing a noise voltage. For low noise levels it has been found that the diameter of these individual particles should not exceed about 0.0001in, that the size must be uniform and "clumping" of particles prevented. It is important to note that noise not only occurs when there is some permanent magnetic influence, but also during recording. Each cycle of signal is really an integration of noise voltages so that, although a bad specimen of wire or tape may be quiet when a.c.-erased, the noise-behind-the-signal on recording may be large, and impart a disagreeable fuzziness to the reproduction. The permanent-magnet test is a good one for checking the quietness of wires and tapes.

Assuming a quiet medium, unnecessary noise is often caused by slight permanent magnetization of the playback head. This may be demagnetized by applying "bias" to it from the oscillator and reducing this slowly to zero. Noise can also be caused by asymmetry of the "bias" waveform, which, in effect, produces a slight permanent magnetization. Even-harmonic distortion of the oscillator must be reduced to a minimum, and in this connection, to reduce loading effects, a Class "A" buffer amplifier is often interposed between oscillator and erase head, which generally requires rather a high power for complete erasure.

While the foregoing notes are by no means exhaustive, they should at least enable the experimenter to obtain satisfactory results from the start. As with other systems of recording, perfection involves further careful experiment and measurements on the individual equipment in use.

TELEVISION RECEIVER KIT

THIS receiver is sold as a kit of parts by Premier Radio Company, 167, Lower Clapton Road, London, E.5, and an assembled model has been tested. There are separate vision- and sound-channel receivers, the former comprising four r.f. stages, diode detector, v.f. stage, d.c. restorer and phase-splitter, while the latter has two r.f. stages, double-diode-triode detector and a.f. amplifier, and a pentode output stage. The vision receiver is designed for single-sideband operation on the London transmissions, the sidebands remote from the sound channel being selected so that rejectors are not needed.

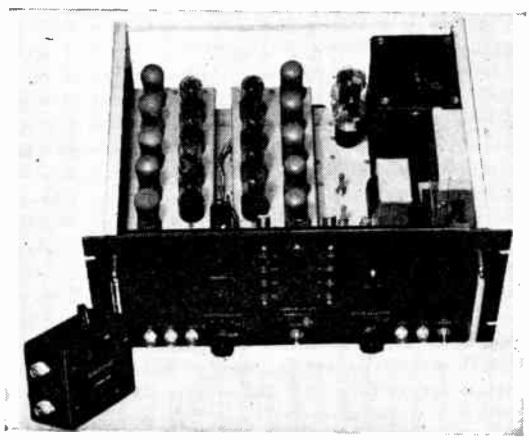
The tube is a 6-in electrostatic with a green screen and operates at about 2.3 kV. Each time base comprises a transitron-Miller integrator with a paraphase stage. Two valves are used for sync separation. The power supply is of the usual full-wave type, with a voltage-doubler using metal rectifiers for e.h.t.

On test the apparatus functioned well, the definition and synchronizing being good. The brightness is hardly sufficient for daylight viewing but is satisfactory for a darkened room. To anyone accustomed to the average television receiver, the small size of the picture and the green screen are unpleasant, but they are both things to which one rapidly becomes accustomed and must be considered as the inevitable concomitants of the extremely low price of this kit—£17 17s.

The construction appears simple and comprises merely the assembly and wiring of the parts. The initial adjustments are few and do not appear to be at all difficult. A booklet describing the construction is available from the firm. A magnifying lens can be supplied at £1 19s 6d.

ELECTRONIC COUNTER

"Scale - of - ten" counter recording up to 999,999 impulses, and pre-amplifier for use with Geiger-Muller tubes, made by Labgear, Willow Place, Fair Street, Cambridge. A stabilized e.h.t. unit for the tube bias is also available.



World Radio History

HIGH-QUALITY AMPLIFIER: New Version

(*Continued from page 287 of August issue*)

By D. T. N. WILLIAMSON

(*Ferranti Research Laboratories*)

Design of Tone Controls and Auxiliary Gramophone Circuits

MOST power amplifiers intended for sound reproduction are designed to have a uniform response to frequencies within the audible range, and it is the aim of designers of pickups, microphones and loudspeakers to give similar characteristics to their products. This represents an attempt to fulfil one of the conditions for the creation of a perfect replica of the original sound and provides a common basis for the design of individual units, which, when connected together, will provide a complete channel with a uniform gain/frequency characteristic.

Considerations of an engineering nature sometimes make it desirable, and even essential, to depart from this ideal of a uniform response in certain sections of equipment, and quite frequently the use of inferior equipment or long and unsuitable transmission lines, leads to an undesirable departure from uniformity. In cases like this, other "equalizer" units have to be inserted in the channel to provide characteristics which are the inverse of those of the offending section, so remedying the defect.

When listening conditions depart from the ideal—and this, unfortunately, happens frequently since most rooms are unsuitable auditoria for the reproduction of orchestral music at realistic intensities—it is sometimes beneficial to modify the frequency response characteristic of the equipment in an attempt to compensate for the more obvious defects in the room acoustics. The word "attempt" is used advisedly, since only very complex equalization could ever hope to provide accurate compensation for room acoustics. This question of the frequency compensation which is desirable when conditions depart from the ideal is a very thorny and subjective one. It provokes much heated, dogmatic, and usually very unscientific discussion, and is beyond the scope of the present article. It must suffice to say that the matter is one in which the individual must exercise his own judgment and act accordingly.

In order that he may have scope to do this, a pre-amplifier designed to be used in conjunction with gramophone recordings and radio transmissions should therefore be capable of providing variable compensation for such defects as are likely to occur in the source, and are capable of being ameliorated. In addition, fixed compensation must be provided for deviations from a uniform response which are deliberately introduced in gramophone records.

The degree of complication which is worthwhile in such a unit must be considered. In theory, it is possible to compensate precisely for deficiencies in the amplitude/frequency and phase/frequency response characteristics, but the equipment to do this is complicated and expensive. When a considerable portion of the channel is outside the control of the listener, as is the case when reproducing records or broadcast transmissions, he has no means, apart from the sensitivity and training of his ears, of determining the defects which have occurred in that portion. Since it is impossible to determine the nature and amount of phase distortion by listening to a transmission, and since it is not usual for much attention to be paid to this form of distortion at the recording or transmitting end, there would seem to be little justification for the inclusion of phase correcting networks in domestic equipment. In the case of a sound reproducing system which is completely under the control of the user, particularly if stereophonic, phase distortion should not be allowed to occur if the finest possible quality is to be obtained. This is especially true at low frequencies, where considerable time delays are involved. Low phase distortion is best achieved by designing a system with a bandwidth considerably greater than the audible range, but where this is not possible compensation may be provided.

Consideration of the causes of frequency distortion leads to the conclusion that it is normal for the levels at the ends of the spectrum to be accentuated or attenuated progressively with respect to the level at middle frequencies and a form of compensation to correct this fulfils most requirements. It is not possible to lay down hard and fast rules about the amount of compensation necessary, but rates of attenuation or accentuation greater than 6 db/octave are not usually required.

As it is often desirable to change the amount of compensation during a programme without calling attention to the fact, methods which give continuous control over the response are to be preferred to switched systems, unless the latter are graded in very fine steps.

The use of inductors to provide gain/frequency compensation is

World Radio History

High-Quality Amplifier—
to be deprecated as, apart from possible troubles due to resonance effects and non-linearity, they are very liable to pick up hum from stray alternating magnetic fields, especially if they are air-cored. Metal- or dust-cored toroids are less troublesome in this respect, but are expensive and not readily obtainable.

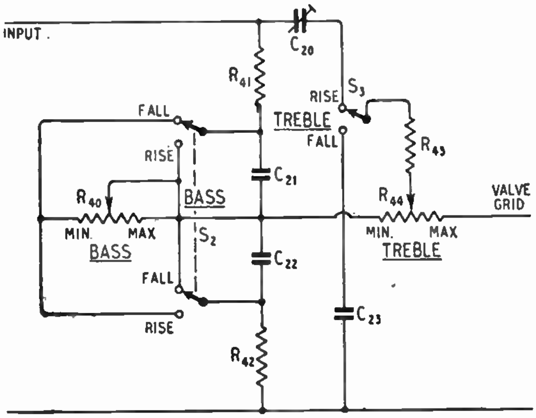


Fig. 5. Basic frequency compensation circuit. Typical values (for use after an EF37, triode-connected) are: R_{40}, 250kΩ, log; R_{41}, 100kΩ; R_{42}, 6.8kΩ; R_{43}, 10kΩ; R_{44}, 100kΩ linear. C_{20}, 150pF max.; C_{21}, 0.01μF, C_{22} 0.05μF; C_{23}, 1000pF.

Frequency Compensation.—Fig. 5 shows a simple compensation circuit which will accomplish bass and treble accentuation and attenuation without the use of inductors. The controls consist of two potentiometers, each associated with a changeover switch. Consider the low frequency controls R_{40} and S_2. When R_{40} is fully anticlockwise (minimum resistance) the response to frequencies below 1,000 c/s is uniform. If the switch S_2 is set to "rise," as R_{40} is rotated clockwise, the amplitude/frequency characteristic will rise at low frequencies to the maximum shown at A in Fig. 6. If S_2 is set to "fall" and R_{40} rotated clockwise from minimum position, progressive low-frequency attenuation will be introduced, up to the maximum shown at B. In a similar manner, by the use of R_{44} and S_3 the high-frequency response is continuously variable from a level response to the extremes shown at C and D with the values given.

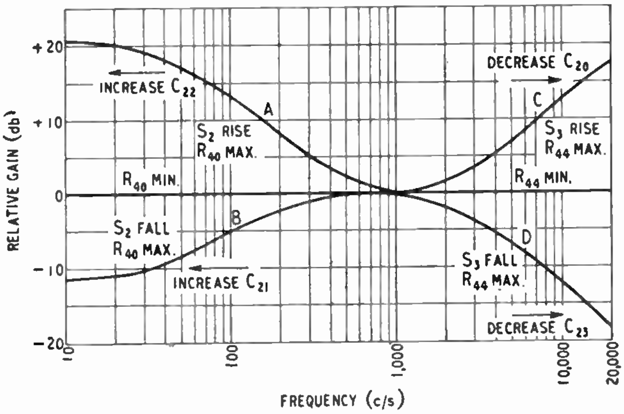


Fig. 6. Response curves of circuit of Fig. 5.

The curves may be shifted bodily along the horizontal axis by modifying the capacitance values as shown by the arrows in Fig. 6.

The attenuation introduced by the network when controls are at the level position is 24 db, and the network must, of course, be introduced into the system at a signal level such that the valve feeding it is not overloaded.

Low-Pass Filter. — The majority of medium-wave broadcast transmissions, when reproduced with wide-range equip-

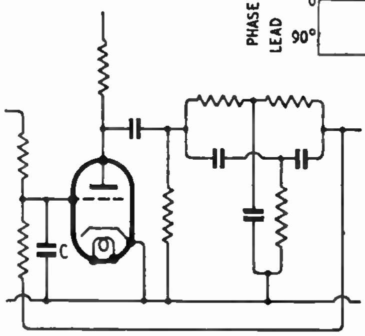


Fig. 7. Basic filter circuit.

ment, exhibit a most objectionable form of non-linear distortion. This takes the form of a rattle or buzz often accompanying transient sounds such as pianoforte music. This type of distortion is commonly caused by minor discontinuities in the transfer characteristic and is frequently associated with Class "B" amplifiers.

Recording and processing defects, record wear and imperfect tracing by the pickup produce a similar type of distortion from gramophone records.

The most offensive frequency components of the rattle or buzz are generally present at

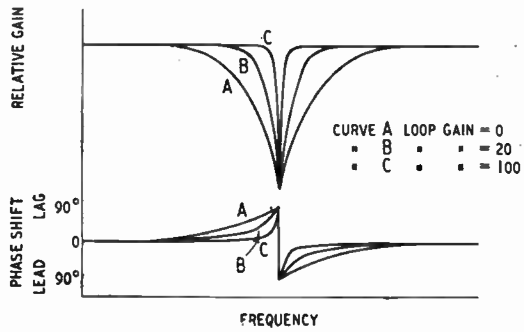


Fig. 8. Characteristics of circuit of Fig. 5.

the extreme upper end of the audible spectrum, and spread downwards as the severity of the effect increases. Fortunately, the concentration of this type of distortion into the extreme upper end of the spectrum makes it possible to effect considerable improvement by removing or reducing the energy in the signal at these frequencies. A low-pass filter with a cut-off frequency variable between the limits of 5 and 13 kc/s

World Radio History

and a fairly high rate of attenuation above the cut-off frequency is a great asset in securing the best possible aural result from indifferent transmissions or recordings.

Although it is practicable to provide a filter with a continuously variable cut-off frequency, the expense and complication are not normally justified and a switched selection of frequencies is satisfactory. To attain the high attenuation rates necessary to secure satisfactory results a normal resonant-section type of filter could be used, but this carries with it the disadvantages associated with the use of inductors.

An alternative type of filter

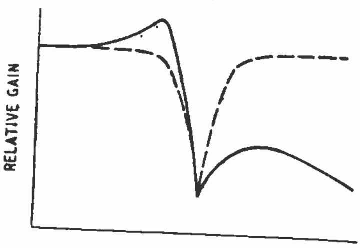


Fig. 9. Modification of basic filter characteristic produced by additional phase shift.

using only resistive and capacitive elements based on the parallel-T network[1] is capable of giving very satisfactory results. Briefly, the principle of this filter is as follows. In Fig. 7 is shown an amplifier feeding a parallel-T null network, the output from the network being fed back to the input of the amplifier. Such a system has amplitude and phase characteristics of the general shape shown in Fig. 8. By altering the loop gain of the amplifier, it is possible to produce a resonance characteristic of any desired degree of sharpness.

If now a lagging phase shift is introduced into the amplifier, for example, by connecting the capacitor C from grid to earth, it will be seen that the total phase shift due to network and amplifier just below resonance will be greater than 90° and the feedback voltage will have a positive component, whilst above resonance a greater negative component will exist. The effect of this is to unbalance the amplitude characteristic as shown in Fig. 9. A rise in response occurs just before the resonance frequency due to the positive component of feedback, and above the resonant frequency the response rises to a fraction of its

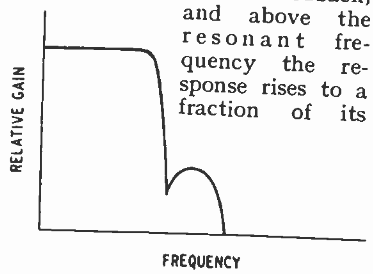


Fig. 10. Final low-pass characteristic resulting from addition of external R-C attenuator.

value below resonance and then falls off due to the attenuation produced by the capacitor C.

The addition of a further R-C attenuating network external to the circuit will produce a frequency response characteristic as shown in Fig. 10. The similarity of this curve to the response of a resonant element L-C filter will readily be appreciated. There is a practical limit to the rate of attenuation which can be achieved with a single stage, since the attenuation rate and the level to which the response rises above the frequency of maximum attenuation are interrelated. Thus a high rate of attenuation is achieved with simplicity only at the expense of a low ratio of response below cut-off to peak response above cut-off. However, a rate of attenuation of 40 db/octave can be obtained from one stage with a minimum attenuation above cut-off of nearly 30 db, which is quite satisfactory. By cascading a number of these filter stages any desired attenuation characteristics may be achieved, and high-pass filters may be similarly formed by the addition of leading phase shift to the amplifier.

A filter designed on these lines, with five switched positions giving nominal cut-off frequencies of 5, 7, 10 and 13 kc/s and a "linear" position is incorporated in the final circuit. The performance is shown in Fig. 11.

Gramophone Pre-amplifier. — The arrangements just described are generally all that is necessary to compensate for defects in radio transmissions. For record reproduction, however, additional fixed compensation is required. The nature of this compensation will depend on the recording characteristic and the type of pickup used.

For reasons now too well known to require repetition, lateral disc recordings are usually cut with a groove amplitude which is proportional to signal below some arbitrarily selected frequency in the 300-400 c/s region and with a lateral groove velocity which is proportional to signal above this frequency. To improve signal/noise ratio it is now common practice to increase the level recorded at high frequencies. This is particularly effective, since the noise energy per cycle increases with frequency due to the structure of the record material. In Fig. 12 is shown the recording characteristic

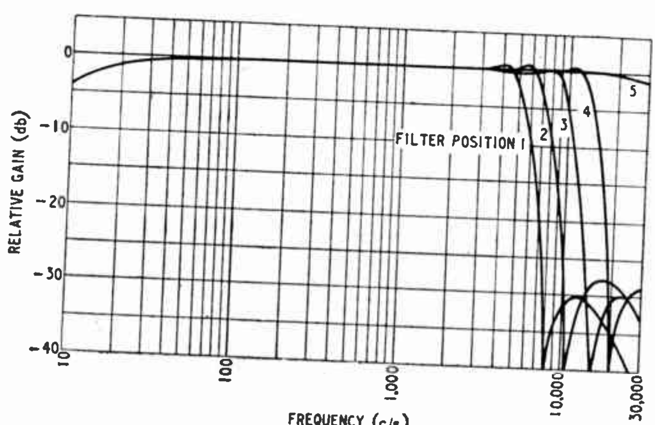


Fig. 11. Measured overall response of low-pass filter, in conjunction with pre-amplifier circuit to be described in a subsequent instalment.

[1] Thiessen, G. J. "R-C Filter Circuits." *Journal of the Acoustical Society of America*. Vol. 16, No. 4, pp. 275-279 April, 1945.

World Radio History

High-Quality Amplifier—

used by Decca. The E.M.I. characteristic does not differ substantially at low frequencies but the rise above 3,000 c/s is absent. It is proposed to use the Decca characteristic as a basis for design. When playing E.M.I. recordings, one fixed capacitor in the pre-amplifiers to be described later may be switched out of circuit, giving a level response. Alternatively the gramophone pre-amplifier may be left unchanged and correction provided by means of the variable treble control in the tone compensation unit. This, when C_{20} is set to 100 pF and R_{44} (Fig. 5) advanced by one quarter of maximum rotation, gives almost perfect correction.

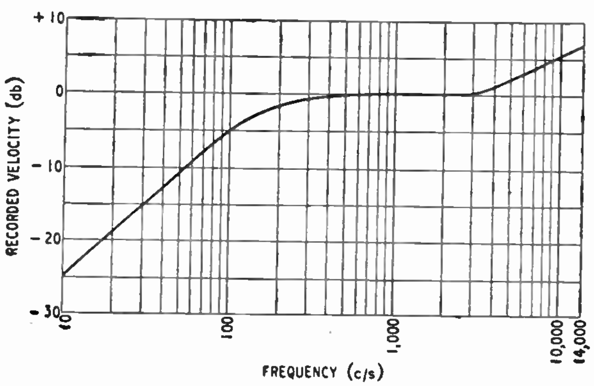


Fig. 12. Decca recording characteristic.

The majority of pickups, with the exception of piezoelectric types, give an electrical output which is proportional to the lateral velocity of the stylus. The output of such a pickup when playing a Decca recording will be of the form shown in Fig. 12, with ordinates of voltage instead of velocity. A pre-amplifier suitable for such a pickup should have a frequency characteristic which is the inverse of this.

Some desirable properties of a pickup pre-amplifier are:—

1. Low noise level.
2. Low distortion at signal levels likely to be encountered with pickups in common use.
3. Sharp attenuation below 20 c/s to suppress turntable rumble, etc.
4. Provision for varying the gain electrically.

Noise Level.—The attainment of a low noise level in high-quality sound systems is of such vital importance that a few remarks of a general nature will not be out of place at this juncture.

It is an unfortunate fact that improvements in microphones and pickups in the direction of wider frequency range and absence of other forms of distortion are almost invariably achieved at the expense of the electrical output. This does not necessarily mean that the efficiency of the transducer is reduced by the other improvements, but merely that it removes less energy from the acoustical field or from the record groove which actuates it, causing less disturbance of this field, or less wear of the record groove.

There is, however, a limit to this tendency set by the noise generated by thermal agitation in the transducer and its auxiliaries and by the noise produced in the first valve of the amplifier. It is desirable in a wide-range, high-quality sound system to attempt to maintain a peak signal/noise ratio of at least 70 db. This figure represents the best that can be achieved with a direct cellulose disc recording when everything is "just right," and it is to be expected that the standards of commercial disc recordings will approach this level when improved techniques are combined with new disc materials. A well-designed magnetic tape recorder will give a signal/noise ratio of 70-80 db, and the increasing use of this type of equipment will doubtless give impetus to the research necessary for the achievement of similar standards in other forms of recording. With a signal/noise ratio of 70 db, a sound reproducing system with a frequency response flat to 20,000 c/s operating at a realistic volume level produces, in the absence of a signal, noise which is just audible as a very gentle rustle and is completely inoffensive.

Most modern microphones and pickups are electromagnetic, although there is a tendency for microphone design to gravitate towards carrier-operated capacitor types. These have problems of their own and will not be treated here. Electromagnetic microphones and pickups are manufactured with impedances ranging from a few milliohms to several thousand ohms, but are normally used in conjunction with a transformer which raises the impedance to a suitably high value to match the input impedance of a valve.

For obvious reasons it is desirable to make this secondary impedance as large as possible—say several megohms—since the voltage output from the transducer will increase simultaneously, reducing the gain required from the electronic equipment and the amount of noise contributed by it.

It is not practicable, however, to increase the secondary impedance much beyond 0.1 MΩ if a flat frequency response is required from the transformer over the audible range.

The noise generated by thermal agitation in a 0.1 MΩ resistor at room temperature is about 6 μV for a bandwidth of 20,000 c/s. To this must be added the noise produced in the first valve of the amplifier. By careful design and construction, and by the use of a suitable valve, the noise from all causes, including mains hum, can be reduced to a value equivalent to about 3 μV at the grid, but under normal conditions a figure of 5 μV is fairly representative. The total noise may be taken as the square root of the sum of the squares of these values, or about 8 μV. To obtain a signal/noise ratio of 70 db, then, the peak signal must be 70 db above this level, say 25 mV r.m.s. The pre-amplifier should have sufficient gain to enable the main amplifier to be fully loaded by a signal at this level.

The choice of a valve type for the first stage must be made carefully. In theory, for equal gain

World Radio History

the noise level in a triode stage is lower than that produced by a pentode, since the pentode has an additional noise component due to electron partition between screen and anode. In fact, however, there are no high-gain triodes commercially available with the requisite characteristics and electrode structures for low-noise operation. A valve designed for such conditions should have a rigidly braced electrode structure to reduce microphony and a balanced "double helical" heater construction to minimize the alternating field surrounding the cathode. The Mullard EF37 has this construction and, connected as a pentode, the noise levels mentioned earlier are obtainable. Before commencing work, the reader who is not familiar with the technique of high-gain amplifier construction should consult an article on this subject.[2, 3] Considerable reduction of residual hum may usually be obtained by demagnetizing the valve.[4] In order to obtain the best signal/noise ratio, the principle which should be followed, when valve noise is the limiting factor in high-gain amplifiers, is to put the whole of the available signal into the valve grid, and to provide any frequency compensation which may be necessary after the signal has been amplified. By this method valve noise is included in any attenuating operations which may be performed and the overall signal noise ratio is improved.

Low Distortion. — Numerous methods of providing a response which varies with frequency are possible and, of course, each method has advantages and disadvantages. Where the response has to be continuously variable the method which gives greatest simplicity of control usually triumphs. Other things being equal, however, methods which employ selective negative feedback are to be preferred, as circuits of this nature generally have a high signal-handling capacity and non-linear distortion is kept to a minimum. In a pickup pre-amplifier this may be of importance where pickups with widely varying output levels are to be used.

High - Pass Characteristic. — Gramophone motors tend to produce vibrations which can cause unpleasant rumbling noises in a wide-range system. Although the energy contained in the "rumble" components may be relatively low, the frequency is also very low, and consequently loudspeaker cone movements of high amplitude may be caused. If the driving coil should move out of the region of uniform flux-density, the whole spectrum being reproduced will be distorted in a particularly unpleasant manner. Distortion in the output transformer is also possible.

This situation can be improved materially by the insertion of a high-pass filter with a cut-off frequency of about 20c/s and a fairly rapid attenuation below cut-off. At these low frequencies, such filters are conveniently composed of resistance-capacitance networks and may be incorporated in the bass-compensation pre-amplifier.

Electrical Fading Control. — When the pickup is placed on, or removed from, the disc the gain must be reduced to avoid unpleasant noises. While this may be done by a mechanical potentiometer the method is clumsy and does not facilitate rapid record changing. It has been found convenient to employ an electrical method in which the gain of one of the stages is reduced to zero at the flick of a switch by a bias voltage applied and removed by means of a network with a suitable time constant.

(To be continued)

[2] Baxandall, P. J., "Hum in High Gain Amplifiers." *Wireless World*, Vol. 53, No. 2, pp. 57-61, February, 1947.
[3] Dickerson, A. F., "Hum Reduction." *Electronics*, Vol. 21, No. 12, p. 112, December, 1948.
[4] Correspondence. *Electronic Engineering*, Vol. 20, No. 245, p. 235, July, 1948; No. 248, p. 339, October, 1948; No. 250, p. 406, December, 1948.

NEWS FROM THE CLUBS

Birmingham.—The annual dinner of the Midland Amateur Radio Society will be held at the Imperial Hotel, Birmingham, on October 15th, at 6.30. Sec.: A. W. Rhodes, 135, Woolmore Road, Birmingham, 23, Warwicks.

Eastbourne.—Meetings of the Eastbourne and District Group of the R.S.G.B. are held on the first Friday of each month at the Friends' Meeting House, Wish Road, Eastbourne. Sec.: R. F. Nugent, Field House, Windmill Hill, nr. Hailsham, Sussex.

Luton and District Radio Society meets each Monday at 7.30 at Surrey Street School. Sec.: H. S. E. Radford, 37, Wilsden Avenue, Luton, Beds.

Richmond.—The formation of the Richmond and District Radio Society is proposed and the inaugural meeting will be held at the Station Hotel, Richmond, at 7.30 on October 5th.

Southend.—The fortnightly meetings of the Southend and District Radio Society recommence on October 7th at 7.15 in Room 1, at the Municipal College. Sec.: J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

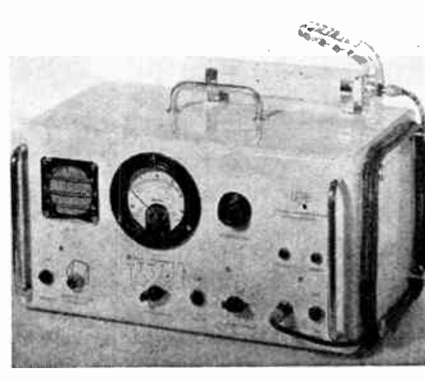
Southport. — In addition to the monthly meetings of the Southport Radio Society, which are held on the third Monday in each month at 8 p.m. at the headquarters, 38a Forest Road, the club premises are open every Monday and Wednesday evening. Sec.: F. H. P. Cawson, 113 Waterloo Road, Southport, Lancs.

Spen Valley Radio and Television Society meets on alternate Wednesdays at the Temperance Hall, Cleckheaton at 7.30. The subjects to be discussed at the meetings on October 12th and 26th are "Measurements and the Radio Amateur" and "Some Aspects of Television." Sec.: N. Pride, 100 Raikes Lane, Birstall, nr. Leeds, Yorks.

Sunderland.—Meetings of the Sunderland Radio Society are held at Prospect House, Prospect Row. On October 19th, B. A. Holden, M.A., will speak on "Quality Disc Reproduction" and on October 26th J. M. Carter, B.Sc., will demonstrate the Wright and Weaire magnetic tape recorder. Both meetings begin at 8 p.m. Sec.: C. A. Chester, 38 Westfield Grove, High Barnes, Sunderland.

RADIATION MONITOR

Both visual and aural indication of pulses from a Geiger-Muller tube are given in this instrument, the meter being arranged to indicate "rate of count". A stabilized power supply is included and the overall accuracy is within ±1 per cent. Alpha and beta-gamma probe units are available. The makers are Airmec Laboratories, High Wycombe, Bucks.



MICROWAVE LENSES

A General Survey of the Three Main Types

By C. SUSSKIND, M.Eng., B.Sc., Assoc.Brit.I.R.E.

(Yale University, U.S.A.)

RADIO waves are essentially of the same nature as light waves. Both are electromagnetic radiation phenomena which differ merely in frequency. At microwave frequencies (*e.g.*, in radar work) the wavelengths—and hence the antenna dimensions—are of the order of only a few centimetres. Accordingly, certain optical analogies suggest themselves. The most widely used device for producing a beam of light, for instance, is the parabolic mirror; if the source is located at the focus, the rays will be reflected parallel to the axis. This arrangement will work equally well for microwaves, provided a conducting surface is substituted for the mirror.

The parabolic "dish" antenna has certain disadvantages, however: the source is in the path of the beam and distorts it by virtue of a shadow effect, in addition to interference introduced as a result of forward radiation directly from the source; there is ample opportunity for radiation in the backward direction, past the reflector, with the attendant loss of energy and possibility of interference with nearby radiators ("cross-talk"); some energy is reflected back into the feed and may disturb the source; and furthermore, the tolerances required in the construction of the reflector are very small.

These difficulties can be obviated if the reflector is replaced by a large lens[1,2,3], made of glass, polystyrene, or some other dielectric material, and placed in front of the source. The source, which is no longer in the beam path, is now made to radiate in the forward direction; the two surfaces give the designer an additional degree of freedom; the possibility of distortion due to warping is greatly reduced; and it can be shown[4] that the tolerances required are four to five times greater than for the parabolic reflector.

The solid lens may, on the other hand, present a considerable mismatch at its surface, and consequently cause loss of gain and interference (scattering). This mismatch may be reduced by the use of quarter-wavelength sheets: the lens surfaces are covered by a sheet consisting of another dielectric, the thickness of which is adjusted so that the waves reflected from it and from the surface proper cancel out.[4]

A more serious disadvantage of the solid dielectric lens is its weight: a lens of a size useful in practical applications would be very heavy indeed. To circumvent this difficulty, Kock[5,6] in America and Rust[7] in Britain have each independently suggested the use of parallel-plate configurations.

Metal Plate Lenses

Two semi-infinite, parallel metal strips constitute a very simple form of waveguide. The velocity with which a surface of constant phase propagates (phase velocity) between parallel plates of separation h is given by

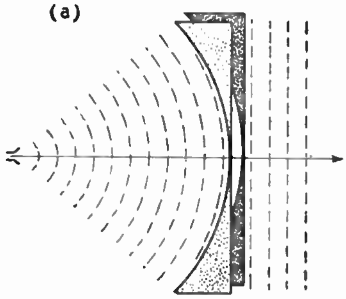
$$v_p = \frac{v_0}{\sqrt{1 - \left(\frac{m\lambda}{2h}\right)^2}} \quad \ldots \quad (1)$$

where v_0 is the phase velocity in free space, m the order of the mode being propagated, and λ the wavelength. The wave will be propagated without attenuation only if

$$h > \frac{m\lambda}{2} \quad \ldots \quad (2)$$

Thus the phase velocity v_p between the plates is always greater than the velocity v_0 in free space. If a set of parallel plates (arranged parallel to the direction of electric intensity **E**) having the shape shown in Fig. 1(a) is used, it is seen that the phase velocity will be increased along paths where the plates are wide, and unaffected where the plates have zero width. Thus the equiphase surfaces (shown dotted), spherical to the left of the lens, will emerge as planes from the lens; this is the condition which will yield maximum gain and directivity.

(a)



(b)

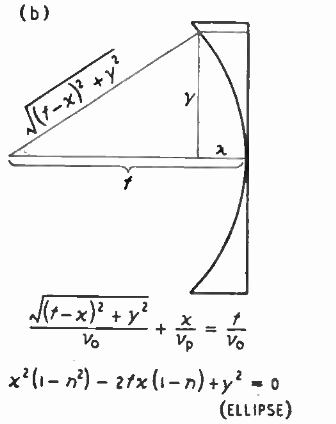


Fig. 1. Metal plate lens element.

To determine the contour of this lens, the times required for two points on the same equiphase surface to travel along two different paths (*cf.* Fig. 1(b)) are equated. Using the terminology of optics, the ratio of the two phase velocities

$$n = \frac{v_p}{v_0} = \sqrt{1 - \left(\frac{m\lambda}{2h}\right)^2} \quad \ldots \quad (3)$$

may be considered to represent ar

World Radio History

equivalent index of refraction. (Note that $n<1$ for this construction.) The equation obtained for the contour of a lens element is that of an ellipse. If the spherical wave emerging from a point source is to be converted into a plane wave by passing through the lens, an ellipsoid of

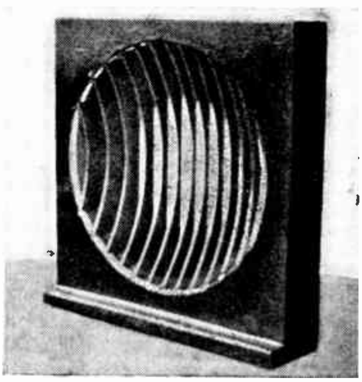


Fig. 2. Metal plate lens for $\lambda = 3$ cm.

revolution is actually required. The system may, of course, be used conversely as a receiver antenna by allowing a plane wave to impinge upon the flat surface and to be focused to a point.

A metal plate lens constructed at the Dunham Laboratory of Electrical Engineering, Yale University, is shown in Fig. 2. This lens, designed for operation at 3 cm, has a focal length of $18\frac{1}{3}\lambda$, an aperture of 11λ (and hence an f-number of 5/3), and an effective index of refraction $n = 0.6$.

The most obvious disadvantage of the metal plate lens is evident from equation (3): it is the dependence of the equivalent index of refraction on the wavelength (or frequency). Experimental results[5] show that a useful bandwidth of not more than 5 per cent of the operating frequency can be achieved. This important limitation has led to the development of a broad-band lens at the Bell Telephone Laboratories[8,9,10], in which so-called artificial dielectrics are utilized.

Artificial-Dielectric Lenses

When an ordinary dielectric is placed into an electric field $\mathbf{E}$, the dielectric is polarized to the extent $\mathbf{P} = N\alpha_e\mathbf{E}$, where N is the number of molecules per unit volume, and α_e the polarizability (always positive). It is customary to define a displacement vector $\mathbf{D} = \epsilon\mathbf{E} = \epsilon_0\mathbf{E} + \mathbf{P}$ where ϵ is the permittivity of the dielectric and ϵ_0 the permittivity of free space ($\epsilon_0 = 8.85 \times 10^{-12}$ farad/metre in the m.k.s. system of units). Thus the permittivity is given by

$$\epsilon = \epsilon_0 + N\alpha_e \quad .. \quad .. \quad (4)$$

and the dielectric constant is given by the ratio

$$\kappa_e = \frac{\epsilon}{\epsilon_0} = 1 + N\frac{\alpha_e}{\epsilon_0} \quad .. \quad (5)$$

Similarly, the magnetic permeability is given by

$$\mu = \mu_0 + N\alpha_m \quad .. \quad (6)$$

where μ_0 is the permeability of free space ($\mu_0 = 4\pi \times 10^{-7}$ henry/metre in the m.k.s. system) and α_m the magnetic polarizability (may be positive or negative). The relative permeability is given by the ratio

$$\kappa_m = \frac{\mu}{\mu_0} = 1 + N\frac{\alpha_m}{\mu_0} \quad .. \quad (7)$$

The polarizabilities α_e and α_m can be calculated for various geometric configurations; their values may be found in many advanced textbooks. The general shape of a molecule is usually assumed to be spherical; for a sphere, $\alpha_e = 4\pi\epsilon_0 a^3$ and $\alpha_m = -2\pi\mu_0 a^3$ where a is the sphere radius.

The index of refraction is given by

$$n = \sqrt{\kappa_e\kappa_m} \quad .. \quad .. \quad (8)$$

and is independent of frequency in the region where the wavelength is large compared with the size of the particles and the spacing between them.

It is found that an analogous artificial dielectric can be constructed by reproducing the molecular structure on a macroscopic scale; such a dielectric may consist of a lattice of metal spheres having a radius and separation which are small compared with the wavelength.

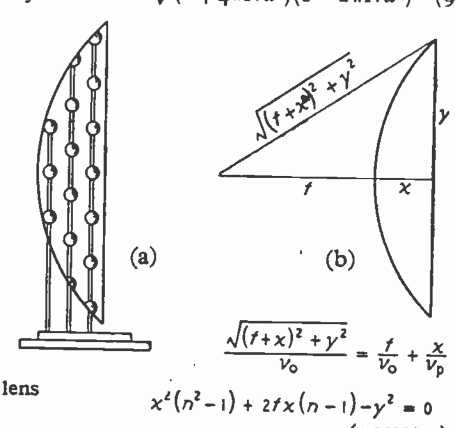


Fig. 3. Artificial-dielectric lens (cross-section)

The artificial dielectric will have the properties described by equations (4) to (8), inclusive. Thus a lens like that in Fig. 3(a) may be constructed from small metal spheres supported as shown. This lens will have the shape and action of a solid dielectric lens, and yet retain the weight advantage of the metal plate lens. Furthermore, the artificial-dielectric lens will have an index of refraction $n = v_0/v_p$ which is essentially independent of frequency, except in the range where the size and separation of the elements become comparable with the wavelength.

To determine the contour of this lens, a procedure similar to that described in the case of the metal plate lens is followed. A comparison of paths (*cf.* Fig. 3(b)) yields the equation of a hyperbola; to transform the spherical waves emanating from a point source into plane waves, a hyperboloid of revolution is needed. It should be noted that the index of refraction $n = v_0/v_p$ will be greater than 1 for artificial dielectrics, since here $v_0 > v_p$. This relationship accounts for the difference between the shapes of the metal plate lens previously described and the artificial-dielectric lens. The action of the latter is to delay the portion of the wavefront passing through the middle of the lens with respect to that passing through the edge, and this lens is therefore sometimes designated as a "delay lens."

The index of refraction of an artificial dielectric consisting of small spheres (radius a) is given, from equation (8), by

$$n = \sqrt{(1 + 4\pi Na^3)(1 - 2\pi Na^3)} \quad (9)$$

where N is the number of spheres per unit volume. It is seen that the value of n is reduced by the factor introduced in the second bracket under the radical. This

World Radio History

Microwave Lenses—

reduction can be eliminated if particles are used which are thin in the direction of propagation, and thus do not disturb the magnetic field. For such elements the index of refraction is given simply by

$$n = \sqrt{\kappa_e} = \sqrt{1 + N\frac{a_e}{\epsilon_0}} \quad .. \quad (10)$$

The spheres of Fig. 3(a) are replaced by thin metal discs lying in vertical planes which are normal to the plane of the paper. Such a lens was first proposed by Kock[8]. The discs may be made of copper foil and affixed to thin slabs of polystyrene foam.* The polarizability of a disc of radius a

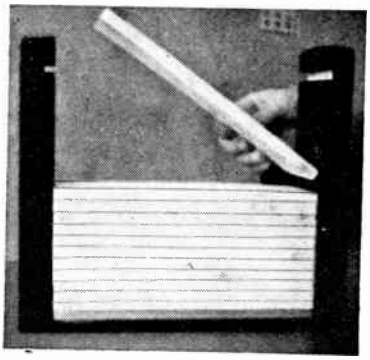


Fig. 4. Artificial-dielectric lens (metal strip type) being assembled.

is given by $a_e = 16\epsilon_0 a^3/3$ and the index of refraction is accordingly

$$n = \sqrt{1 + \frac{16}{3}a^3 N} \quad .. \quad (11)$$

where N is the number of discs per unit volume. This lens, like the lens consisting of spherical elements, will beam waves of any arbitrary polarization, provided the elements are arranged isotropically.

If waves of only a single polarization need be considered, metal strips may be substituted for the discs. With reference to Fig. 3, these strips would extend horizontally, standing on edge in a vertical plane normal to the plane of the paper. One way of constructing such a lens is to stack "Styrofoam" slabs as shown in Fig. 4. Each slab is milled to accept metal strips of varying lengths (*cf.* Fig. 5) and arranged to give the desired hyperbolic contour. The polarizability of a strip of

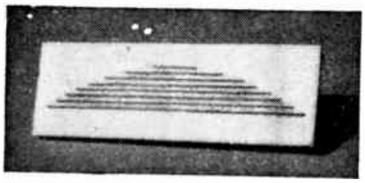


Fig. 5. Element or metal strip type lens.

width d is given by $a_e = \pi\epsilon_0 d^2/4$ and the index of refraction is therefore

$$n = \sqrt{1 + \frac{\pi}{4}d^2 N} \quad .. \quad (12)$$

where N is now the number of strips per unit area, looking on edgewise.

The assembled lens is shown in Fig. 6; designed for operation at 3 cm, it has a focal length of 17 λ and an index of refraction of $n = 1.375$.

The Bell Telephone Company's microwave relay systems at present utilize both the metal plate and the artificial-dielectric lens: the former on the New York-Boston line, and the latter on the New York-Chicago line.

Path-Length Lenses

Since the above was written, still another type of delay lens

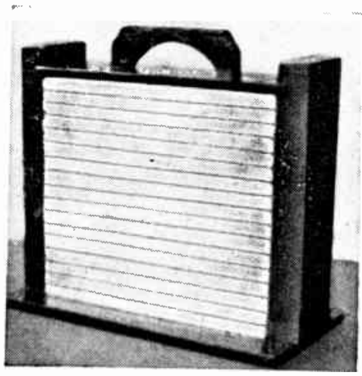


Fig. 6. Artificial-dielectric lens fully assembled.

has been developed at the Bell Telephone Laboratories: the path-length lens[11]. This lens, which has the over-all hyperbolic contour of Fig. 3(b), comprises corrugated metal plates arranged horizontally, or flat plates supported at an angle with the horizontal. Either arrangement serves to "delay" the part of the wavefront passing through the centre of the lens with respect to that passing through the edge, thus giving focusing action. The main advantage of the new lens, as compared with the delay lens previously described, is simpler construction. The path-length lens retains the broad-band characteristics of the earlier type and even improves upon them at the high-frequency end by eliminating dispersion and refraction; the only requirement is that the vertical spacing between the plates must be smaller than $\lambda/2$ for the highest frequency desired.

* This material, known commercially as "Styrofoam" and manufactured by the Dow Chemical Company, has found wide application in antenna work because it is very light (yet comparatively rigid) and has a dielectric constant which differs only very slightly from that of free space.

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"Electrons in Triodes," the second of a series of educational booklets being produced by Ediswan, is now available gratis to radio societies, education authorities and other bona fide bodies. This 48-page booklet outlines briefly the historical development of the triode and gives an explanation of its working principles. The first booklet in the series covered diodes and subsequent issues will deal with screened grids, pentodes, beam tetrodes, frequency changers and multiple diodes. Requests for copies should be sent to the Ediswan Electric Co., 155, Charing Cross Road, London, W.C.2.

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1T4	Batt. Pent. Vari-Mu	1.4	0.05	90	67.5	0/–16	3.5	1.4	500,000	0.9	—	—
1R5	Heptode F.C.	1.4	0.05	90	67.5	0/–14	1.6	3.2	600,000	300*	—	—
1S4	Batt. Beam Tetrode	1.4	0.1	90	67.5	–7	7.4	1.4	100,000	1.58	8000	0.27
1S5	Batt. Diode Pentode	1.4	0.05	90	67.5	0	1.6	0.4	600,000	0.63	—	—
3S4	Batt. Beam Tetrode	1.4 2.8	0.1 0.05	90	67.5	–7	7.4	1.4	100,000	1.58	8000	0.27
3V4	Batt. Beam Tetrode	1.4 2.8	0.1 0.05	90	90	–4.5	9.5	2.1	100,000	2.15	10000	0.27

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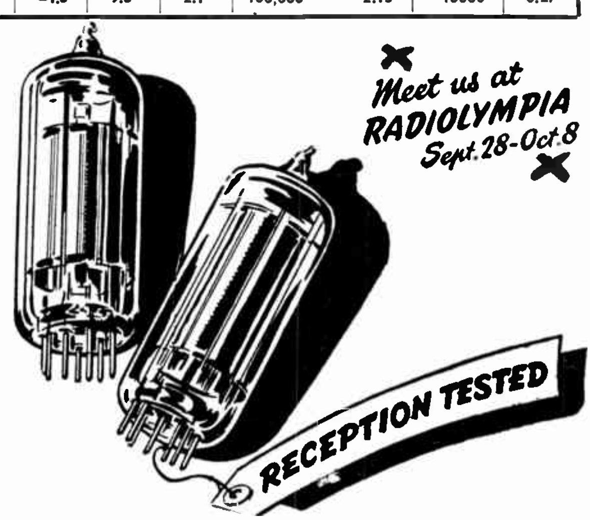

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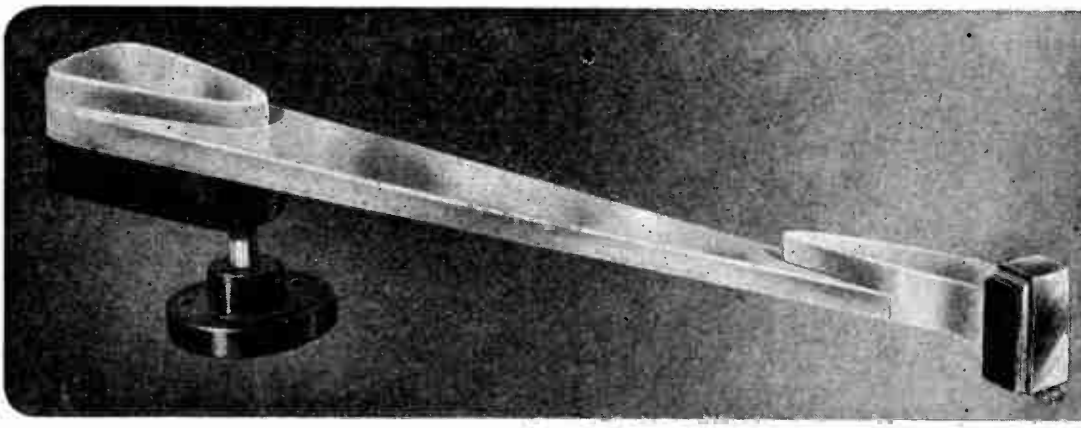

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New V.H.F. Equipment Shown at Farnborough

THE exhibition of aircraft equipment, which accompanies the flying display held by the Society of British Aircraft Constructors at Farnborough, Hants, revealed an interestingly new development in the field of v.h.f. radio equipment for use in aircraft. Hitherto most makers have provided a number of alternative channels in the one set with some simple form of selecting switch. In recent years the tendency has been for more and more channels to be made available, but this year some makers have decided to anticipate future requirements and provide the maximum number possible in the allotted band of 118 to 132Mc/s.

Control Unit of Murphy 140-channel v.h.f. transmitter-receiver. In each case one knob selects the whole number and another the decimal part of the operating frequency.

At present the channel separation is fixed at 200Kc/s, which allows for 70 channels and equipment giving this number was shown by Standard Telephones. The send and receive frequencies are crystal controlled on all channels, but individual crystals are not used; indeed, it would be uneconomical so to do and the circuit is so arranged that 24 crystals are made to provide all the necessary frequency pegging.

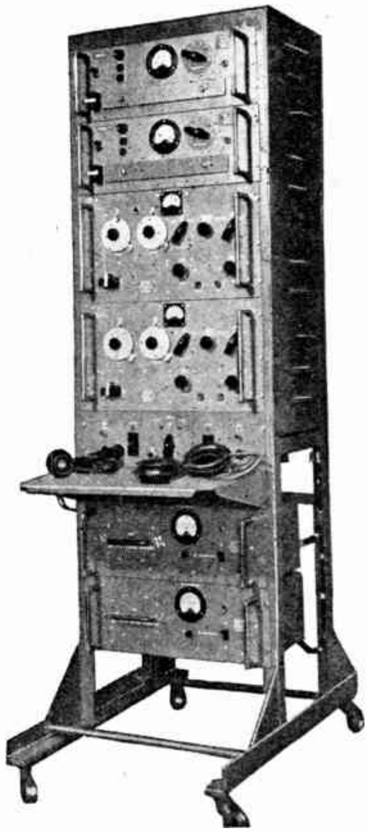
On the control box, which contains the crystals, are two switches, one marked in whole numbers of Mc/s from 118 to 131 and the other in decimal fractions of 0.1, 0.3, etc., up to 0.9Mc/s. Selection of the operating channel is then made by setting the switches to the frequency required, for example, 120.1, 124.5 and so on.

To facilitate channel selection and avoid the need for retuning circuits, wide-band inter-stage couplings are usually employed. The Standard 70-channel set uses two wide-band transmitter units to cover the 14-Mc/s band, the remote control unit selecting the appropriate transmitter. One receiver unit only is used.

Murphy were showing a multi-channel v.h.f. set also, but in this case they have anticipated future needs to the extent of providing 140 channels with 100-Kc/s separation. Crystal control of both the send and receive frequencies is adopted and here again comparatively few crystals suffice for all purposes.

Channel selection is made on the basis of the frequency required, two switches being employed for the transmitter and two for the receiver. One selects the whole number of the frequency between 118 and 131Mc/s, while the other selects the decimal fraction.

Plessey PTR61 lightweight aircraft v.h.f. equipment providing six crystal-controlled channels.



Ekco airport installation consisting of two transmitters, two receivers, power supplies and remote control panel.

The transmitter circuits are, in this case, divided into 7 bands of 2Mc/s each, while the receiver has 5 bands of 3Mc/s and the switching automatically selects the required crystals and, by remote control, the appropriate transmitter and receiver bands.

A v.h.f. transmitter-receiver covering a considerably wider frequency range was shown by Ekco. It has been developed for the Ministry of Supply and is capable of providing, by remote control alone, some 312 channels spaced 180Kc/s apart in the band 100 to 156Mc/s or 281 channels with 200Kc/s spacing. The equipment is divided into five units comprising aerial unit, transmitter-receiver, main controller and power-modulator respectively. In addition Ekco had some lightweight v.h.f. equipments pro-

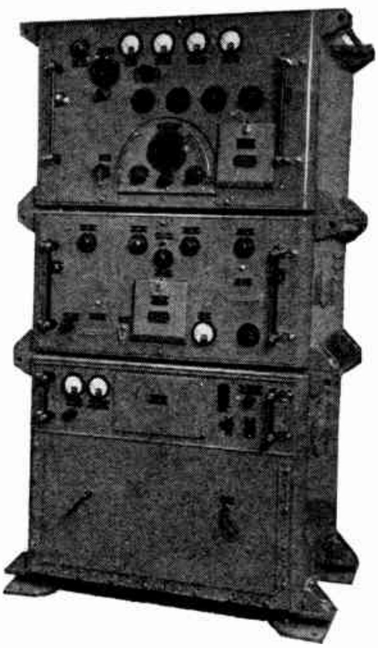
World Radio History

Air Radio—

viding up to 21 channels by the movement of a single switch.

There was a new v.h.f. aircraft set shown by Plessey known as the PTR61 and which has been designed for use where small size and low weight are of first importance, with simplicity of operation a close second. Six spot frequencies, all crystal controlled, in the band 116 to 132Mc/s are provided, but as crystals can be changed easily in the air many more channels are potentially available. A single control suffices to tune simultaneously both the transmitter and the receiver. The set gives intercom facilities for three positions in the aircraft.

For airport use Plessey were showing a single-channel crystal controlled receiver covering 116 to 132Mc/s, while another set of a somewhat similar kind was seen on the Ekco stand. These sets are primarily for rack mounting with separate receivers permanently set up on the various frequencies used by the airport where they are installed.



Redifon 300-watt airport transmitter designed for ease of transport.

Other v.h.f. equipment seen this year was a twin-channel transmitter and receiver in rack form for airports made by Ekco, a 50-watt twin-channel transmitter, with both transmitters taking the same modulation, shown by Standard and a 100-watt twin transmitter working on spot frequencies in two bands, one being 116 to 132Mc/s and the other 2.5 to 13Mc/s. The last mentioned is a Plessey product known as the PT16.

Whilst the predominating interest was in the new v.h.f. equipment the other aspects of aircraft communications and radio navigation were not entirely forgotten. For example, Cossor Radar had an improved GEE ground station and a new miniature GEE receiver designed especially for small aircraft and very simple to operate. All the information needed to fly along a GEE lattice line is given by a visual "left-right" pointer indicator.

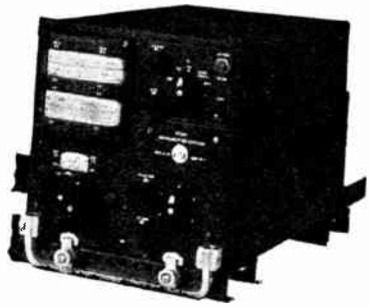
Also for air navigation Ferranti showed a prototype version of a new Consol and Radio Range Receiver, combining also facilities for r.t. reception in the band 225 to 510Kc/s. It is a miniature set measuring $4 \times 8 \times 5\frac{1}{4}$in only.

Another aid to air navigation was the Cloud and Collision Warning Radar operating in the centimetre band made by Ekco. Clouds up to 40 miles away are clearly visible on the display unit.

High-power ground transmitters for point-to-point communication for use as aircraft beacons and for long-distance communication with aircraft in the medium and high frequency bands, were shown this year. Redifon had a 300-watt transmitter which, while extremely robust, can readily be separated into three self-contained units each under 200lb in weight. This should help to solve some of the difficulties often met with when moving heavy equipment to remote airfields.

An output of 300 watts is also given by the new Cossor Radar airport transmitter which is capable of operation over the band 1.5 to 20 Mc/s using either telephony or c.w. or m.c.w. telegraphy.

A new communications receiver for ground use was shown by Redifon in the form of a junior version of the R50 set. Housed in the same cabinet and having most of the distinctive features of this set, it differs primarily in the frequency coverage provided. In the R50A, as it is called, the coverage is from 585Kc/s to 32Mc/s in five ranges and one i.f. amplifier only is needed, which in this case is 465Kc/s.



Marconi AD94 lightweight aircraft communication receiver.

Another recently introduced communications set, designed for use in aircraft, is the Marconi AD94 which is described as a high discrimination set in view of the small increments of calibration actually appearing on the extremely long moving tape scales. Calibrations are made at intervals of 10Kc/s, but much closer reading, and setting, than this is possible. It covers 2 to 18.5Mc/s and 150 to 510Kc/s.

For medium and high frequency operation in aircraft Marconi was showing, among other apparatus, a new high-power transmitter, the AD107 giving between 100 and 150 watts output on ten spot frequencies in the band 2 to 18.5 Mc/s and 10 to 120 watts from 320 to 250Kc/s. A 140-watt 12-channel aircraft transmitter for a similar service was included in the Standard range of aircraft sets. The frequency range is 2.8 to 18Mc/s.

"WIRELESS WORLD" DIARY

ALL available copies of the *Wireless World* Diary for 1950 are being distributed by 12th October to newsagents and booksellers. The new edition of this useful pocket-sized book contains an 80-page reference section of technical data and general information which has again been revised. New and more convenient valve base tables show the connections of over 600 valves, and v.h.f. aerial data for the projected new B.B.C. services are given. The price of the Diary is 3s $4\frac{1}{2}$d, including purchase tax.

MAINS-BATTERY TURNTABLE

A Simple Circuit Suitable for Public Address Work

By I. C. HUTCHESON, M.A.

THE public address operator finds, in general, a wide variety of apparatus from which he may choose to suit his needs. If, however, he wishes to reproduce gramophone records through a mobile public address system, such as a loudspeaker van, he is forced either to purchase a turntable which will operate directly from a battery supply, or to use one with a clockwork motor which requires frequent rewinding.

The ordinary a.c. mains induction turntable forms a part of the equipment of most public address engineers, and it can quite simply be operated by means of a special vibrator pack from a 12-volt car battery. This device has several advantages over the use of a rotary converter. The initial cost is lower, there is a moderate saving in size and weight, the noise is very much less and there is considerable reduction in current consumption.

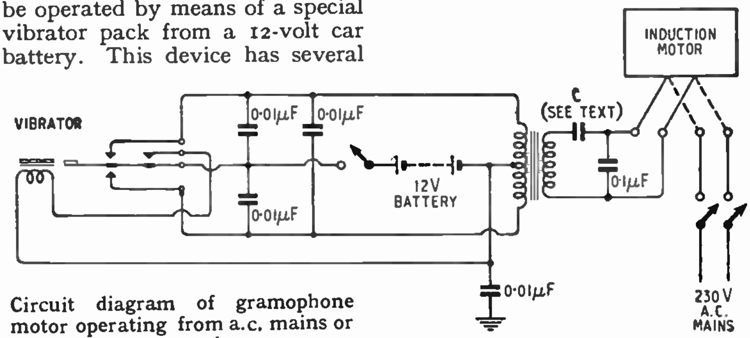
The apparatus consists of a non-synchronous vibrator, a vibrator transformer with a centre-tapped primary and a number of small condensers. All these can be comfortably accommodated under the motor board of the normal turntable with the exception of the vibrator, which may be arranged to plug in through the board and thus be readily changeable.

The circuit, which is given above, is basically the same as that of a normal power pack giving an unsmoothed output of 230 volts a.c. at the vibrator frequency of about 100 c/s. There is, however, an important modification which consists of the condenser C in series with the motor winding. This has the effect of turning the inductive load, presented by the motor to the vibrator, into one which is resistive or capacitive.

It is well known that the breaking of a current in an inductive circuit causes high e.m.f.s to be set up, and in this case if C is omitted heavy sparking occurs at the vibrator contacts. If C is inserted, however, and a suitable value discovered by trial and error, the sparking can be reduced to negligible proportions. Under these conditions the vibrator remains cool and does not burn out. With values of C below that giving resistive conditions, there is no further alteration in the amount of sparking, and, as the total impedance of the motor and C in series is greater, the motor torque is less. Thus a value of C must be struck which eliminates sparking, while not unduly reducing the torque.

A preliminary estimate of the aproximate value of C can be made by assuming a vibrator frequency of 100 c/s and calculating a value of C which will have the same reactance as the inductive reactance of the motor. The latter can be calculated (if we ignore such things as change of phase angle with load) from a knowledge of the power consumed, the supply voltage and the d.c. resistance of the windings. In a particular case, the calculated value turned out to be 0.34 μF, and in practice a value of 0.25 μF was found to be satisfactory.

The current taken by the vibrator pack from a 12-volt battery is a little under 3 amps. This vibrator pack has had many hours of use and continues to function very satisfactorily. Similar methods could, no doubt, be employed for the running of other small mains motors from a low-voltage d.c. source.



Circuit diagram of gramophone motor operating from a.c. mains or car accumulator.

PROXIMITY METER

THIS instrument, illustrated here, has many industrial applications for the control of thickness and composition in non-conducting films, the setting up of machine tools, etc. It functions on the measurement of minute changes of capacitance and has a sensitivity of 0.01 pF.

The manufacturers of the meter are Fielden (Electronics), Holt-Town Works, Manchester, 10.

NATIONAL RADIO EXHIBITION, 1949

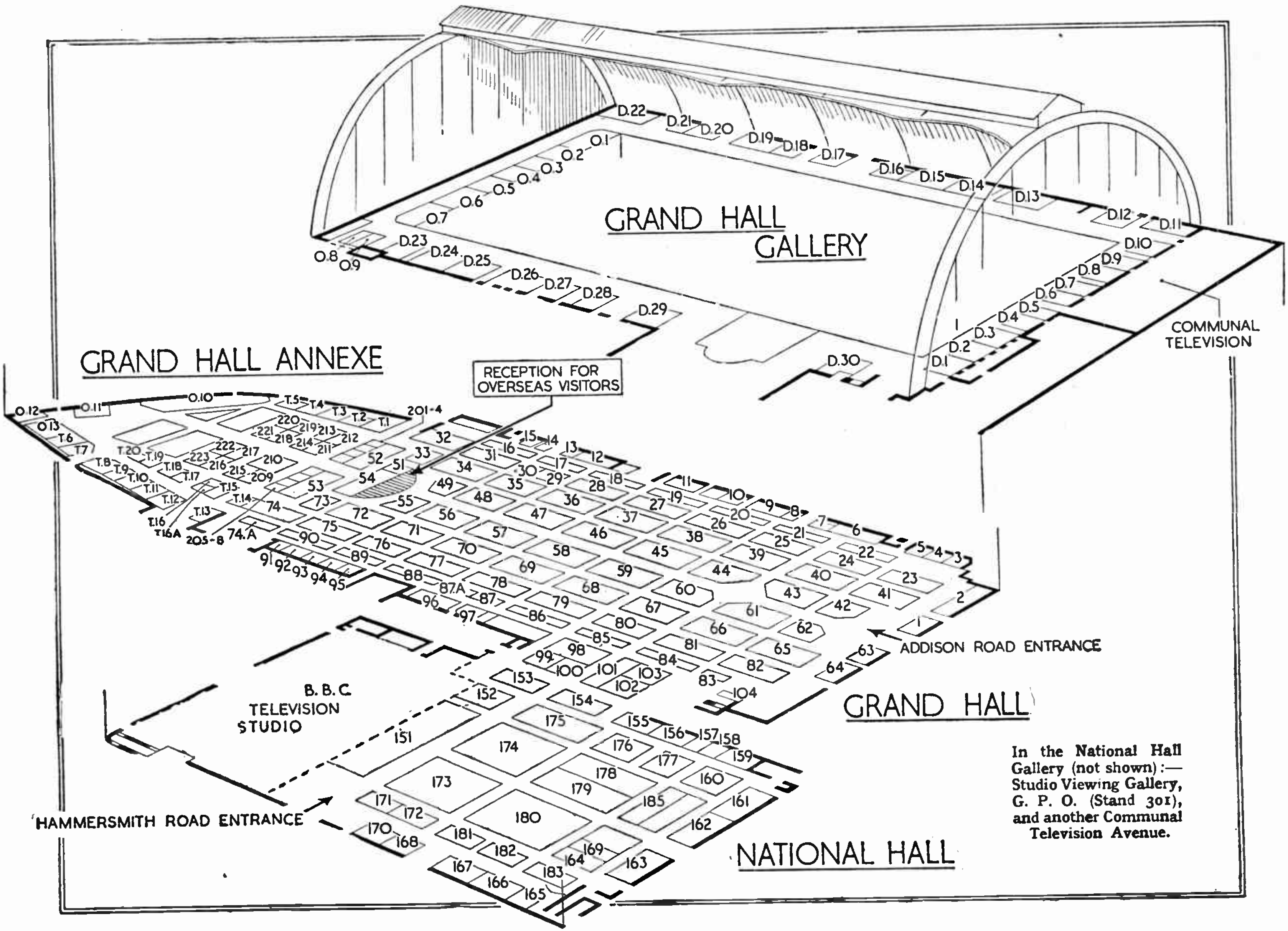
OLYMPIA, LONDON. Wednesday, 28 SEPTEMBER, to Saturday, 8 OCTOBER

(Open daily, except Sunday, 11 a.m.—10 p.m. Admission 2/6)

Alphabetical List of Exhibitors and Guide to the Stands

Name	Stand
A.W.F.	203
Ace	21
Acos (Cosmocord)	7
Acoustical Mfg.	91
Acrylite (Motor and Air)	164
Admiralty	73
Advance	209
Aerialite	62
Airmec	156
Alba (Balcombe)	44
Albion	T10
Ambassador (Fitton)	80
Amplion	20
Antiference	64
Armstrong	92
Auratone	T16
Avo (Automatic Coil Winder)	85
B.B.C.	151
B.R.E.M.A.	211
B.R.V.M.A.	214
B.S.R.	81
B.T.H.	178
Bafflette (Allan Radio)	49
Baird (Scophony)	27
Barclays Bank	166
Beethoven	11
Belclere (Bell & Croyden)	3
Belling-Lee	25
Bernards	217
B.I. Callender's	55
Board of Trade	51
Brimar (Standard)	60
Brit. Moulded Plastics	22
British Railways	171
Brown Bros.	T12
Bulgin	1
Burndept	172
Bush	66
Celestion	87
Champion	26
Chloride	19
Collaro	61
Concordia	5
Connoisseur (Sugden)	207
Cossor	35
D.S.I.R.	52
"Daily Mail"	220, 221
Dallas	T8
Decca	41
Defiant (Co-op W. Soc.)	28
Dibben	T20
Dubilier	82
Dynatron	2
E.I.B.A.	T16A
E.M.I.	67
E.R.I.C.	181
Econasign	169
Eddystone (Stratton)	182
Ediswan	47
Eelex (Eastick)	T3
Ekco (E. K. Cole)	58, 153
"Electrical & Radio Trading"	T14
Electron (New London)	98
"Electronic Engineering"	155
Erie	86
Etronic (Hale)	68
"European Radio Programme"	94
Ever Ready	46
Ferguson	40
Ferranti	43
Franklin	204
G.E.C.	38, 175
G.P.O.	301
Gamma	4
Garrard	79
General Sonic	74A
Goldring (Scharf)	97
Goodmans	6
Grampian	90
H.M.V. (Gramophone Co.)	57
Haynes	9
Hazlehurst	205
Hobday	T15
Houghton & Osborne	93
Hunt	17
Imhof	89, 183
Invicta	71
Judge	206
K.B.	65
Keith Prowse	104
Kerry's	T1
Kleergaze (Levene)	158
L.E.S.	T17
L. & P. Factors	T11
Lectrona (Acoustic Products)	208
Lee	157
Lloyds Bank	162
Long & Hambly	14
Lowther	165
Lugton	T7
M.S.S.	76
McMichael	70
Magnavista (Metro-Pex)	10
Marconi	174
Marconi Inst.	154
Marconiphone	48
Martins Bank	159
Masteradio	41
Metrovick	179
Midland Bank	161
Min. of Civil Aviation	33
Min. of Supply	54
Mullard	36, 176, 210
Multicore	83, 84
Murphy	56, 160
National Prov. Bank	163
Nettlefolds (Guest-Keen)	185
Norman (Rose)	T6
Oldham	218
Ossicaide (V. A. Foot)	170
Peerless	15
Petter	T18
Philco	39
Philips	34
"Pianomaker, Music Seller & Radio Retailer"	T13
Pilot	45
Plus-a-Gram (Margolin)	102
Polar (Wingrove & Rogers)	212
Portogram	99
"Practical Wireless"	100
Pye	72, 180
Qualrad	202
R.A.F. (Air Ministry)	74
R.C.E.E.A.	152
R.E.M.E. (War Office)	53
R.G.D.	37
R.W.F.	T9
Radiomobile	42
Regentone	59
Roberts	96
Rola (Brit. Rola)	87A
Romac	88
Rota-Time	103
Royal Signals (War Office)	32
Scott	201
Scott Wire	8
Servisol	216
Shannons & Bishop	T19
Simon	213
Sobell	23, 24
Standard	173
T.C.C.	75
Taylor	16
Telcon (T.C.M.C.)	30
"Television Weekly"	168
Trix	101
Truvox	18
Ultra	78
Vidor	69
Vitavox	12
W.B. (Whiteley)	77
Wearite (Wright & Weaire)	63
Webber	T2
Westinghouse	177
Westminster Bank	167
Weston (Sangamo)	219
Wharfedale	215
Winter Trading	T5
"Wireless & Electrical Trader"	T4
"Wireless World"	29
Wolsey	13

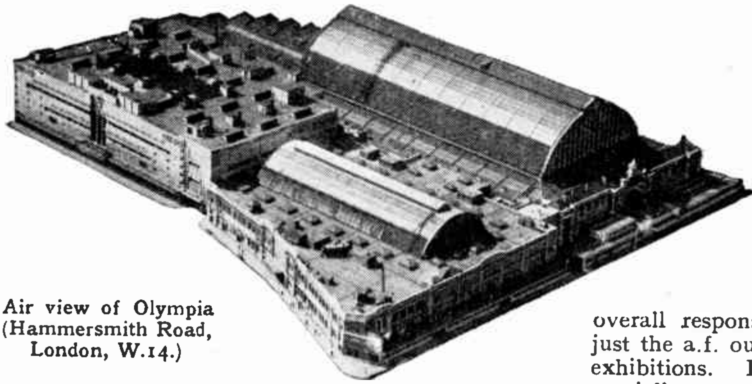
World Radio History



In the National Hall Gallery (not shown):—Studio Viewing Gallery, G. P. O. (Stand 301), and another Communal Television Avenue.

CLASSIFIED

Principal Classes of Exhibits at a Glance



Air view of Olympia (Hammersmith Road, London, W.14.)

IN preparing our "Guide to the Show" we have this year adopted a different method of presentation in the belief that it gives a more comprehensive view of the present activities of the firms represented, both for the visitor to the show and those who will have to depend on the pages of *Wireless World*. All the main products of the radio industry are classified under convenient headings, and the exhibitors of any particular product, with their stand numbers, can be found in a moment. These tables, which are on pp 379-382, are as complete as they can be up to the time of going to press.

It is not easy to pick outstanding features from the mass of information obtained from manufacturers, but it would appear that the return of the television-broadcast-radiogramophone set is *the* feature of Radiolympia, 1949, which, organized by the Radio Industry Council, is the sixteenth in the series. There will, of course, be the usual "surprise" items, details of which have been kept closely guarded by manufacturers until the show opened.

Television and Sound Distribution

Television is the *pièce de résistance*, and nearly 40 manufacturers are exhibiting sets. Special arrangements have been made to provide visitors with facilities for viewing both the transmitted scene and the received picture. The B.B.C. television studio in the National Hall, which is more than twice the size of the entire studio space at Alexandra Palace, is overlooked by a glass-enclosed gallery from which visitors can watch rehearsals and performances. The studio equipment includes three of the new C.P.S. Emitron cameras.

Additional floor space and improved arrangements for the viewing of a variety of receivers in the television communal demonstration avenues in the two galleries have been provided this year. In addition to these, a number of manufacturers have their own demonstration rooms where both sound and vision receivers are demonstrated. A list of these is given at the end of the numerical list of stand holders on p 384.

As already announced, a radio-frequency distribution system is fed to the demonstration rooms. Long- and medium-wave transmissions picked up by an aerial erected on the roof of the hall are fed by r.f. to these rooms, thus enabling visitors to assess the overall response of broadcast receivers instead of just the a.f. output as has been the case at previous exhibitions. In conjunction with this system, a specially recorded programme of speech and music is distributed on 767 kc/s (391.1 metres)—the frequency of the Scottish Home Service, which is not normally receivable at an entertainment value in London.

Our tabular guide to the show deals only with the commercial exhibits. There are, in addition, a number of stands occupied by non-commercial producers and users of radio and electronic equipment including the Ministries of Supply, Air and Civil Aviation, the D.S.I.R., G.P.O., Board of Trade and the Armed Forces. One section of the Post Office exhibit, which is located on a large site in the National Hall Gallery, is devoted to a display dealing with the suppression of electrical interference. An Interference Information Bureau is also provided. In another section a Post Office coast station is reproduced and visitors can see how distress calls from ships are dealt with. The part played by the Post Office in the extension of the television service to the Midlands—the provision of the radio and cable links—is also shown.

The cathode-ray direction-finding equipment for the location of thunderstorms, as used by the forecasting stations of the Meteorological Office at Dunstable, Camborne, Leuchars and Irvinestown, is being demonstrated by the Department of Scientific and Industrial Research. The D.S.I.R. is also showing the apparatus used by its Radio Research Station at Slough for ionospheric sounding.

Radio research and development work undertaken at the various establishments of the Ministry of Supply are featured on Stand 54. Among the equipment shown is a pulse code modulator designed to code and decode speech and automatic frequency-selecting mechanism for airborne transmitter-receivers.

Ground controlled Approach equipment (G.C.A.) is shown on the stand of the Ministry of Civil Aviation to demonstrate its use at London Airport. Visitors can watch the course of a model aircraft as it comes in to land and at the same time see the "blips" on the G.C.A. screen.

The War Office has two stands. One is devoted to a display showing the diversity of wireless equipment used by the Army. It includes the latest "walkie-talkie" (No. 88) receiver which is frequency modulated. This stand is staffed by Royal Signals. The maintenance of Army telecommunication and electronic control equipment is the responsibility of R.E.M.E., and members of the Corps are demon-

World Radio History

GUIDE TO THE SHOW

strating the work on the second War Office stand.

Special arrangements have been made for overseas visitors who will find the R.I.C. reception rooms and Board of Trade information bureau at the west end of the Grand Hall. We have not indicated in our tabular lists the equipment which is for export only, but a large numbers of manufacturers have receivers specially designed for the foreign market and at least two are showing television receivers designed for use in North America.

Although the sectionalizing of the exhibition has not been strictly adhered to, in general the broadcast set manufacturers are in the Grand Hall and wholesalers in the Grand Hall Annexe, whilst the National Hall is devoted to electronics—industrial, scientific and medical equipment—and transmitting apparatus.

RECEIVERS: Broadcast, Television, Communications and Special Purpose

FIRM	(Stand)	Broadcast					Television	Television-broadcast	Special-purpose
		Mains	Battery	Mains/battery	Portable	Radio-gramophone			
Ace	(21)	●	●	—	—	●	—	—	—
Alba	(44)	●	—	●	●	●	●	—	—
Ambassador	(80)	●	—	—	—	●	●	—	—
Amplion	(20)	●	—	—	●	●	—	—	—
Armstrong	(92)	●	—	—	—	—	●	—	—
Auratone	(T16)	—	—	—	●	—	—	—	—
Baird	(27)	—	—	—	—	—	●	●	—
Beethoven	(11)	●	●	—	●	●	●	—	—
Bush	(66)	●	●	—	●	●	●	—	—
Champion	(26)	●	—	●	●	●	●	●	—
Cossor	(35)	●	●	—	●	●	●	●	—
Decca	(41)	—	—	●	—	●	●	●	—
Defiant	(28)	●	●	—	●	●	●	●	—
Dynatron	(2)	—	—	—	—	●	●	●	—
E.R.I.C.	(181)	●	—	—	—	●	●	—	—
Eddystone	(182)	●	●	—	—	—	—	—	C
Ekco	(58,153)	●	●	●	●	●	●	●	A,S
Etronic	(68)	●	—	—	●	●	●	—	—
Ever Ready	(46)	—	●	—	●	—	—	—	—
Ferguson	(40)	●	●	—	●	●	●	●	—
Ferranti	(43)	●	●	—	—	●	●	—	—
G.E.C.	(38,175)	●	●	—	●	●	●	●	C
Gamma	(4)	●	●	—	—	●	—	—	—
General Sonic	(74a)	●	●	—	—	●	—	—	—
Grampian	(90)	●	—	—	—	—	—	—	—
H.M.V.	(57)	●	●	—	—	●	●	●	F
Haynes	(9)	●	—	—	—	—	●	●	—
Houghton & Osborne	(93)	—	—	—	—	—	—	—	K

FIRM	Stand	Broadcast					Television	Television-broadcast	Special-purpose
		Mains	Battery	Mains/battery	Portable	Radio-gramophone			
Imhof	(89,183)	●	—	—	—	●	—	●	—
Invicta	(71)	●	●	●	●	●	●	—	T
K.B.	(65)	●	—	—	—	●	●	●	—
Lee	(157)	—	—	—	—	—	—	—	K
Lowther	(165)	●	—	—	—	●	●	—	—
M.S.S.	(76)	—	—	—	—	●	—	—	—
McMichael	(70)	●	●	—	●	●	●	●	—
Marconi	(174)	—	—	—	—	—	—	—	C
Marconiphone	(48)	●	—	—	●	●	—	●	—
Masteradio	(31)	●	●	—	—	●	●	—	A
Mullard	(36, 176, 210)	●	●	—	—	●	●	●	C
Murphy	(56, 160)	●	●	—	●	●	●	—	C
Peerless	(15)	●	—	—	—	●	●	—	C
Philco	(39)	●	●	—	●	●	●	—	—
Philips	(34)	●	●	—	—	●	●	●	—
Pilot	(45)	●	—	—	●	—	●	—	—
Portogram	(99)	—	—	—	—	●	●	●	S
Pye	(72, 180)	●	●	●	●	●	●	●	A
R.G.D.	(37)	—	—	—	—	●	●	●	—
Radiomobile	(42)	—	—	—	—	—	—	—	A
Regentone	(59)	●	—	—	—	●	●	—	—
Roberts	(96)	●	—	—	●	—	—	—	—
Romac	(88)	—	—	—	●	—	●	—	A
Simon	(213)	●	—	—	—	—	—	—	—
Sobell	(23, 24)	●	—	—	—	●	●	●	—
Trix	(101)	—	—	—	—	●	—	—	—
Ultra	(78)	●	—	●	—	—	—	—	—
Vidor	(69)	●	—	●	●	—	●	—	—

A, Car radio; C, Communications receivers; F, F.M. receivers; K, Receiver kits; S, Schools receivers; T, Trawler sets.

TEST AND MEASURING GEAR: Including Signal Generators and Test Sets

FIRM	(Stand)	Indicating instruments	Multi-range sets	Bridges and accessories	Valve voltmeters	Test sets	Signal sources	Oscilloscopes	Servicing tools and materials
A.W.F.	(203)	—	—	—	—	—	—	—	●
Advance	(209)	—	—	—	—	—	●	—	—
Airmec	(156)	●	—	●	●	●	●	●	—
Amplion	(20)	—	●	—	—	—	—	—	—
Avo	(85)	—	●	●	●	●	●	—	—
B.S.R.	(81)	—	—	—	—	●	●	—	—
Bulgin	(1)	—	—	—	—	—	—	—	●
Burndept	(172)	—	—	—	—	●	●	—	—
Cossor	(35)	—	—	—	—	—	—	●	—
Dynatron	(2)	—	—	—	—	—	—	●	—
E.M.I.	(67)	—	—	●	—	●	●	●	●
E.R.I.C.	(181)	—	—	—	●	—	—	—	—
Eddystone	(182)	●	—	—	—	—	—	—	●
Eelex	(T3)	—	—	—	—	—	—	—	●
Ekco	(58,153)	—	—	—	—	—	T	—	●
Franklin	(204)	—	—	—	—	—	—	—	●

FIRM	(Stand)	Indicating instruments	Multi-range sets	Bridges and accessories	Valve voltmeters	Test sets	Signal sources	Oscilloscopes	Servicing tools and materials
G.E.C.	(38,175)	—	—	—	—	—	—	●	—
Gamma	(4)	—	—	—	—	—	T	—	—
Hazlehurst	(205)	—	—	—	—	●	—	—	—
Hunt	(17)	—	—	●	—	—	—	—	—
Kerry's	(T1)	—	●	—	—	—	—	—	—
Marconi Inst.	(154)	—	—	●	●	●	●	●	—
Metrovick	(179)	—	●	—	—	—	—	●	—
Mullard	(36,176,210)	—	—	—	●	—	—	●	—
Murphy	(56,160)	—	—	—	—	●	—	—	—
Norman	(T6)	—	—	—	—	—	—	—	●
Pye	(72,180)	—	—	—	—	—	T	—	—
Qualrad	(202)	—	—	—	—	—	—	—	●
Servisol	(216)	—	—	—	—	—	—	—	●
Taylor	(16)	●	●	●	●	●	●	●	—
W.B.	(77)	—	—	—	—	●	—	—	—
Weston	(219)	●	●	—	—	●	—	—	—

T. Television Signal Source.

World Radio History

ACCESSORIES: Including Materials, Valves and Non-electronic Rectifiers

FIRM (Stand)	Aerials: Broadcast	Aerials: Television & E.H.F.	Aerials: Anti-interference	Aerials: Car	Valves	C.R. tubes	Photocells	Metal rectifiers	Crystal valves	Time switches	Batteries	Power units	Interference suppressors	Magnets	Magnetic materials	Wire & cable	R.F. cable	Insulants	Solder	Television pre-amps.	Television lenses
Acrylite ... ... (164)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●
Aerialite ... ... (62)	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	●	●	—	—	—	—
Amplion ... ... (20)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
Antiference ... ... (64)	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—
B.I. Callender's... ... ... (55)	●	—	●	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	—	—	—
B.T.H. ... ... (178)	—	—	—	—	●	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—
Belling-Lee ... ... (25)	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	—	●	—	—	—	—
Brimar ... ... (60)	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bulgin ... ... (1)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—
Concordia ... ... (5)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	—	—	—
Cossor ... ... (35)	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dubilier ... ... (82)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—
Chloride ... ... (19)	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
E.M.I. ... ... (67)	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eddystone ... ... (182)	—	●	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
Ediswan ... ... (47)	—	—	—	—	●	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ekco ... ... (58, 153)	—	●	—	●	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Electron ... ... (98)	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Erie ... ... (86)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—
Etronic ... ... (68)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—
Ever Ready ... ... (46)	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Franklin ... ... (204)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	●	—	●	●	—	—
G.E.C. ... ... (38,175)	—	—	—	—	●	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Houghton & Osborne ... (93)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—
Kerry's ... ... (T1)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
Magnavista ... ... (10)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●
Marconiphone ... ... (48)	—	—	—	—	●	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Metrovick ... ... (179)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
Mullard ... ... (36, 176, 210)	—	—	—	—	●	●	●	—	—	—	—	—	—	●	●	—	—	—	—	—	—
Multicore ... ... (83, 84)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—
Oldham ... ... (218)	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—
Qualrad ... ... (202)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—
Radiomobile ... ... (42)	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rola ... ... (87a)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Rota-Time ... ... (103)	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Scott ... ... (201)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Scott Wire ... ... (8)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—
Standard ... ... (173)	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—	●	—	—	—	—
Telcon ... ... (30)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	●	—	—	—
Vidor ... ... (69)	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—
W.B. ... ... (77)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—
Wearite ... ... (63)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
Westinghouse ... ... (177)	—	—	—	—	—	—	●	●	—	—	—	●	—	—	—	—	—	—	—	—	—
Wolsey ... ... (13)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

SCIENTIFIC, INDUSTRIAL AND MEDICAL APPARATUS: Equipment for Applied Electronics

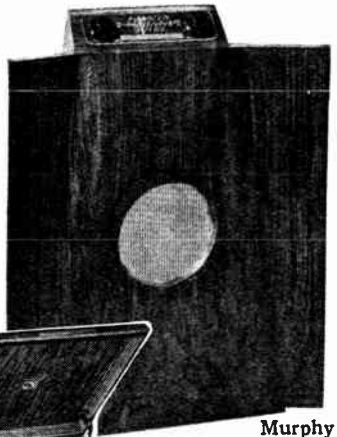
FIRM (Stand)	Radio heaters	Electronic meters	Control devices	Counters	Medical app.	Hearing aids	Computers	Magnetic amplifiers
Acos ... ... (7)	—	●	—	—	—	—	—	—
Airmec ... ... (156)	—	●	●	●	—	—	●	●
Auratone ... ... (T16)	—	—	—	—	—	●	—	—
B.S.R. ... ... (81)	—	●	—	—	—	—	—	—
B.T.H. ... ... (178)	●	●	●	—	—	—	—	—
Belclere ... ... (3)	—	—	—	—	●	●	—	—
Cossor ... ... (35)	—	—	—	—	●	—	—	—
Dynatron ... ... (2)	—	●	—	●	—	—	—	—
Ekco ... ... (58,153)	—	●	—	●	—	—	—	—
G.E.C. ... ... (38,175)	—	●	—	—	—	—	—	—
K.B. ... ... (65)	—	—	—	—	—	●	—	—
Marconi Inst.... ... (154)	—	●	—	●	●	—	—	—
Metrovick ... ... (179)	●	—	—	—	—	—	—	—
Murphy ... ... (56,160)	●	—	—	—	—	—	—	—
Ossicaide ... ... (170)	—	—	—	—	—	●	—	—
Taylor ... ... (16)	—	●	—	—	—	—	—	—

TRANSMITTERS: Including Radar and Low-power Transmitter/Receivers

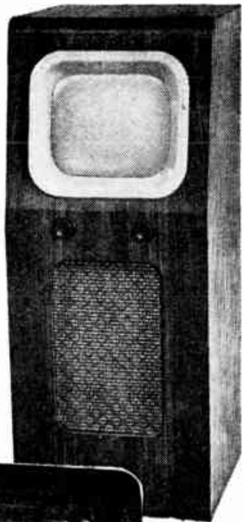
FIRM (Stand)	Broadcasting	Point-to-point	Television	Airport	Airborne	Marine	Mobile V.H.F.	Radar
B.T.H. .. .. (178)	—	—	—	—	—	—	—	●
Ekco ... ... (58,153)	—	—	—	●	●	—	●	●
G.E.C. ... ... (38,175)	—	●	—	—	●	—	●	●
Marconi ... ... (174)	●	●	●	●	●	●	●	●
Metrovick ... ... (179)	—	—	—	—	—	—	—	●
Mullard ... (36,176,210)	—	—	—	—	—	●	●	—
Murphy ... (56,160)	—	—	—	●	●	—	●	●
Pye ... ... (72,180)	—	—	●	—	—	●	●	—
Romac ... ... (88)	—	—	—	—	●	—	—	—
Standard ... ... (173)	●	●	—	—	—	—	—	—
W.B. ... ... (77)	—	—	—	—	M	—	—	—

M, Meteorological.

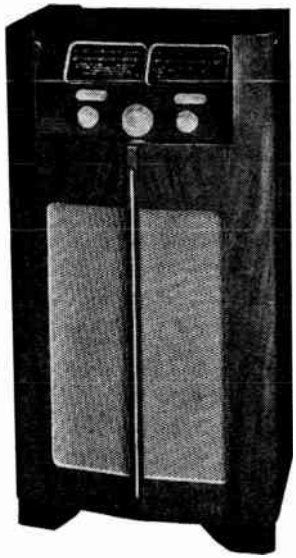
World Radio History



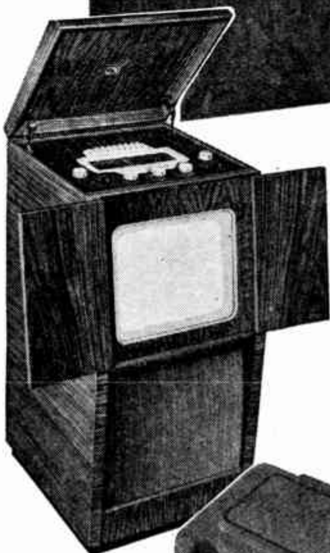
Murphy baffle type receiver, Model A146C.



(Below) Pye Model D18T television console.

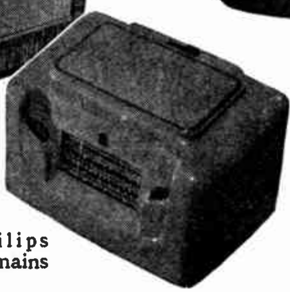


McMichael Model 492 console a.c. receiver.

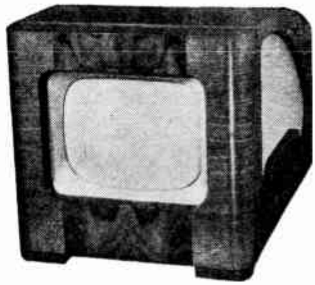


H.M.V.1851 television receiver with 15-in tube and all-wave set.

Bush DAC90 mains portable.



(Right) Philips Model 291U mains portable.

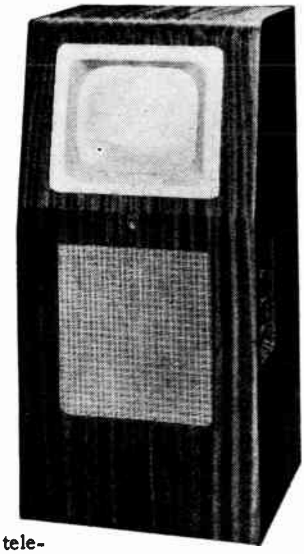


Baird "Everyman" television receiver.

Invieta Model 55 portable (" Twin-victa ").

Cossor 914 television set with 10-in tube and all-wave broadcast receiver.

Vidor a.c./battery attaché portable.



Ekco TSC93 television console.

World Radio History

COMPONENTS : Excluding Accessories and Sub-Assemblies

FIRM (Stand)	Capacitors: Fixed	Capacitors: Variable	Capacitors: Trimmers	Resistors: Non-ohmic	Resistors: Fixed	Resistors: Fixed high-stability	Resistors: Fixed wire-wound	Resistors: Variable	Switches	Coils, R.F.	Transformers, Mains	Transformers, Audio	Plugs, sockets, connectors	Chassis fittings (valveholders, etc.)	Cabinets, racks, chassis	Dials, drives, knobs	Relays	Vibrators	Television scan. coils	Television E.H.T. units
Advance ... ... (209)	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—
Aerialite ... ... (62)	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—
Antiference ... ... (64)	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—
B.S.R. ... ... (81)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
Belling-Lee ... ... (25)	—	—	—	—	—	—	—	—	—	—	—	—	•	•	—	—	—	—	—	—
B. I. Callender's ... ... (55)	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brimar ... ... (60)	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brit. Moulded Plastics ... ... (22)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—
Bulgin ... ... (1)	•	—	•	—	•	—	•	•	•	•	—	•	•	•	—	•	•	•	—	—
Burndept ... ... (172)	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—
Celestion ... ... (87)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
Dubilier ... ... (82)	•	—	•	—	•	•	•	•	—	—	—	—	—	—	—	—	—	—	—	—
E.R.I.C. ... ... (181)	—	—	—	—	—	—	—	—	—	—	•	•	—	—	—	—	—	—	—	—
Eddystone ... ... (182)	—	•	•	—	—	—	—	—	—	•	—	—	•	•	•	•	—	—	—	—
Eelex ... ... (T3)	—	—	—	—	—	—	—	—	—	—	—	—	•	•	—	—	—	—	—	—
Erie ... ... (86)	•	—	•	—	•	•	•	•	—	—	—	—	—	—	—	—	—	—	—	—
Franklin ... ... (204)	•	•	•	—	•	—	•	•	•	•	•	•	•	•	—	•	—	—	—	—
Goodmans ... ... (6)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	•	—	—	—	—	—
Grampian ... ... (90)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	•	—	—	—	—	—
Haynes ... ... (9)	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	•	•
Hazlehurst ... ... (205)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•
Houghton & Osborne ... ... (93)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—
Hunt ... ... (17)	•	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Imhof ... ... (89, 183)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—
Lectrona ... ... (157)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
Metrovick ... ... (179)	—	—	—	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mullard ... ... (36, 176, 210)	•	—	•	•	—	•	—	—	—	—	—	—	•	—	—	—	—	—	•	•
Nettlefolds ... ... (185)	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—
Norman ... ... (T6)	—	—	—	—	•	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
Polar ... ... (212)	—	•	•	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—
Pye ... ... (72, 180)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—
Qualrad ... ... (202)	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—	—
Rola ... ... (87a)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
T.C.C. ... ... (75)	•	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Taylor ... ... (16)	—	—	—	—	—	—	•	•	•	—	—	—	—	—	—	•	—	—	—	—
Truvox ... ... (18)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—
W.B. ... ... (77)	—	—	—	—	—	—	—	•	•	—	•	•	—	•	—	—	—	—	—	—
Wearite ... ... (63)	—	—	—	—	—	—	—	—	•	•	•	•	—	—	—	—	—	•	—	—
Weston ... ... (219)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—
Wharfedale ... ... (215)	—	—	—	—	—	—	—	—	—	—	—	•	—	—	—	—	—	—	—	—

SOUND REPRODUCING EQUIPMENT : Audio-Amplifiers and Electro-Acoustic Apparatus

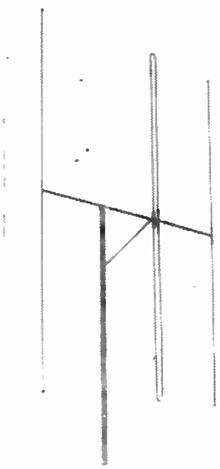
FIRM (Stand)	Microphones	Pickups	Amplifiers	Loudspeakers	Recorders	Electric gramophones	Gram. motors	Record players	Intercom. sets
Ace ... ... (21)	—	—	—	—	—	—	—	•	—
Acos ... ... (7)	•	•	—	—	—	—	—	—	—
Acoustical Mfg. (91)	—	—	•	•	—	—	—	—	—
Airmec ... ... (156)	—	—	—	—	—	—	—	—	•
Amplion ... (20)	—	•	—	•	—	—	—	—	—
B.S.R. ... ... (81)	•	—	•	—	D	—	—	—	•
Bafflette ... (49)	—	—	—	•	—	—	—	•	—
Celestion ... (87)	—	—	—	•	—	—	—	—	—
Collaro ... ... (61)	—	•	—	—	—	•	•C	—	—
Connoisseur ... (207)	•	•	•	—	D	—	•	•	—
Dallas ... ... (T8)	—	—	—	—	—	•	—	•	—
Decca ... ... (41)	—	•	—	—	—	•	—	—	—
Dynatron ... (2)	—	—	•	—	—	—	—	—	—
E.M.I. ... ... (67)	•	—	•	•	—	—	—	—	—
E.R.I.C. ... ... (181)	—	•	•	•	—	•	•	•	•
Eddystone ... (182)	—	—	—	•	—	—	—	—	—
Ediswan ... (47)	—	•	—	•	—	—	—	—	—
G.E.C. ... (38,175)	•	—	•	•	M	—	—	—	—
Garrard ... (79)	—	•	—	—	—	—	•C	•	—
Goldring ... (97)	—	•	—	—	—	—	—	—	—
Goodmans ... (6)	—	—	—	•	—	—	—	—	—
Grampian ... (90)	•	—	•	•	D	—	—	•	—
H.M.V. ... ... (57)	—	—	—	—	D	•	—	•	—
Haynes ... ... (9)	—	—	•	—	—	—	—	—	—
Judge ... ... (206)	—	—	—	—	M	—	—	—	—
K.B. ... ... (65)	—	—	—	—	M	•	—	—	—

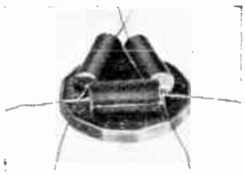
FIRM (Stand)	Microphones	Pickups	Amplifiers	Loudspeakers	Recorders	Electric gramophones	Gram. motors	Record players	Intercom. sets
Lectrona ... (208)	—	—	—	•	—	—	—	—	—
Lowther ... (165)	—	•	•	•	—	—	—	—	—
M.S.S. ... ... (76)	—	—	—	—	D	—	—	—	—
McMichael ... (70)	—	—	—	—	—	•	—	—	—
Marconiphone... (48)	—	•	—	—	—	—	—	•	—
Metrovick ... (179)	—	—	•	—	—	—	—	—	—
Mullard ... (36, 176, 210)	—	—	•	—	—	—	—	—	—
Murphy ... (56,160)	—	—	—	—	—	—	—	—	•
Peerless ... (15)	—	—	•	—	—	—	—	—	—
Plus-a-gram ... (102)	—	—	—	—	—	—	—	•	—
Portogram ... (99)	—	—	—	—	—	—	—	•	—
Pye ... (72,180)	•	—	•	•	—	—	—	•	—
R.G.D. ... ... (37)	—	—	—	•	M	—	—	•	—
Rola ... ... (87a)	—	—	—	•	—	—	—	—	—
Romac ... ... (88)	—	—	—	—	—	—	—	—	•
Simon ... ... (213)	—	—	•	—	DM	—	—	—	—
Standard ... (173)	—	—	•	—	—	—	—	—	—
Trix ... ... (101)	•	—	•	•	—	—	—	•	•
Truvox ... ... (18)	—	—	—	•	—	—	—	—	—
Vidor ... ... (69)	—	—	—	—	—	•	—	—	—
Vitavox ... ... (12)	•	—	—	•	—	—	—	—	—
W.B. ... ... (77)	•	—	•	•	—	—	—	—	—
Wearite... ... (63)	—	—	—	—	M	—	—	—	—
Wharfdale ... (215)	—	—	—	•	—	—	—	—	—

C, Record Changers; D, Disc Recorders; M, Magnetic Recorders.

World Radio History

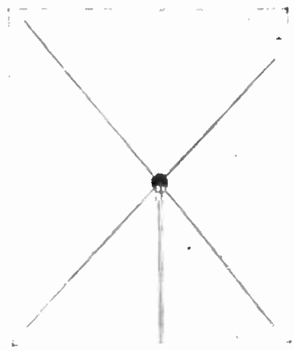
(Below): Wolsey television aerial with folded dipole.





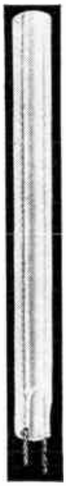
Hunt's moulded paper capacitors (up to 0.01μF) on a 3d piece.

Vitavox hand microphone.



Antiference "X" television aerial.

New Dubilier Type Q volume control with switch.



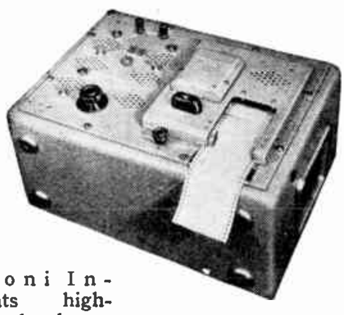
(Left) Telcon 300-Ω transmission line Type K35.

(Right) Wharfedale "Super 12" loudspeaker.

Belling-Lee anti-interference aerial kit.

Avo electronic test unit.

Erie diode filter unit.



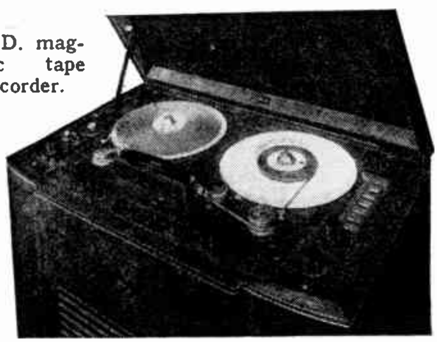
Marconi Instruments high-velocity level recorder Type TF946.

Sangamo-Weston Model S75 portable test set.

E.R.I.C. valve voltmeter with ranges up to 1,000V.

Collaro RC500 rim-drive automatic record-changer.

R.G.D. magnetic tape recorder.



NUMERICAL LIST OF STANDHOLDERS

Names and Addresses of Exhibitors : List of Demonstration Rooms

1 **A. F. Bulgin & Co.**, Bye-Pass Rd., Barking, Essex.
2 **Dynatron Radio**, Perfecta Works, Ray Lea Rd., Maidenhead, Berks.
3 **John Bell & Croyden**, 50-54, Wigmore St., London, W.1.
4 **Gamma Electronics**, Burwood Rd., Hersham, Surrey.
5 **Concordia Electric Wire & Cable Co.**, Long Eaton, Nr. Nottingham.
6 **Goodmans Industries**, Lancelot Rd., Wembley, Middx.
7 **Cosmocord**, 700, Gt. Cambridge Rd., Enfield, Middx.
8 **Scott Insulated Wire Co.**, Queensland Works, Westmoreland Rd., London, N.W.9.
9 **Haynes Radio**, Queensway, Enfield, Middx.
10 **Metro-Pex**, 38, Gt. Portland St., London, W.1.
11 **Beethoven Electric Equipment**, Chapel Lane, Sands, High Wycombe, Bucks.
12 **Vitavox**, Westmoreland Rd., London, N.W.9.
13 **Wolsey Television**, 75, Gresham Rd., London, S.W.9.
14 **Long & Hambly**, Slater St., High Wycombe, Bucks.
15 **Peerless Radio**, 374, Kensington High St., London, W.14.
16 **Taylor Electrical Instruments**, 419-424, Montrose Ave., Slough, Bucks.
17 **A. H. Hunt**, Bendon Valley, Garratt Lane, London, S.W.18.
18 **Truvox Engineering Co.**, Exhibition Grounds, Wembley, Middx.
19 **Chloride Electrical Storage Co.**, Exide Works, Clifton Junction, Nr. Manchester, Lancs.
20 **Amplion (1932)**, 230, Tottenham Court Rd., London, W.1.
21 **Ace Radio**, Tower Works, Tower Rd., London, N.W.10.
22 **British Moulded Plastics**, Avenue Works, Walthamstow Avenue, London, E.4.
23, 24 **Sobell Industries**, Langley Park, Nr. Slough, Bucks.
25 **Belling & Lee**, Cambridge Arterial Rd., Enfield, Middx.
26 **Champion Electric Corpn.**, Champion Works, Seaford, Sussex.
27 **Scophony-Baird**, Lancelot Rd., Wembley, Middx.
28 **Co-operative Wholesale Society**, 1, Balloon St., Manchester, 4, Lancs.
29 **"Wireless World,"** Dorset House, Stamford St., London, S.E.1.
30 **Telegraph Construction & Maintenance Co.**, Telcon Works, London, S.E.10.
31 **Masteradio**, 10-20, Fitzroy Place, London, N.W.1.
32 **War Office**, Whitehall, London, S.W.1.
33 **Ministry of Civil Aviation**, Ariel House, Strand, London, W.C.2.
34 **Philips Electrical**, Century House, Shaftesbury Avenue, London, W.C.2.
35 **A. C. Cossor**, Highbury Grove, London, N.5.
36 **Mullard Electronic Products**, Century House, Shaftesbury Avenue, London, W.C.2.
37 **Radio Gramophone Development Co.**, Bridgnorth, Salop.
38 **General Electric Co.**, Magnet House, Kingsway, London, W.C.2.
39 **Philco (Overseas)**, 204-6, Gt. Portland St., London, W.1.
40 **Ferguson Radio Corpn.**, 105-9, Judd St., London, W.C.1.
41 **Decca Record Co.**, 1-3, Brixton Rd., London, S.W.9.
42 **Radiomobile**, Cricklewood Works, London, N.W.2.
43 **Ferranti Ltd.**, Hollinwood, Lancs.
44 **A. J. Balcombe**, 52-58, Tabernacle St., London, E.C.2.
45 **Pilot Radio**, 31-37, Park Royal Rd., London, N.W.10.
46 **Ever Ready Co.**, Hercules Place, London, N.7.
47 **Edison Swan Electric Co.**, 155, Charing Cross Rd., London, W.C.2.
48 **Marconiphone Co.**, Blyth Rd., Hayes, Middx.
49 **Richard Allan Radio**, Baffiette House, Calendonia Rd., Batley, Yorks.
51 **Board of Trade**, I.C. House, Millbank, London, S.W.1.
52 **Dept. of Scientific & Industrial Research**, Rex House, Regent St., London, S.W.1.
53 **War Office**, Whitehall, London, S.W.1.
54 **Ministry of Supply**, Shell Mex House, Strand, London, W.C.2.
55 **British Insulated Callender's Cables**, Norfolk House, Norfolk St., London, W.C.2.
56 **Murphy Radio**, Welwyn Garden City, Herts.
57 **Gramophone Co.**, Blyth Rd., Hayes, Middx.
58 **E. K. Cole**, Ekco Works, Southend-on-Sea, Essex.
59 **Regentone Products**, Eastern Avenue, Romford, Essex.
60 **Standard Telephones & Cables**, Footscray, Sidcup, Kent.
61 **Collaro**, Ripple Works, Bye-Pass Rd., Barking, Essex.
62 **Aerialite**, Castle Works, Stalybridge, Cheshire.
63 **Wright & Weaire**, 138, Sloane St., London, S.W.1.
64 **Antiference**, 67, Bryanston St., London, W.1.
65 **Kolster Brandes**, Footscray, Sidcup, Kent.
66 **Bush Radio**, Power Rd., London, W.4.
67 **E.M.I. Sales & Service**, Blyth Rd., Hayes, Middx.
68 **Hale Electric Co.**, Talbot Rd., London, W.13.
69 **Vidor**, West St., Erith, Kent.
70 **McMichael Radio**, 190, Strand, London, W.C.2.
71 **Invicta Radio**, 79, Parkhurst Rd., London, N.7.
72 **Pye**, Radio Works, Cambridge.
73 **Admiralty**, Whitehall, London, S.W.1.
74 **Air Ministry**, London, S.W.1.
74a **General Sonic Radios**, 21-24, Shene St., London, E.C.1.
75 **Telegraph Condenser Co.**, Wales Farm Rd., London, W.3.
76 **M.S.S. Recording Co.**, Poyle Close, Colnbrook, Bucks.
77 **Whiteley Electrical Radio Co.**, Victoria St., Mansfield, Notts.
78 **Ultra Electric**, Western Avenue, London, W.3.
79 **Garrard Engineering & Mfg. Co.**, Newcastle St., Swindon, Wilts.
80 **R. N. Fitton, Ltd.**, Hutchinson Lane, Brighouse, Yorks.
81 **Birmingham Sound Reproducers**, Claremont Works, Old Hill, Staffs.
82 **Dubilier Condenser Co.**, Ducon Works, Victoria Rd., London, W.3.
83, 84 **Multicore Solders**, Mellier House, Albemarle St., London, W.1.
85 **Automatic Coil Winder & Electrical Equipment Co.**, Winder House, Douglas St., London, S.W.1.
86 **Erie Resistor**, Carlisle Rd., The Hyde, London, N.W.9.
87 **Celestion**, Ferry Works, Summer Rd., Thames Ditton, Surrey.
87a **British Rola**, Ferry Works, Summer Rd., Thames Ditton, Surrey.
88 **Romac Radio Corpn.**, The Hyde, London, N.W.9.
89 **Alfred Imhof**, 112-116, New Oxford St., London, W.C.1.
90 **Grampian Reproducers**, Hanworth Trading Estate, Feltham, Middx.
91 **Acoustical Mfg. Co.**, Huntingdon.
92 **Armstrong Wireless & Television Co.**, Warlters Rd., London, N.7.
93 **Houghton & Osborne**, Electron Works, 6, High St., Thame, Oxon.
94 **"European Radio Programme,"** 93-94, Queens Rd., Brighton, Sussex.
96 **Robert's Radio Co.**, Creek Rd., East Molesey, Surrey.
97 **Erwin Scharf**, 49, De Beauvoir Rd., London, N.1.
98 **New London Electron Works**, Boleyn Rd., London, E.6.
99 **Portogram Radio Electrical Industries**, Preil Works, St. Rule St., London, S.W.8.
100 **"Practical Wireless,"** Tower House, Southampton St., London, W.C.2.
101 **Trix Electrical Co.**, 1-5, Maple Place, Tottenham Court Rd., London, W.1.
102 **J. & A. Margolin**, 112-116, Old St., London, E.C.1.
103 **Devices**, Hydeway, Welwyn Garden City, Herts.
104 **Keith Prowse & Co.**, 159, New Bond St., London, W.1.
151 **British Broadcasting Corpn.**, Broadcasting House London, W.1.
152 **Radio Communication and Electronic Engineering Assoc.**, 59, Russell Sq., London, W.C.1.
153 **E. K. Cole**, Ekco Works, Southend-on-Sea, Essex.
154 **Marconi Instruments**, Long Acres, St. Albans, Herts.
155 **"Electronic Engineering,"** 28, Essex St., London, W.C.2.
156 **Airmec Laboratories**, Cressex Works, High Wycombe, Bucks.
157 **Lee Products (G.B.)**, 90, Great Eastern St., London, E.C.2.
158 **William Levene**, 30a, Sackville St., London, W.1.
159 **Martins Bank**, Lombard St., London, E.C.3.
160 **Murphy Radio**, Welwyn Garden City, Herts.
161 **Midland Bank**, Poultry, London, E.C.2.
162 **Lloyds Bank**, London, E.C.3.
163 **National Provincial Bank**, 15, Bishopsgate, London, E.C.2.
164 **Motor & Air Products**, 3, St. James' Square, London, W.1.
165 **Lowther Mfg. Co.**, St. Mark's Rd., Bromley, Kent.
166 **Barclays Bank**, 54, Lombard St., London, E.C.3.
167 **Westminster Bank**, 41, Lothbury, London, E.C.2.
168 **"Television Weekly"** 50, Old Brompton Rd., London, S.W.7.
169 **Econasign Co.**, 92, Victoria St., London, S.W.1.
170 **V. A. Foot**, 1, Upper Richmond Rd., London, S.W.15.
171 **British Railways Executive**, 222, Marylebone Rd., London, N.W.1.
172 **Burndept**, West St., Erith, Kent.
173 **Standard Telephones & Cables**, Connaught House, Aldwych, London, W.C.2.
174 **Marconi's Wireless Telegraph Co.**, Marconi House, Chelmsford, Essex.
175 **General Electric Co.**, Magnet House, Kingsway, London, W.C.2.
176 **Mullard Electronic Products**, Century House, Shaftesbury Ave., London, W.C.2.
177 **Westinghouse Brake & Signal Co.**, 82, York Way, London, N.1.
178 **British Thomson-Houston Co.**, Rugby, Warwicks.
179 **Metropolitan Vickers Electrical Co.**, Trafford Park, Manchester, 17, Lancs.
180 **Pye**, Radio Works, Cambridge.
181 **Electrical & Radiological Instrument Co.**, 54-56, Church Rd., London, W.3.
182 **Stratton & Co.**, Eddystone Works, Alvechurch Rd., Birmingham, 31, Warwicks.
183 **Alfred Imhof**, 112-116, New Oxford St., London, W.C.1.
185 **Guest, Keen & Nettlefolds**, Box 24, Heath St., Birmingham, 18, Warwicks.
201 **Geo. L. Scott & Co.**, Cromwell Rd., Ellesmere Port, Cheshire.
202 **Qualrad Products**, 3, Lammas Rd., Ham, Richmond, Surrey.
203 **A.W.F. Radio Products**, Borough Mills, Manchester Rd., Bradford, Yorks.
204 **Franklin Electric Co.**, 27a, Howland St., London, W.1
205 **Hazlehurst Designs**, 186, Brompton Rd., London S.W.3.
206 **Judge Industries**, 676-8, Romford Rd., London, E.12
207 **A. R. Sugden & Co.**, Well Green Lane, Brighouse Yorks.
208 **Acoustic Products**, 50-58, Britannia Walk, City Rd., London, N.1.
209 **Advance Components**, Back Rd., Shernhall St., London, E.17.
210 **Mullard Electronic Products**, Century House, Shaftesbury Ave., London, W.C.2.
211 **British Radio Equipment Manufacturers' Assoc.**, 59, Russell Sq., London, W.C.1.
212 **Wingrove & Rogers**, Polar Works, Old Swan, Liverpool, 13, Lancs.
213 **Simon Sound Service**, Recorder House, 48-50, George St., London, W.1.
214 **British Radio Valve Manufacturers' Assoc.**, 16, Jermyn St., London, S.W.1
215 **Wharfedale Wireless Works**, Bradford Rd., Idle, Bradford, Yorks.
216 **Servisol**, 14, North John St., Liverpool, 2, Lancs.
217 **Bernards**, The Grampians, Western Gate, London, W.6.
218 **Oldham & Son**, Denton, Manchester, Lancs.
219 **Sangamo Weston**, Great Cambridge Rd., Enfield, Middx.
220, 221 **"Daily Mail,"** Northcliffe House, London, E.C.4.
301 **General Post Office**, London, E.C.1.
T 1 **Kerry's (G.B.)**, Warton Rd., London, E.15.
T 2 **J. M. Webber & Co.**, 244, Tottenham Court Rd., London, W.1.
T 3 **J. J. Eastick & Sons**, 12, Errol St., London, E.C1.
T 4 **"Wireless & Electrical Trader,"** Dorset House, Stamford St., London, S.E.1.
T 5 **Winter Trading Co.**, 6, Harrow Rd., London, W.2.
T 6 **Norman Rose (Electrical)**, 53, Hampstead Rd., London, N.W.1.
T 7 **Lugton & Co.**, 209-212, Tottenham Court Rd., London, W.1.
T 8 **John E. Dallas, & Sons**, Dallas Building, Clifton St., London, E.C.2.
T 9 **Radio Wholesalers' Federation**, 58, Gordon Square London, W.C.1.
T10 **Albion Electric Stores**, 125, Albion St., Leeds, Yorks.
T11 **London & Provincial Factors**, 230, Tottenham Court Rd., London, W.1.
T12 **Brown Brothers**, Great Eastern St., London, E.C.2.
T13 **"Pianomaker, Music Seller & Radio Retailer,"** 13, St. George St., London, W.1.
T14 **"Electrical and Radio Trading,"** 96, Long Acre, London, W.C.2.
T15 **Hobday Brothers**, 21-27, Great Eastern St., London, E.C.2.
T16 **Aurotone Laboratories**, 43, Grays Inn Rd., London, W.C.1.
T16a **Electrical Industries Benevolent Association**, 32, Old Burlington St., London, W.1.
T17 **L.E.S. Distributors**, 15-16, Alfred Place, Tottenham Court Rd., London, W.C.1.
T18 **Petter Radio & Electrical Supplies**, 201-9, Forest Road, London, E.17.
T19 **Shannons & Bishop**, 182, Wardour St., London, W.1.
T20 **Horace Dibben**, Upper Banister St., Southampton, Hampshire.

BROADCAST AND TELEVISION DEMONSTRATION ROOMS

Acos	D 10	Goodmans	D 6	Pilot	D 9
Acoustical Mfg.	D 23	H.M.V.	D 19	Pye	D 25
Alba	D 18	Invicta	D 8	R.G.D.	D 17
Co-op. W. S.	D 27	Kolster-Brandes	D 29	Scophony-Baird	D 11
Cossor	D 24	M.S.S.	D 4	Sobell	D 5
Decca	D 13	McMichael	D 7	Ultra	D 30
Ekco	D 22	Marconiphone	D 20	Vidor	D 3
Ferguson	D 1	Mullard	D 2	Vitavox	D 28
Ferranti	D 12	Murphy	D 15	W.B.	D 16
G.E.C.	D 26	Philips	D 14	Wearite	D 21

World Radio History

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

NEW AERIALS

By the time this page is being read, Radiolympia will be open and we sincerely hope to meet many of the readers of "The Belling-Lee Page" on our stand No. 25, where we will be showing our new range of aerials and many types making use of ingeniously engineered light alloy die castings for fixing brackets, etc. The light-weight range will be shown for the first time, symbolised by the illustration Fig. I on this page. This new 'H' with its cranked arm is introduced for use in locations other than fringe areas, or where interference is severe in "close-in" areas. All types are available for London and Midland frequencies, and in addition, those normally sold complete with cable, such as the "Doorod" are now available, suitable for either balanced or unbalanced receiver inputs.

Two entirely new dipoles are introduced in this page for the first time, the "Twinrod" Fig. II and the "Viewflex" Fig. III.

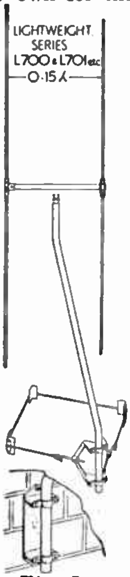


Fig. I

The New "Twinrod" T.V. Aerial for windowsill mounting.

This new dual purpose aerial may be used either for the reception of broadcast or television programmes. As a broadcast aerial it will give better results than the "Winrod" and much better results than any indoor aerial.

When used for television, it is excellent and convenient, provided always that its use is confined to locations not greatly in excess of fifteen miles depending upon the absence of metal-framed buildings, etc., close to and between it and the television transmitter. In favourable conditions this distance would be greatly exceeded. It is a fully dimensioned half wave dipole and must not be confused with compressed dipoles and therefore should give by comparison a better picture.

The "Twinrod" might be described as the marriage of the "Winrod" and the "Doorod." It is the obvious development to use the now well-known and very popular "Doorod" as an outdoor aerial suitable for mounting on a window sill or gutter board. The upper element is rigid and like the "Winrod" is designed to stand away from the building. The lower element is a flat flexible which, for best results, should be allowed to hang straight down, being stapled to the wall to prevent swaying in the wind, which would cause picture flutter and would soon impair the insulator. For absolute optimum results this flexible element should be "stood off" the wall by a few inches, but this is by no means essential. Where it is not practicable or desirable to let the flexible element hang straight down, it may be bent over, to run under the window ledge, but if at right-angles from the rigid element, there will be an appreciable loss in signal, but even then there should be adequate pick-up if the location is normal, and the distance not greater than 5—8 miles from the transmitter.

At the centre insulator there will be found a metal strap. The position of this decides whether or not the aerial is adjusted for television or broadcast reception. It cannot normally be used for both at one time. Each "Twinrod" is supplied with eighteen feet of coaxial feeder which is sufficient for most normal rooms. This may be lengthened within reason.

The "Viewflex" Indoor T.V. Aerial.

This is revolutionary in design, but technically it is as efficient as a "Doorod," or in fact any other type of indoor television aerial. It may not be found so convenient to fix as the "Doorod," but it will only require the household steps so as to make the full use of height. In the "Viewflex" both elements of the dipole are flat flexible conductors with polythene insulation. It should be fixed with as much of it as possible, vertical. Where the height of the room is such that it cannot all be vertical then the lower element may be bent at right angles without too much loss in signal.

Fig. III

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

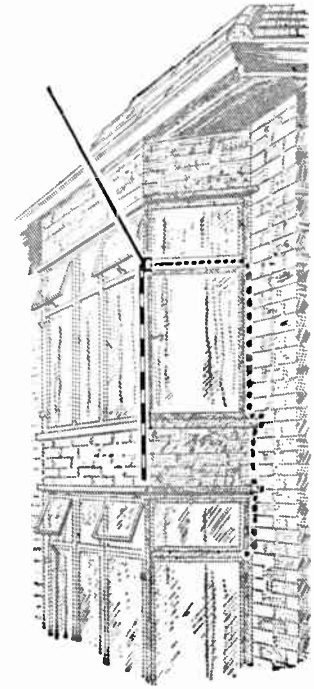


Fig. II

Mobile Research Unit.

Readers of this page will be interested to know that our Mobile Research Unit will be sited at Radiolympia and will be open for visitors inspection.

*1. **"Viewrod"** light-weight series (Registered patents applied for) 'H' type 0.15 wave spacing ⅜ in. dia. elements
L.700 London } with suffixes
L.701 Midland } below
/C for own mast **45/-.**
/W mast wall fixing **70/-.**
/L mast, 1 lashing, **84/-.**

*2. **"Twinrod"** window mounting (Registeration & patents applied for)
L.694 London } with suffixes
L.695 Midland } below
/1 with coaxial feeder, **32/6.**
/2 with balanced feeder, **29/-.**

*3. **"Viewflex"** indoor T.V. aerial (Registeration & patents applied for)
L.696 London } with suffixes
L.697 Midland } below
/1 with coaxial feeder, **21/-.**
/2 with balanced feeder, **17/6.**
Lightweight dipoles from **25/-.**
Indoor T.V. Aerials from **17/6.**
Senior range T.V. aerials from **57/6.**
Multi element arrays. **210/-**

World Radio History

MEET US AT
RADIOLYMPIA
SEPT 28 – OCT 8
STAND No. 77

UNRIVALLED TECHNICAL FACILITIES,
UNRIVALLED PRODUCTION RESOURCES,
MAKE POSSIBLE
THIS GREAT RANGE

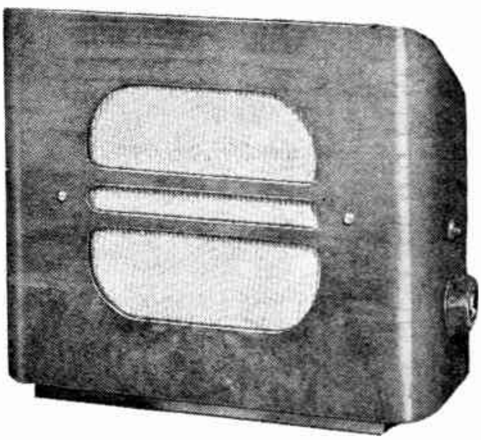
★

12 In. chassis.
Flux density 13,500 gauss.
Pole diameter $1\frac{1}{2}''$.
Gap .050″
Handling capacity 15 watts.
Price: £7.7.0. with tranformer

Every part of every W/B speaker—cone, magnet, speech coil assembly, cabinet—is made within the one organisation. The close correlation of design thus made possible is part of the reason for the typical performance. High fidelity large units, diffusers, industrial and relay speakers, extension speakers, each in their class give outstanding reproduction and unmatched reliability.

★

" Baffle " extension speakers for any set from 39/6



W B *Stentorian*

WHITELEY ELECTRICAL RADIO CO. LTD · MANSFIELD · NOTTS

WORLD OF WIRELESS

Television at Home and Abroad ✦ Cable and Wireless Changes

Anglo-French Television

FURTHER details of the recent meeting of the C.C.I.R. at which the question of European television standards was discussed, resulting in the French decision to adopt 405 lines, have been issued by the International Broadcasting Organization.

The Study Group of the C.C.I.R. responsible for investigating this vexed question of television standards met in Zurich in July. The countries represented were: Austria, Belgium, Czechoslovakia, Denmark, France, Italy, Netherlands, Sweden, Switzerland and the United Kingdom. It is noteworthy that in addition to these European administrations the United States was represented and among the manufacturing companies present was the R.C.A.

In order to facilitate the discussion of standardization, a questionnaire had been circulated to countries represented and replies were considered. The two bands under consideration were the 41 to 68 Mc/s and 174 to 216 Mc/s.

It was concluded that world standardization, although desirable, was not possible in these bands, but would be practicable in the 470 to 960-Mc/s band.

When considering what was regarded as the most suitable number of lines per frame, the French and U.K. delegations stated that they intended to unify their existing "medium" definition systems on 405 lines and proposed the establishment of a high definition system on 819 lines operating in the 174 to 216-Mc/s band. It was further stated by France and the U.K. that a change to 525 lines, recommended by America, or even 625, recommended by other European countries, would not be justifiable.

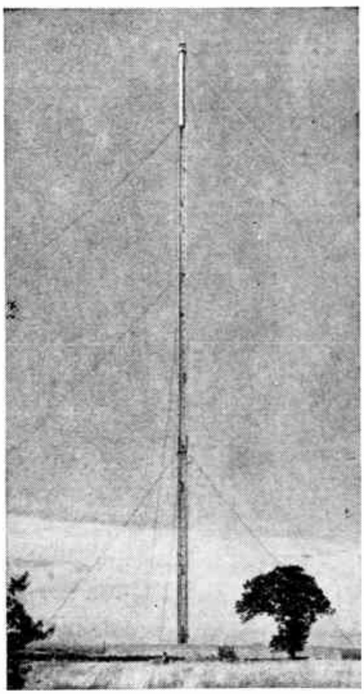
International Television

DELEGATES to the International Television Convention and Exhibition held in Milan in the middle of September had the opportunity of comparing British, French and American television gear.

Large-screen 625-line equipment, working on a closed circuit, was demonstrated jointly by Marconi's and Cinema Television. The screen used measured 16 × 12.5 feet. The French delegation demonstrated 819-line equipment and the Americans 525-line gear. The British 405-line standard was not shown. L. H. Bedford of Marconi's was one of the British delegates and addressed the Convention.

U.N. Radio

IN preparation for the installation of communications equipment in the new United Nations headquarters, a firm of American consultants is compiling an analysis of available equipment, including British. Manufacturers are therefore asked to submit catalogues and descriptive matter of any of the following equipment: television gear, including cameras, amplifiers, control gear, monitors and tele-ciné equipment; and broadcast studio equipment, including control consoles, amplifiers, loudspeakers, microphones, turntables and disc, wire and tape recorders. Material should be sent to Dr. Walter Duschinsky, c/o Van Doren-Nowland & Schladermundt, 205, East 42nd St., New York, 17.



MIDLAND TELEVISION.—The completed mast of the Sutton Coldfield television station which has been installed by B.I. Callender's Cables. The topmost section, which is tubular, is slotted for F.M. transmissions.

Midland Television

COMPLAINTS have been made in the Midland area regarding the inability of television set owners to receive the signals from the B.B.C. pilot transmitter, which, as mentioned in August, are being radiated from Birmingham, Wolverhampton and Coventry.

It is stressed by the B.B.C. that the signals are intended to help the radio trade only so that dealers within the limited range of the pilot transmitter, using aerials specially aligned for the purpose, can tune in the transmissions and thereby test receivers and get used to adjusting them. Aerials erected for members of the public are, of course, orientated on the Sutton Coldfield transmitter, which is not yet operating. Some private viewers are receiving the signals because they are favourably situated in relation to the site of the temporary transmitter.

Commonwealth Telegraphs Act

SOME interesting details of the events leading up to the passing of this Act, which was recently given the Royal Assent, are outlined in the August issue of our contemporary, the *Post Office Telecommunications Journal.*

The two main effects of the Act are:—(a) the setting up of the Commonwealth Telecommunications Board and (b) the P.M.G. is empowered to take over all the assets and staff of Cable and Wireless Ltd. within the U.K. This transfer will take place on April 1st next year but C. & W. will continue as a U.K. limited liability company operating radio and cable telegraph networks in the colonies and in foreign countries. Of the companies staff of 5,000 in this country, about 90% will be absorbed by the Post Office; the remainder will be retained by the company at its headquarters.

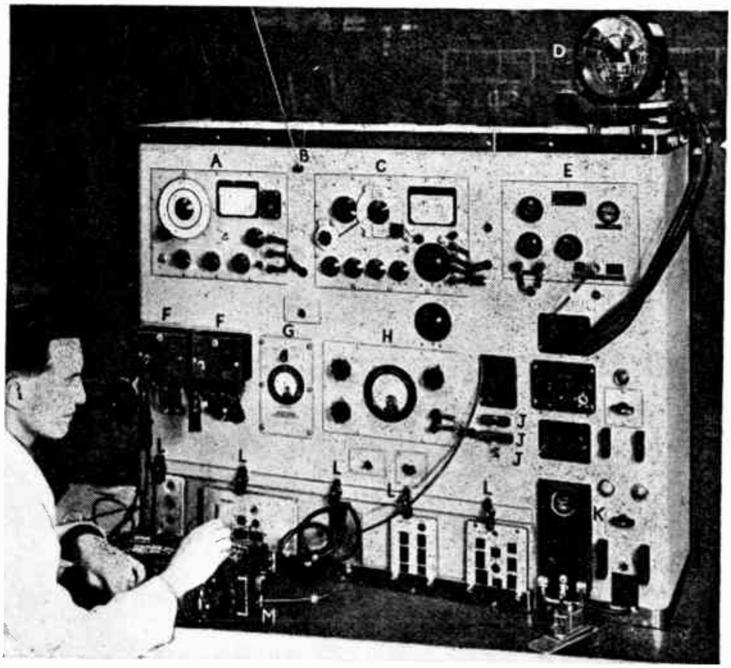
Aircraft Radio

IN order to expedite the testing of and fault locating in aircraft radio apparatus at airports, an equipment tester simulating the conditions under which the sets are used in the aircraft has been designed and produced jointly by Marconi's Wireless Telegraph Company and Marconi Instruments. Described as the type OA216, it is a comprehensive collection of test ap-

World Radio History

World of Wireless—
paratus incorporated in one steel cabinet measuring 4ft wide, 3ft high and 16in deep.

Although it has been specifically designed for testing the Marconi range of aircraft sets, intercom systems and radio compass, it is sufficiently flexible to enable any other make of apparatus to be dealt with expeditiously. The principal items in the assembly can be identified by the lettering on the accompanying illustration and the inscription below it.

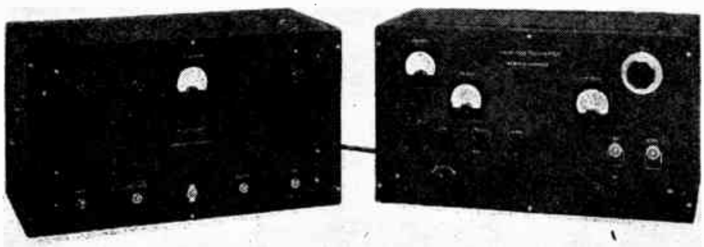


TYPE OA216 Marconi aircraft radio tester. The principal items are as follows :— A—beat frequency a.f. oscillator, C—signal generator, D—radio compass loop, E—direction finder test set, G—artificial aerial for transmitters, H—output meter, J—artificial aerials for receivers, K—l.t. voltage regulator.

Two-Metre Transmitter

A CRYSTAL-controlled transmitter for use on the 145Mc/s band has been introduced by Labgear, Willow Place, Fair Street, Cambridge, for amateur use. The design is based on orthodox and well-tried practice, and it should give reliable and efficient service.

It is designed to take three 8Mc/s crystals and selection of the desired final frequency is effected by a panel switch. The crystal oscillator is an EF50 and this is followed by two frequency multipliers using QVO4-7 valves. The output stage is a push-pull 829B beam tetrode. Anode modulation is employed and sufficient a.f. gain is provided to permit the use of a crystal microphone.



AMATEUR'S SET.—The two units comprising the Labgear 145 Mc/s amateur transmitter referred to above.

OBITUARY

It is with regret we record the death of **Captain A. G. D. West**, managing director of Cinema Television, as the result of a climbing accident in Switzerland on August 22nd. He joined the B.B.C. in 1923 at the age of 26 as asst. chief engineer. In 1929 he left the B.B.C. to become chief of design and development for the Gramophone Co. His first appointment in television came in 1933 when he became technical director of Baird Television (now Cinema Television). Captain West was a founder member of the International Television Committee and was this year appointed vice-president. He was to have taken a prominent part in the international television exhibition which opened in Milan on September 11th. He was president of the British Kinematograph Society from 1938 to 1946.

PERSONALITIES

Arthur L. Budlong, who has been assistant secretary of the American Radio Relay League for twenty-three years, has been appointed secretary and general manager in succession to the late Kenneth B. Warner.

G. Darnley-Smith, who has been on the Board of Cinema Television for some time, has been appointed managing director in succession to the late Captain A. G. D. West. He is also managing director of the associated company, Bush Radio, and was chairman of the R.I.C. in 1946.

Alan Knight has joined Philips Electrical as car radio manager. Prior to entering the radio industry some seventeen years ago, he was in the export department of General Motors of New York. During the war he was in the Ministry of Production.

H. J. Leak, director of the company bearing his name, has gone to America to exhibit audio amplifiers at the Audio Fair which is being held in New York from October 27th to 29th. The show is sponsored by the Audio Engineering Society of America.

J. T. Moore, who has been with the Philips organization since 1928, has been appointed Midlands television executive by the company.

Louis G. Pacent, president and technical director of Pacent Engineering Corp., New York, has been appointed consulting engineer by Plessey International of Ilford.

H. M. Thorne has been appointed radio sales manager by Philips Electrical. He joined the company in 1929 and has been for some time personal assistant to H. Slater, director in charge of the radio and television side of the business.

IN BRIEF

Licences.—With increases of 40,150 "sound" licences and 7,250 television licences during July, the total at the end of the month was 11,958,250. Of this total 155,150 were for television receivers.

Radiolympia, 1951.—It is announced by the Radio Industry Council that Olympia has been booked for a session in June each year from 1951 for the National Radio Exhibition. The relative merits of an early or late summer show have been discussed for some years; the disadvantages of the latter being that it follows too soon after the

World Radio History

annual holiday period when most works are closed and, too, it interferes with autumn production plans.

American Amateurs.—New amateur regulations proposed by the American F.C.C. would, according to the A.R.R.L., amount to undesirably rigorous control of amateur transmitting activities. The A.R.R.L. has lodged with the Commission a lengthy statement by way of protest.

Electronics.—Among the courses of lectures arranged by the Dept. of Mathematics and Physics at the Polytechnic, Regent St., London, is a post-graduate course on electronics which will be held on Thursdays from 7.0 to 8.30, commencing September 29th. The first part of the course will deal with emission of electrons from solids, the second with amplifiers and oscillators and the third with ultra-high frequency techniques. The fee for Parts A or B is 12s 6d and for C 25s.

Overseas Standards.—The British Standards Institution asks us to remind manufacturers that the institution acts as the agent in this country of all overseas national standards organizations and, as such, is in a position to supply copies of Standards issued by them.

Amateurs' Examination.—The Dept. of Technology of the City and Guilds of London Institute announces that 636 of the 898 candidates passed the Radio Amateurs' Examination in May preparatory to receiving a transmitting licence. In the report of the examiners it is stated that the only question which appeared to give serious trouble was that dealing with the calculation of circuit values.

Evening Courses.—Among the courses arranged by the South-East London Technical College, Lewisham Way, S.E.4, is one of thirty lectures on r.f. and electronic measurements. It commences on October 14th at 7.0; fee £1. Another course of about thirty lectures, which commences on October 17th at 7.0 deals with the theory and design of communication networks.

Broadcasting Stations.—The fifth edition of the 88-page *Wireless World* booklet "Guide to Broadcasting Stations" is now available, price 1s 6d from booksellers and newsagents. In addition to the lists giving operating details of over 350 long- and medium-wave European stations and of some 1,300 short-wave stations of the world, it includes the European frenquencies allocated under the Copenhagen Plan which is due to come into force next March.

"Wireless World" at Radiolympia.—A range of new technical books, including some new editions and reprints, will be on view at our stand (No. 29, Grand Hall).

Sound Reproducing Equipment consisting of two 300-watt amplifiers feeding 360 loudspeakers has been installed by the G.E.C. in the Central Office of the Ministry of National Insurance at Benton, Newcastle-on-Tyne, where 7,500 are employed.

Magnetic Recording.—The latest of the series of booklets to be issued by E.M.I. containing papers read by members of the staff to learned societies is entitled "Some Fundamentals of Magnetic Recording" by E. W. Berth-Jones, B.Sc. of E.M.I. Studios. It is based on a lecture given by the author to members of the British Sound Recording Association. The booklet, priced 2s 6d, is available from the Advertising Division, E.M.I. Sales and Service, Hayes, Middx.

Radio Servicing.—Of the 153 candidates who sat for the Radio Servicing Certificate examination in May, 89 passed both the written and practical sections and 24 passed the written examination only. The exam is organized jointly by the Radio Trades Examination Board and City & Guilds.

Components Exhibition.—The seventh annual exhibition of radio components, valves and test gear organized by the Radio and Electronic Component Manufacturers' Federation, will be held at Grosvenor House, Park Lane, London, W.1, from April 17th to 19th next year.

Reunion.—We have been asked to announce that a reunion of those who worked in the Test Dept., No. 1 Signals Depot, R.A.F., West Drayton, will be held at Paxtons Head, 153 Knightsbridge, London, S.W.1, on October 8th at 7. Further information is obtainable from H. Coker, 18 Beechdale, London, N.21.

"Mechanical Handling," our associate journal, is organizing the second Mechanical Handling Exhibition which will be held at Olympia, London, from June 6th to 17th next year.

Packaging. — The first National Packaging Exhibition, sponsored by the Institute of Packaging, will be held at the City Hall, Deansgate, Manchester, from October 5th to 15th. The British Standards Institution has recently issued a revised Code of Practice for packaging—BS.1133.

Electronics Symposium.—Among the papers to be read during the electronics exhibition at the Examination Hall, Queens Square, London, W.C.1, from November 2nd to 4th, are the following: "Electronic Amplifiers," by D. L. Banks (Furzehill); "Some Recent Improvements in Electronic Measuring Techniques," by C. H. W. Brookes-Smith and J. A. Colls (Southern Instruments); and "The Measurement of Some Transient Phenomena," by Dr. H. A. Dell (Mullard). Further particulars and tickets are obtainable from the Electronics Section of the Scientific Instrument Manufacturers' Association, 17, Princes Gate, London, S.W.7.

Schools' Radio.—The Essex Education Committee recently accepted tenders for the supply of £10,000 worth of radio equipment for installation in schools during 1949/50.

Television Training School for G.E.C. dealers in the Manchester area has been opened by the company. The course of instruction, which lasts a week, includes practical work on the diagnosis and rectification of faults in television sets.

Amateur Radio.—An exhibition is being held at the Corn Exchange, Manchester, from October 21st to 23rd, in connection with the R.S.G.B. National Convention. On the first day it opens at 2.30 and on subsequent days at 11 a.m. It closes daily at 9.

Italian Television.—It is learned from an Italian correspondent that the Italian broadcasting authorities are installing both American (625-line) and French (819-line) television transmitters near Turin with a view to conducting a series of experiments before establishing a service. One of the difficulties to be overcome in establishing a service in Italy is the non-standard periodicity of the electric mains.

Benelux Exhibition.—*Wireless World* and books issued by *W.W.* are among the publications of the Associated Iliffe Press being displayed in the Century Hotel, Antwerp, during the Benelux Exhibition which closes on October 9th.

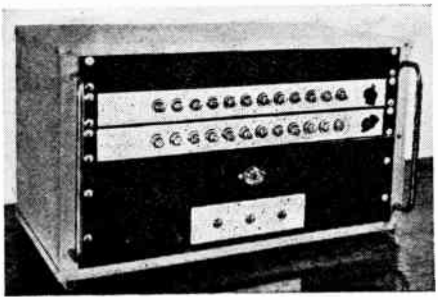
INDUSTRIAL NEWS

Electronics Centre. — Cinema-Television and Dawe Instruments have jointly opened a London showroom at 83, Piccadilly, W.1 (Tel.: Mayfair 4613). A wide range of test and measuring gear and electronic instruments is on show.

British Mechanical Productions and their associated company, the General Accessories Co., makers of Clix components, whose works are at Barton Hill Works, Maze Street, Bristol. 5, and the head office at 21, Bruton Street, London, W.1, announce that they are no longer subsidiaries of the Radio and Television Trust.

Murphy.—By the acquisition of General Radiological, Ltd., and Solus-Schall, Ltd., manufacturers of X-ray tubes and equipment, Murphy Radio has extended its interests to the electro-medical field.

Radio Heaters, Ltd., manufacturers of Radyne industrial R.F. heaters, are building a new factory at Wokingham, Berkshire. The joint managing direc-



DESIGNED FOR COUNTING and batching small articles at high speed, the type ECB144 electronic counter made by Sargrove Electronics, Effingham, Surrey, will operate in units, tens, dozens or grosses, giving visual indication of the process, and automatically repeating at the end of the chosen cycle. Maximum counting speed is 20,000 per second.

World Radio History

World of Wireless—

tors of the company, which was formed in 1945, are E. C. Stanley and C. E. Tibbs, who were previously in the industrial electronics department of Rediffusion, Ltd. (now Redifon).

A. E. Cawkell, who specializes in the design and production of electronic instruments to special order, has recently developed such apparatus as noise measuring sets, a d.c. amplifier, diathermy equipment, photometry equipment and many kinds of special-purpose amplifiers.

Aerialite is opening a new depot at 44-45, Suffolk Street, Birmingham.

Wolsey Television have opened a Midland depot at 59, Soho Hill, Birmingham, 19 (Tel.: Northern 2762 and 3493).

Sound Sales.—The London office and demonstration rooms of Sound Sales, Ltd., are now at Lloyds Bank Chambers, 125, Oxford Street, W.1 (Tel.: Gerrard 8782).

Masteradio (Australia) Pty. has been formed in Melbourne for the assembly of British Masteradio car receivers.

EXPORT

India.—Enquiries have been received by the U.K. Trade Commissioner at Madras for details of manufacturers who are able to supply dry battery or combined mains/battery receivers. Frequency coverage should be from 13 to 90 metres and 200 to 550 metres, with Indian station names marked on the dials. Manufacturers should send literature, prices and delivery dates to the Commercial Relations and Exports Dept., Board of Trade, Thames House North, Millbank, London, S.W.1, quoting reference CRE(IB) 21112/49.

Switzerland.—Control and surveillance radar equipment for use at the new Kloten airport is required by the Zurich authorities and they will be interested to receive offers from British firms. Communications should be sent direct to Radio Suisse A.G. Hauptpostegabaude, Berne.

Iran.—A report on the Iranian market for receivers has been supplied by the Commercial Counsellor at Tehran. The two main criticisms of British sets are that they are too conservative in design and seem "old-fashioned" to Persians and that they are not so extensively advertised as American sets.

U.S.A. — The British Consulate General at Detroit states that Buhl Sons Co. have agreed to consider offers from British manufacturers of broadcast receivers. Particulars should be sent to H. Pilbeam, Buhl Sons Co., 120, Adair Street, Detroit, Mich., U.S.A.

Nyasaland. — The International Marine Radio Co., of Croydon, has received an order from the Nyasaland Railways for the installation of eight shore stations and associated equipment for the provision of a radio-telephone system on Lake Nyasa.

Radio Components and hearing-aid parts are among the articles listed by the French authorities for token imports from this country.

Pye (Canada), Ltd., a subsidiary of Pye of Cambridge, has recently opened a factory at Ajax, Ontario, for the production of television sets operating on the American 525-line system. Six prototype receivers were sent from this country and demonstrated at the Canadian National Exhibition in Toronto. As there are no television stations operating in Canada, transmissions from the American station at Buffalo (60 miles away) were received.

MEETINGS

Institution of Electrical Engineers

Inaugural address of the president, Professor E. B. Moullin, M.A., Sc.D., at 5.30 on October 6th.

Radio Section.—Inaugural address of the chairman, R. T. B. Wynn, C.B.E., M.A., at 5.30 on October 19th.

"The C.B.S. Colour Television System in the United States," by P. C. Goldmark, B.S., Ph.D., at 5.30 on October 1st.

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

Cambridge Radio Group.—Address of the chairman, C. W. Oatley, M.A., M.Sc., at 6.0 on October 11th, at the Cambridgeshire Technical College.

North - Eastern Radio Group.—Address of the chairman, G. E. Moore, at 6.15 on October 17th at King's College, Newcastle-on-Tyne.

North-Western Radio Group.—Discussion on "Wave-guides" opened by E. Colin Cherry, M.Sc. (Eng.), at 6.30 on October 19th, at the Engineers' Club, Albert Square, Manchester.

South Midland Radio Group.—"Hot-Cathode Thyratrons: Practical Studies of Characteristics," by H. de B. Knight, M.Sc., at 6.0 on October 24th, at the James Watt Memorial Institute, Great Charles Street, Birmingham.

British Institution of Radio Engineers

London Section. — "Experimental Study of the Magnetic Amplifier," by E. H. Frost-Smith, B.A., at 6.30 on October 13th, at the London School of Hygiene and Tropical Medicine, Gower Street, W.C.1.

Merseyside Section.—"The Sensitivity and Other Properties of Television Camera Tubes," by L. H. Bedford, O.B.E., M.A., B.Sc., at 7.0 on October 5th at the Accountants' Hall, Derby Square, Liverpool.

Scottish Section.—"Electronics in Aircraft Design," by A. L. Whitwell, at 6.30 on October 5th, at the Electrical Department, Glasgow University.

South Midlands Section.—"The Performance and Stability of Permanent Magnets," by A. J. Tyrrell, at 7.0 on October 27th, at the Technical College, The Butts, Coventry.

West Midlands Section.—"Television Receiver Design," by W. Jones, at 7.0 on October 26th, at the Technical College, Wulfrunar Street, Wolverhampton.

British Sound Recording Association

The date of the opening meeting of the session has been changed to September 30th at 7.0 at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, when W. S. Barrell will give his presidential address, which will deal *inter alia* with microgroove recording.

Television Society

North Midlands Centre.—"Single Side-band Aspects of Television," by M. Reeder, at 7.30 on September 30th, at the Great Eastern Hotel, Leeds, 1.

Society of Relay Engineers

"Line Equalization with Special Reference to Programme Circuits," by H. J. Marchant, at 2.30 on October 4th, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

MANUFACTURERS' LITERATURE

LEAFLET dealing with "Sonogard" audible protection systems for works, offices, etc., from Ardente Acoustic Laboratories, Guildford, Surrey.

Descriptive leaflets No. 117 (Type MN Vacuum-cell Photometer), No. 118 ("Ionex" Ionization Meter, and No. 119 (X-ray Monitor), from the Baldwin Instrument Co., Dartford, Kent.

List of hire charges for public address equipment from Alexander Black, 34, Marlborough Grove, London, S.E.1.

"This is Ediswan," an illustrated brochure dealing with the activities and interests of the Edison Swan Electric Co., 155, Charing Cross Road, London, W.C.2.

Technical details of Type 2350E ribbon microphone. from E.M.I. Sales and Service, Hayes, Middlesex.

Leaflet describing loudspeakers and transformers made by Electro Acoustic Industries. Broad Lane, Tottenham, London, N.15.

Brochure on "Cold Welding" technique, licences for which are now being granted by the General Electric Co., Magnet House, Kingsway, London, W.C.2.

Folders describing p.a. loudspeakers, amplifiers, moving-coil microphones and type-approved schools broadcasting equipment from Magneta Time Company, Goblin Works, Leatherhead, Surrey.

Technical brochure on vibrators issued by the Plessey Co. (Components Division), Ilford, Essex.

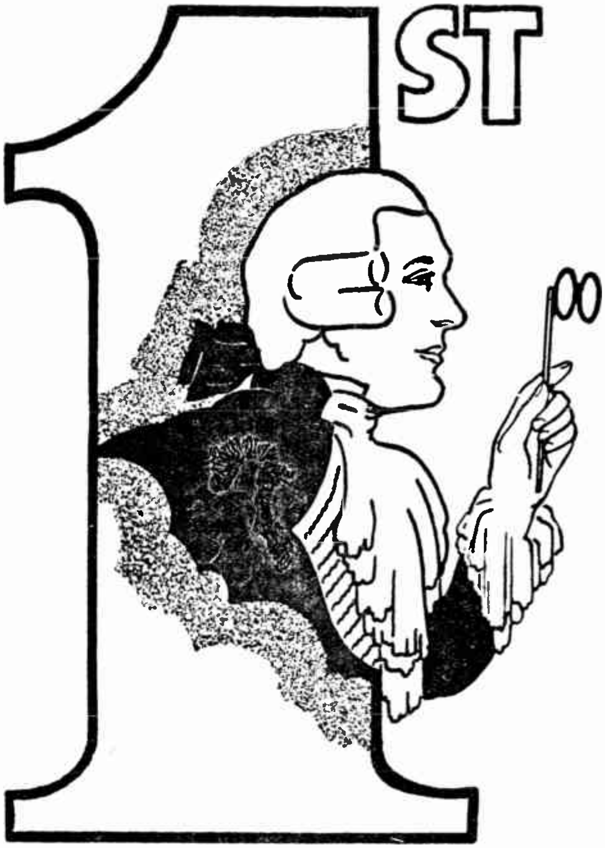
"Television; Build it Yourself." Constructional details for assembling the television kit sold by Premier Radio, 167 Lower Clapton Road, London, E.5. Price of booklet only 2s 6d.

Catalogue of v.h.f. and h.f. radio-telephone equipment for mobile, fixed station and small craft use from Pye Telecommunications, Cambridge.

Folder of illustrated leaflets describing equipment made by Radio Heaters, Ltd., Wokingham. Berkshire.

Catalogue of S.E.I. barrier-layer photocells, and leaflet describing quartz crystals for radio communication services, from Salford Electrical Instruments, Silk Street, Salford, 3, Lancashire.

World Radio History



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SMOOTHING CIRCUITS:

(1) Resistance - Capacitance

How to Calculate the Best Number of Sections

By "CATHODE RAY"

MANY readers have asked me to write about filters, with particular reference to smoothing circuits. This I have hesitated to do, because the subject of filters is so involved that most people like to leave it to a specialist. Most of the general books on radio take care not to embark on it at all seriously, while the books devoted specially to electrical networks almost invariably plunge the reader into a morass of hyperbolics, where he is likely to lose sight of all physical realities.

The orthodox manner of complying with the above request would be to start by dealing with the general theory of filters. That would take several months (at least), by the end of which there would be few survivors to take an interest in the application of that theory to smoothing circuits. I have therefore decided to reverse the order and start with smoothing circuits—which are of practical interest to nearly everybody—and use that familiar ground as an approach to filters in general.

Nobody ought to be encouraged to hope that he can become a proficient filter designer without prolonged study and much practice. But I do think that anybody seriously interested in radio ought to have at least a clearly defined and reliable skeleton of information on filters in place of the vague and mysterious ghost that too often haunts him.

Greatly daring, I shall attempt to construct such a skeleton without going more mathematical than usual. But if you propose to go through with it I should say beforehand that you ought to be entirely familiar with the meanings of reactance and impedance, and the standard relationships:

$$\omega = 2\pi f$$
$$X_L = \omega L$$
$$X_C = 1/\omega C$$

from which

$$X_L X_C = L/C$$

and $X_L/X_C = \omega^2 LC$ (= 1 at the resonant frequency $\omega_r/2\pi$)

$$Z = \sqrt{R^2 + X^2}$$

These formulæ for X and Z are "magnitudes" only; to take account of phase angle one has to bring in j.

Whenever I am reckoning with circuits I always try to have by me one of the charts or abacs connecting L, C, f, and X. Of the several kinds, the one I prefer has four parallel vertical scales which can be connected anywhere by a stretched thread or a celluloid

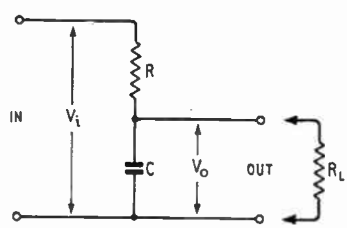


Fig. 1. The R-C filter is simply a potential divider in which the ratio varies with frequency

ruler. Among other things it shows the frequency at which any given L and C resonate, or conversely the L and C required to resonate at any given frequency. Its main use is to indicate the reactance of any L or C without any of that 2π arithmetic in which the decimal point so often gets into the wrong place.

But it is time we finished with introductory remarks and got down to smoothing circuits.

The simplest of all is the combination of one resistance with one capacitance (Fig. 1). It is the commonest type of "decoupler," and when the current is small or the drop in voltage doesn't rule it out it is a convenient form of rectified a.c. smoother. It appears in almost every detector circuit, to filter out the r.f., and in every a.g.c. circuit, to filter out the a.f.

It works, of course, as a simple potential divider in which the impedance of the element across which the output is taken (C) is less for high frequencies than for low.

As with all potential dividers, the loss of voltage depends not only on the ratio of its two impedances, but also on the impedance connected across its output terminals—the load impedance. Unless we say otherwise, we shall assume that the load impedance is a resistance, denoted by R_L. Whenever R_L is very large compared with the impedance of the part of the potential divider it comes across (in this case X_C) it makes calculations much easier, because then the ratio of input to output voltage (V_i/V_0) is equal simply to the ratio of the whole impedance ($\sqrt{R^2 + X_C^2}$) to X_C.

We shall call V_i/V_0 the attenuation, and denote it by a. If a is 3, for example, it means that only one third of the input voltage reaches the output.* In Fig. 1, then, we have

$$a = \frac{\sqrt{R^2 + X_C^2}}{X_C} \quad .. \quad (1)$$

One should always scrutinize equations to see if they are in the most convenient form. In (1) the part that depends on frequency appears twice; so to see more clearly how it affects a and to avoid needless duplication of

* You can, of course, if you prefer, reckon a in decibels, but they would have to be turned back into ratios to fit our equations.

World Radio History

Smoothing Circuits—
effort when evaluating α it is beneficial to divide above and below by X_C, with the result

$$\alpha = \sqrt{\frac{R^2}{X_C^2} + 1} \quad .. \quad (2)$$

It can be made to look even tidier, and at the same time to express the relationship more distinctly, by using any convenient symbol, say p, to denote the ratio of resistance to reactance. Then we have

$$\alpha = \sqrt{p^2 + 1} \quad .. \quad .. \quad (3)$$

Using this we can draw a curve of α against p that will hold good for the Fig. 1 class of circuit in general (Fig. 2). Incidentally, this illustrates last month's story about generalized graphs.

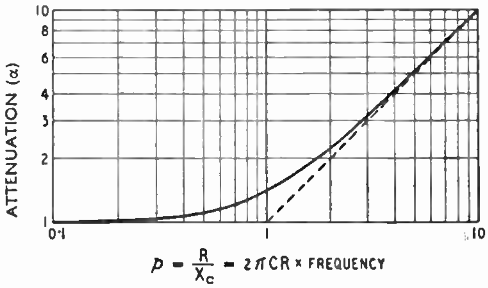


Fig. 2. Curve of attenuation against p (ratio of resistance to reactance) for a single section. This is an example of a generalized frequency curve, for $p = 2\pi CR$ times frequency. The dotted line shows the result of making the "vector" assumption.

Still more of a simplification can be made so long as we are aiming at a fairly large attenuation, so that α is at least several times greater than 1. For then the 1 can by comparison be neglected and we get

$$\alpha \simeq p \quad .. \quad .. \quad .. \quad (4)$$

Up to the present I have not been able to think of any further simplification. On the contrary, in case you forget what p stands for I suggest the fuller version

$$\alpha \simeq \frac{R}{X_C} = 2\pi f CR \quad .. \quad (5)$$

Remember that for (5) to be reasonably accurate it is necessary for

(a) R_L to be much greater than X_C.

(b) R to be at least several times greater than X_C (i.e., α to be several times greater than 1).

We shall call (a) the shunting assumption and (b) the vector assumption. As an example, suppose R is 4 times X_C; then (5) gives α as 4, which can be compared with the correct value given by (2) or (3), 4.12. The 3% error is quite negligible in this kind of work. The dotted line in Fig. 2 is drawn to equation (5), so that you can see how the error becomes imperceptible as p increases.

As we saw last month, this type of circuit doesn't discriminate sharply between different frequencies. Its characteristic curve (Fig. 2) shows it to have a slope that approaches 6 db per octave at the high-frequency end. In other words, doubling the frequency only halves the output, at best. If it is necessary for the lower of two frequencies to be nearly 100% preserved, the reduction of a voltage at double the frequency is much less still, owing to the gradualness of the bend in the region of $p = 1$ or less. The effect of R_L not being relatively very large reduces the discrimination still more, because it cuts down the output at low frequencies without making much difference at high.

In smoothing filters, however, the only frequency to be passed is zero, so one can hardly have too much a.c. attenuation. At the very least, the lowest a.c. frequency present should come on to the main slope, and preferably as far up it as is required for the purpose in view. At the same time, R must fit into the d.c. requirements.

For example, suppose an attenuation of at least 40 is required from a half-wave 50 c/s rectifier to supply 5 mA at 1,000 V., and the output of the rectifier across the reservoir capacitor is 1,300 V. at 5 mA. The value of R is fixed at once by the voltage drop; it is $(1300 - 1000)/5 = 60\text{k}\Omega$ (remembering that mA and kΩ are "consistent" units). For α as large as 40 we can use equation (5), and, as the lowest frequency is 50 c/s, we find $C = 40/(2\pi \times 50 \times 60{,}000)\text{F} = 2\mu\text{F}$ approximately. R_L is $1000/5 = 200\text{k}\Omega$, so the shunting assumption is justified. The harmonics present are reduced 2, 3, etc., times as much, so it might seem that so long as the lowest frequency is sufficiently attenuated it won't matter about any of the others. And that is quite so when the objectionable effects of the ripple depend only on its magnitude. But it must be remembered that the sensitiveness of the ear to hum increases more rapidly with frequency than the attenuation shown in Fig. 2, so in sound-producing equipment it is necessary to do better than reduce the *lowest* frequency to inaudibility.

Distribution of R and C

It should be clear by now that the effectiveness of the Fig. 1 circuit depends solely on p, which is $2\pi f CR$, and therefore at a given frequency depends solely on the product CR. (This is not necessarily true where the effect of R_L is appreciable, but for the time being we are continuing the shunting assumption.) A specified α can therefore be obtained by any C and R which give the right figure when multiplied. But, as we have seen, R is usually dictated by the required or allowable d.c. drop, in which case C is also decided. If a very smooth output is needed, the value of C found in this way may be disconcertingly large. So we may well ask whether the Fig. 1 circuit makes the best use of C and R.

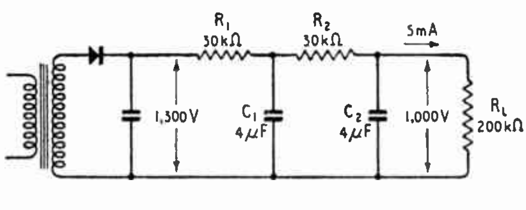


Fig. 3. Is this the best way to use these filter components?

Any number of units or "sections" like Fig. 1 can be used in cascade (i.e., one feeding into another), and, so long as our two assumptions apply to every section, the α of the whole combination will be the product of the α's of the separate sections. A second section like the first in the example just taken would reduce the 50 c/s content another 40 times, making the overall

$$\alpha = 40 \times 40 = 1600$$

To keep the total voltage drop the same, the R in each section would have to be halved, so to preserve the original CR in each section the capacitances would have to be doubled (Fig. 3). A single section having the same total CR would have an α at 50 c/s of $2\pi \times 50 \times 8 \times 60{,}000 \times 10^{-6} = 160$, or only one tenth that of the two sections. In this case the advantage of splitting up is obvious enough. But is it always an advantage? And, if so, into how many sections?

Never having seen definite answers to these questions, I tackled them as follows:

Making the shunting and vector assumptions, the total α due to a given CR used all in one section (call it α_1) is p, which is ωCR. But if this CR is divided equally into two sections, say by halving both C and R, their product is CR/4. So the α of each section is $p/4$. The total α (call it α_2) is therefore $p/4 \times p/4 = p^2/16$. If you try a few values for p you will find that with low values α_1 is greater than α_2, but with high values it is the other way round. So that is the answer to the first question—it is *not* always an advantage to sectionalize; it depends on the value of p.

If you want to find the value of p (and hence CR) that gives the same total α whether in one section or two, you just put $\alpha_1 = \alpha_2$:

$$p^2/16 = p$$
$$\therefore p = 16.$$

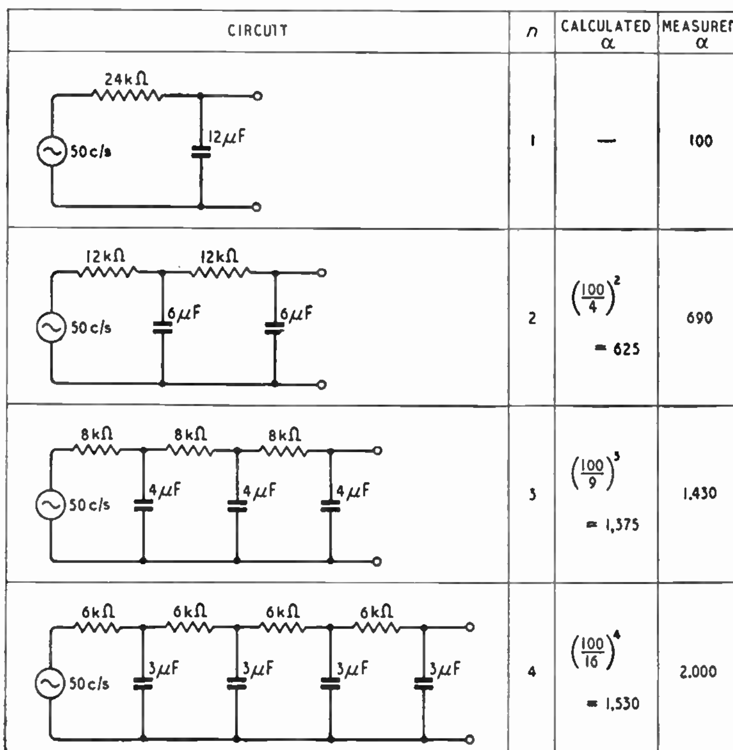
So 16 is the critical value of p, below which one section is better than two. Let us call it p_1, to indicate that there is no sense in going beyond one section until p exceeds that value.

To answer the second question we have to find another value—p_2—above which it pays to use three sections instead of two; and so on. In general, we want p_n, the value of p at which the best number of sections changes over from n to $n+1$. The calculation is made along exactly the same lines as for p_1 (for details see the Appendix) and the results are given in Table 1 above.

TABLE I.

n	p_n	α_n	RC in kΩ-μF *per section*, when f=100c/s	$p_{s(n+1)}$
1	16	16	25.5	4
2	45.5	129	18	5.06
3	90	1,000	16	5.62
4	149	7,540	15	5.86
5	223	56,600	14	6.19
6	311	416,000	13.7	6.35

Fig. 4. **Summary of attenuation measurements made on filters having the same total C and R, nominal values as shown.**



Suppose you have a certain total capacitance and want to know the best way of connecting it. For example, the d.c. drop requirement gives you 20kΩ, and you have 16μF. It is a 50 c/s full-wave rectifier, so the lowest ripple frequency is 100 c/s. So your total p is $2\pi \times 100 \times 20 \times 16/1000 = 200$. The table shows this is more than p_4 but not more than p_5; so 5 is the best number of sections. The total α (third column) lies between 7,540 and 56,600; the actual value is $(p/n^2)^n$, in this case $(200/25)^5 = 32{,}770$. Whether it is convenient to divide your 16μF into five equal sections is another matter, of course; you may have to make it four, at some slight sacrifice of α. But at least the table gives you something more to go on than pure guesswork.

Or you may want to find the minimum C and R for a specified attenuation, say 1000. The table shows that you can get it with three (or four) sections having sufficient total C and R to make $p = 90$, and (fourth column) that

Smoothing Circuits—
each section should be made up of 16 kilohm-microfarads.

You may wonder why I have included the last column, which shows the p per section on changing over to the next higher number of sections. For example, we saw that one section is best up to $p = 16$, and changing over to two sections at that point has no effect on the total attenuation, but it would reduce the p per section to 4. The last column, therefore, shows the lowest p you would ever get if you followed the table strictly. The point is that if this figure dropped to something like 2 or less, the vector assumption would be unjustified and the table would be invalid. But we see the least p is 4, with a vector error of 3%, which is not serious even when multiplied by 2. The other errors are still smaller, so are not serious even when multiplied by the larger number of sections. Such error as there is tends to make the true α_n larger and reduce p_n. p_1, for example, would be 15 instead of 16.

What about the shunting error? Even if R_L is infinitely large, so that the last section is unshunted, the last section shunts the last but one, and so on. It is difficult to work out the size of the error exactly when there are several sections, and anyway it depends on the load resistance; but the $p_{s(n+1)}$ figures show that it ought not to be very serious, and again it would tend to make the actual attenuation and also the best number of sections higher than in the table. But since the cost of the filter generally goes up with the number of sections, the fact that the table puts the change-over point higher than the theoretical ideal is all to the good.

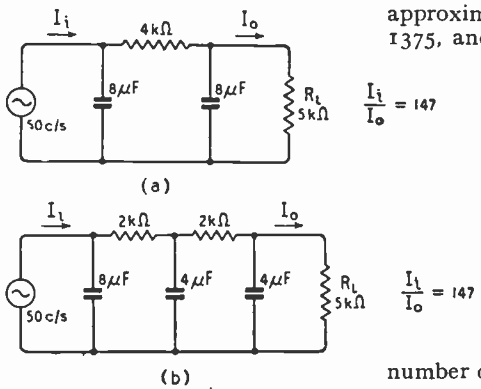


Fig. 5. Another comparative test.

Another point to be considered is that the attenuation increases in proportion to the nth power of the frequency, so in sound-reproducing equipment, at least, it is advisable to make n not less than 2.

To check the theory and to see how far its assumptions were justified I did a few measurements. I aimed at $p = 90$, to check the middle lines in the table, but had to use the components available, so it worked out at about 100. Fig. 4 shows the nominal values, which were subject to commercial tolerances. Assuming that the measured p in one section (100) was divided exactly into 2, 3 and 4 sections, the attenuations predicted by the approximate theory were · 625, 1375, and 1530 respectively. The measured attenuations (subject to possibly ± 10% error of measurement) were 690, 1430, and 2000. These results show that

(a) The theoretical table is good enough for design purposes.

(b) It tends to underestimate the results.

(c) The discrepancy increases with the number of sections. (This is what one would expect, because the p per section is less with more sections, so the assumptions are less justifiable.)

To get still nearer to working conditions I did a test using a typical value of reservoir capacitor (8μF) and load resistance (5kΩ), as in Fig. 5. The reservoir, without any other filtration, would reduce the hum current passing into the load. Adding one filter section having a p of about 10 made the total measured current attenuation 147. Splitting this filter section into two, the attenuation was the same. According to the approximate theory, the p for which this would happen would be 16 (or 15, correcting the vector

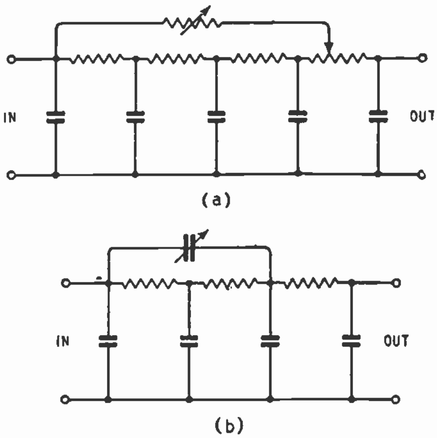


Fig. 6. Two methods of balancing out one ripple frequency completely—usually the lowest.

error). But the actual p per section in Fig. 5 (b) is only $2\frac{1}{2}$, so one would expect the approximate theory to be thrown out somewhat by shunting. Taking into account the higher cost with two sections, one would almost certainly want p to be at least 16 before sectionalizing.

There are at least two methods (Fig. 6(a) and (b)) for eliminating the most troublesome ripple frequency altogether. They take advantage of the fact that its phase shifts as one moves along the filter. If the right amount of ripple from the input is fed to a point where there is a 180° phase difference, the two will cancel one another out. There may be some occasions when these devices are worth while (such as when only a small d.c. drop is allowable), but there are several objections. One is that success depends on both magnitude and phase being correctly adjusted. Another is that only one frequency is cancelled; for the others the attenuation of the original filter (admittedly relatively high for the higher frequencies) is actually reduced. It is necessary to use several sections to get the required phase shift, and the table has shown us that quite a large α can be obtained with several sections straightforwardly, without going beyond reasonable limits for CR. Still another disadvantage is that the necessary design information would increase the length of this

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article, and it is already full size. Calculation of actual hum voltage, and inductance-capacitance filters must wait until next month.

APPENDIX

(Showing how to calculate the table giving the number of sections for maximum attenuation).

$$p = 2\pi f \times \text{total CR.}$$

If CR is divided into n equal sections, the attenuation per section is approximately p/n^2 (assuming that it is at least several times greater than 1, so that the simplifying assumptions apply). The total attenuation, α_n, is therefore

$$\alpha_n \simeq \left(\frac{p}{n^2}\right)^n$$

If the same CR were divided into $n + 1$ equal sections the attenuation would be

$$\alpha_{n+1} \simeq \left(\frac{p}{(n+1)^2}\right)^{n+1}$$

If p_n is the value of p that makes $\alpha_n = \alpha_{n+1}$, then approximately

$$\left(\frac{p_n}{n^2}\right)^n = \left(\frac{p_n}{(n+1)^2}\right)^{n+1}$$

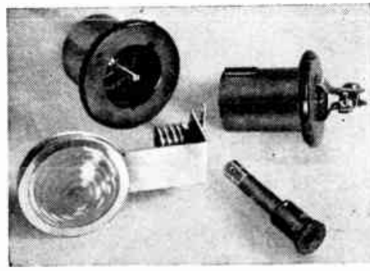
$$\therefore \quad \frac{p_n{}^{n+1}}{p_n{}^n} = p_n = \frac{(n+1)^{2(n+1)}}{n^{2n}} \quad .. \text{(A)}$$

$$\text{So } \alpha_n \simeq \left(\frac{p_n}{n^2}\right)^n = \left[\frac{(n+1)^{2(n+1)}}{n^{2n} \times n^2}\right]^n$$

$$= \left(\frac{n+1}{n}\right)^{2n(n+1)} \quad .. \text{(B)}$$

And $p_{s(n+1)}$ (the p per section when p_n is divided into $n + 1$ sections) is

$$p_{s(n+1)} \simeq \sqrt[n+1]{\alpha_n} \simeq \left(\frac{n+1}{n}\right)^{2n} \quad .. \text{(C)}$$

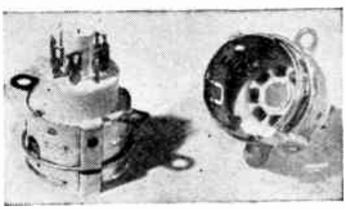


Bulgin accessories comprising a two-pin connector, signal lamp and a car ignition interference suppressor.

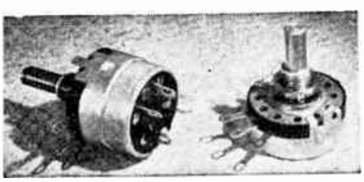
MANUFACTURERS' PRODUCTS

New Plessey Components

SEVERAL new components have been introduced recently by the Plessey Company, Vicarage Lane, Ilford, Essex. One is a ceramic type B8A valve holder with floating nickel silver contacts having a wide lead-in angle, which should prevent any likelihood of bent pins or a fractured base provided that the "float" in the socket is not destroyed by stiff wiring. It has a metal centre spigot tube, which also serves as an earthing contact, and a base screening shield incorporating a locating keyway. The inter-socket capacitance is between 0.1 and 0.2 pF while, between all sockets and earth, the capacitance is less than 0.15 pF, a very necessary feature for v.h.f. applications.



Plessey ceramic B8A valveholder and (below) solid moulded-track volume control.



There is a laminated plate-type valveholder for the B9A valves having silver-plated phosphor bronze contacts giving a firm but sound electrical contact with the valve pins.

A volume control, having a solid moulded resistance element contained in a moulded body, is also among the new items. It is designed to be very robust and reliable in operation. Resistance values range from 100 ohms to 2 megohms, while the minimum values, often called the "hop-on" and "hop-off" values, are kept down to 1.0 per cent of the track resistance, or 50 ohms in the lower values. The track will safely carry some direct current so that their usefulness is extended to television controls and cathode bias circuits.

Conventional single-hole fixing is employed and either single- or double-pole on-off switches can be incorporated.

Some Useful Accessories

THE introduction of a new signal lamp fitting taking a modified "Pigmy Sign" mains bulb of 15 watts rating adds some fifty further varieties of signal fittings to the already extensive range made by A. F. Bulgin and Co., Ltd., Bye-pass Road, Barking, Essex.

The new signal lamp has a B.E.S. screw fitting for the bulb and a 1½in diameter plastic lens which is secured in position by means of three springy tongues and slots cut in the annular ring of the back plate. This plate is riveted to a bracket carrying the B.E.S. lamp holder. Ten varieties of coloured lenses are available and the metal rim can be finished in a wide range of colours and styles. The price is 2s 3d.

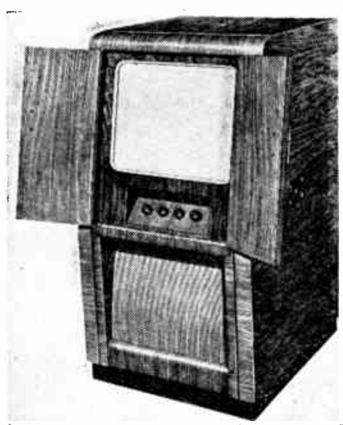
Another recently introduced Bulgin product is a fully insulated non-reversible moulded connector. In a 2-pin type it will handle mains supplies up to 500 volts at 1 amp, or on low voltages up to 10 amps. High-grade Bakelite is employed and although the normal colour is black other shades can be supplied to order.

The non-reversible feature is obtained by a moulded key on the withdrawable socket part and a corresponding keyway in the fixed plug housing. This is a useful feature for d.c. sets. A cable grip is also included. Two-, three- and six-pin connectors are available and the prices are 5s 9d, 6s 3d and 8s 3d respectively.

An interference suppressor for motor car engines has now been added to this firm's range of accessories. It is a plug-in type for the distributor head and is inserted in the lead to the coil. The suppressor resistor is wire wound and is enclosed in a flexible weatherproof moulding. The price is 1s 6d.

New Television Receiver

THE 15-inch tube in the Model 1806 H.M.V. gives a picture size 12½in × 10in and it is claimed that the aluminized screen gives sufficient brilliance for viewing by normal room lighting. The price is £148 4s 5d, with tax.



H.M.V. Model 1806 receiver.

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Unbiased

By FREE GRID

North of the Border

TELEVISION aerials are not a very conspicuous feature of the Scottish landscape at present. This is not very surprising as Scotsmen very sensibly like to have value for their money and freak reception from A.P. has no attractions for them. In fact, the only installation I actually saw on a recent visit there was owned by a mad dog of an Englishman, but that was not very surprising for, as Noel Coward reminds us, they are apt to do odd things such as going out hatless in the midday sun in the tropics. Licence figures, too, show that there is a dearth of Scottish television installations. I cannot refrain from mentioning, however, that doubts as to the accuracy of licence figures were aroused in my mind when I noticed that some of the "Monarchs of the Glen" showed no signs of movement even when I got to wind'ard of them; their antlers, too, seemed staggeringly symmetrical.

"Staggeringly symmetrical."

In spite of the apparent dearth of television in Scotland, however, I was privileged to witness a better and clearer picture on a television screen than any I have ever seen down here. It was in the saloon of one of those pleasure steamers which convey holiday - makers through the lovely lochs of Scotland. The scene on the screen was merely the same as could have been viewed by going on deck and looking over the side. It was coming from a closed circuit transmitter mounted for'ard. The idea behind the scheme was to enable passengers to view the surrounding scenery in comfort during inclement weather. It was proposed, so I was told, to mount a screen in front of each seat in the saloon and to arrange for it to be switched on by the insertion of a sixpence.

I need hardly say that the promoter of this money-losing scheme is an Englishman who has omitted to do anything in the way of "market research." As I told him, if he, or anybody else, seriously thinks that a sixpence can be extracted from a Scotsman as easily as this he is very much mistaken. I pointed out that a much simpler plan would be to forego the sixpence and merely provide in the saloon a pre-taken cine-film of the passing scenery. The Scots at home are simple-minded folk—it is only the astute ones who come south—and they wouldn't know the difference between a cine-film and television. They don't know what the latter looks like and are not likely to for many a long day, despite B.B.C. and Government promises. In fact, my opinion of the authors of these promises is aptly expressed by the words of Macbeth about the double-crossing witches, or, better still, by Mr. Asquith's famous "wait and see."

"Electronicometry"

THE extent to which the technique of radio and electronics is pervading even the most commonplace aspects of our daily lives was brought home to me very vividly a short time ago when I spent one of the last sad days of dying summer at a popular seaside resort. It goes almost without saying that the place had a pier, that strange and bizarre mixture of Byzantine and Victorian architecture which would be tolerated in no other country but England. I stood meditating for a while among the serried ranks of the ubiquitous what-the-butler-saw machines; I was once told at a political meeting that they were installed by the bloated plutocracy at a time when butlers were in short supply in order to induce youths to rush to fill the gaps in their ranks.

The butler has long since gone—he probably died of shock. In return for my penny I was regaled with the sight of some ultra-modern bathing beauties which, I was informed, came to me by courtesy of "Seymour Swim-Suits Limited"—*very* limited, judging by the dimensions of some of the "water-wear."

"I heaved up the platform."

I was about to leave the pier in search of a shrimp tea when I was attracted to a machine calling itself an electronic brain. It claimed to give my height and weight without any resort to the usual principles of mechanics. In appearance it was much the same as the usual weighing machines except that it had an extra dial for recording height and also a large box-like canopy suspended over the platform.

It was, of course, quite easy to see how the height was calculated as the box-like canopy overhead contained radar apparatus which merely measured the distance of the top of my head from itself and then subtracted it from the known distance to the platform on which I stood. The method of ascertaining my weight did, however, puzzle me and I suspected that the ordinary mechanism of levers and what-not was being used. To settle the question I heaved up the platform with the aid of my umbrella and a monkey wrench which I usually carry about with me and was astounded to find nothing but a stout spiral spring supporting the platform at each corner.

It was not, in fact, until I had sat far into the night in my cell at the local police station that I realized how it worked. The overhead radar gear had measured the distance down to the top of my head when I first stood on the platform, thus giving my height, and then had measured it again when the spring-borne platform and myself had sunk a fraction of an inch under the influence of gravity. The difference between these two readings would, of course, give my weight.

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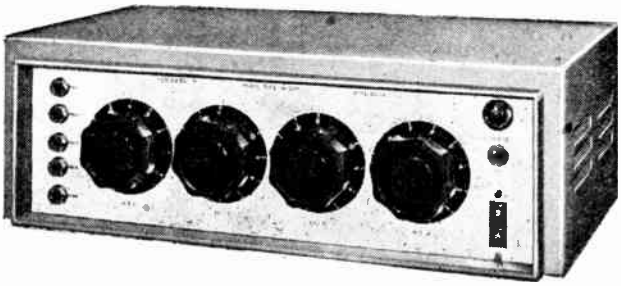

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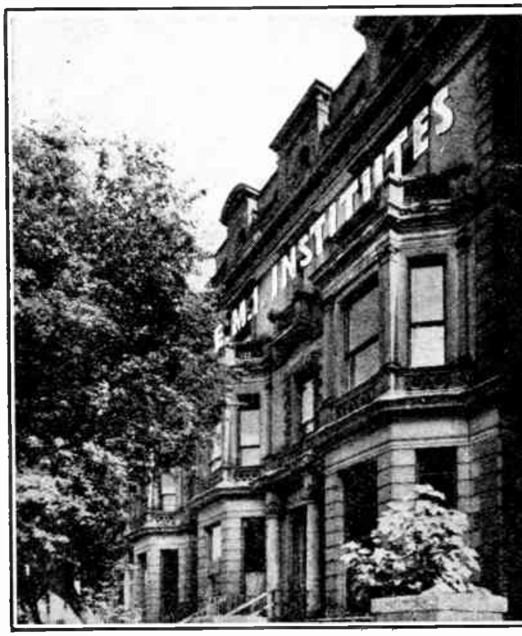

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By J. McG. SOWERBY (Cinema Television Ltd.)

Direct Current Stabilizers

SOME months ago it was pointed out in these columns[1] that a cathode follower is sometimes used for stabilizing the current in a television cathode-ray tube focus coil. As this aroused some interest it has been thought worth while to present the following brief notes on current stabilizers in general, as they have various laboratory uses, one of which is the stabilization of the currents in the lens coils of an electron microscope.

Normally a current stabilizer is required to stabilize not only against fluctuations of the supply mains, but also against changes of resistance of the component through which an unvarying current is required. To be definite, let us call this component a coil whose resistance (if wound with copper wire) will change with temperature. A significant change in temperature may well be caused by the power dissipated in the coil when the current is flowing.

Current stabilizers may be looked at in two different ways, and it is largely a matter of personal preference which is chosen, as they lead to the same conclusions. If the coil is placed in series with a resistance of value high compared with that of the coil and a correspondingly high voltage applied to the two components in series, then changes of coil resistance will have little effect on the current flowing, provided the supply voltage is constant. For example, if the series resistance is ten times the coil resistance, a change of one per cent in the resistance of the coil will represent a change of only 1/11 per cent in the total resistance, and the percentage current change is similarly reduced by a factor of eleven.

A straightforward current stabilizer for a coil of resistance 5,000 ohms to be supplied with 20 mA might be constructed as indicated in Fig. 1. This arrangement would discriminate against mains fluctuations by the stabilization ratio of the voltage stabilizer, and against coil resistance fluctuations by a factor of eleven. The supply voltage required is 55 kΩ × 20 mA = 1,100 volts. The power to be supplied is equally easy to calculate and is 1,100 volts × 20 mA = 55 watts, and of this total power only 5 kΩ × (20 mA)^2 = 2 watts is actually supplied to the coil. Thus the arrangement is very wasteful of power, and this is only one of its faults.

By the use of a device capable

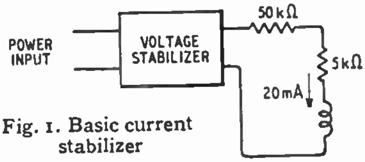


Fig. 1. Basic current stabilizer

of passing a useful current at a reasonable voltage, and yet having a high (a.c.) resistance to *changes* of current a much more economical circuit can be designed. Such a circuit is that shown in Fig. 2.

Here V_1 is a triode whose effective internal resistance is increased from r_a (the normal anode resistance of the valve) to

$R_0 = r_a + (\mu+1)\ R_k$

where μ = amplification factor.

V_2 is a stabilizer tube whose running potential is V_n, and this supplies a nominally constant grid bias to V_1. If we make the assumption—which is nearly true for a high-μ valve—that the potential across R_k is also V_n, we may re-write the internal resistance as

$$R_0 = r_a + \frac{(\mu+1)\ V_n}{i}$$

where i = required stabilized current.

Putting in practical values of $R_a = 3\text{k}\Omega$, $\mu = 28$ (for an EF55) $V_n = 85$ volts (for an 85A1) and $i = 20$ mA, we find $R_0 = 126$ kΩ. If the coil resistance $R_c = 5$ kΩ the coil will drop 100 volts at 20 mA so that the coil and R_k together account for 185 volts. If a supply potential of 350 volts is used, 165 volts will appear across the valve, and, at this anode voltage, reference to the valve curves shows that no grid current flows.

In such an arrangement the effect of a change of coil resistance of one per cent on the current flowing is reduced to about 0.04 per cent. The total resistance in the circuit is $(126+5) = 131$ kΩ, so that if the h.t. supply line changes by 10 per cent (35 volts), the change in current is only $35/131 = 0.27$ mA, or rather less than 1.5 per cent of the total coil current. The total power consumed (excluding the stabilizer tube circuit) is 350 V × 20 mA = 7 watts, and of this, 2 watts is supplied to the coil. This contrasts very favourably with the arrangement of Fig. 1.

The circuit of Fig. 2 can be looked at a second way in which the coil is regarded as having a resistance R_k in series with it,

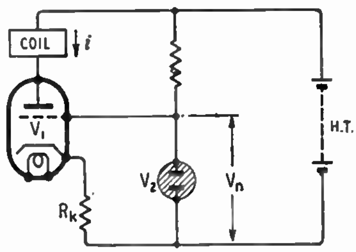


Fig. 2. Simple practical current stabilizer

and the aim is to maintain a constant voltage across R_k. Obviously if the voltage across R_k is unchanged, and R_k remains unchanged, then the current through R_k must remain unchanged As any current that

[1] *Wireless World*, September, 1948, p. 322.

Electronic Circuitry—

flows through R_k also flows through the coil, the coil current must also remain unchanged. This way of looking at the circuit quickly leads one to the more refined and effective circuit of Fig. 3.

In Fig. 3, V_1 and V_2 correspond to V_1 and V_2 in Fig. 2, but now an amplifier valve V_3 has been interposed As this valve is actually a cathode-coupled pair it amplifies the difference in potentials applied to the two grids. One of these potentials is the reference potential V_n derived across V_2, and the other is that

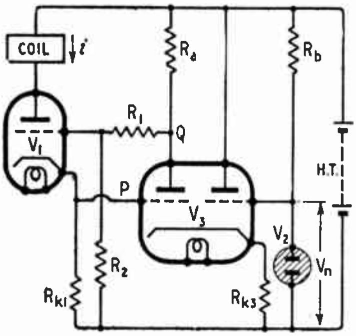


Fig. 3. More advanced current stabilizer

across R_{k1}. The amplified signal across R_a is applied via the potentiometer chain R_1, R_2 back to the grid of V_1 in such a way as to tend to maintain the potential across R_{k1} equal to V_n. Analysis shows that the effective resistance in series with the coil is increased by the introduction of the amplifier valve V_3. It is found that for this circuit

$R_0 = \mu_1 A_3 V_n/i$ approximately
where μ_1 = amplification factor of V_1.
A_3 = gain from cathode to grid of V_1 through V_3.

In practice it is not easy to make A_3 much greater than 10, and if each triode of V_3 has $\mu_3 = 70$, the cathode coupling will restrict the gain from P to Q to less than 70/2—say 25, and a further loss of 1/2 will take place from Q to the grid of V_1 if $R_1 = R_2$. So much loss in the R_1R_2 coupling chain is a consequence of the need to maintain the correct standing potentials at P and Q. The choice $R_1 = R_2$ is often convenient, and the anode-cathode potential of the left-hand side of V_3 will be nearly equal to V_n.

Taking practical values of $\mu_1 = 28$ (EF55), $V_n = 85$ volts, $i = 20$mA, $A_3 = 10$, we find the effective resistance $R_0 = 1.2\ M\Omega$ (approximately) in series with the coil. Making the assumption* that V_n is constant, the effective stabilization ratio to the cathode of V_1 is approximately $S_0 = \mu_1 A_3$ (= 280 for the values assumed above), so that discrimination against both mains fluctuations and changes of coil resistance is very good. One point is rather important; as the coil current is determined by the current through R_{k1}, it is imperative that this component shall be highly stable, and low temperature coefficient wire-wound resistors should be used. To control the value of the stabilized current it is generally best to switch in different values of R_{k1} for large changes, and to vary the effective value of V_n for small changes by arranging for the right-hand grid of V_3 to be connected to the slider of a potentiometer across V_2, so that the effective V_n can be varied (say) from 85 to 70 volts.

The informed reader will have recognised that the arrangement of Fig. 3 closely resembles a voltage stabilizer, and other voltage stabilizer circuits were ably described recently in this journal.[2] The interested reader will be able to adapt these other circuits in the light of what has been said above, and it may be remarked that the circuit of Fig. 3 by no means represents the ultimate in performance, although it is satisfactory for a variety of applications.

Neutralizing Phase-splitters

RESISTANCE-coupled phase-splitters were discussed at length in this journal[3] some time ago, and these may broadly be divided into low- and high-gain types. Examples of the latter are the cathode-coupled and see-saw phase-splitters. Some designers of these circuits avoid the use of triodes, because of the increase of input capacitance due to the Miller effect. It is not always realized that neutralization can often be employed, and this may, in some circumstances, be a material aid in maintaining the response at the higher frequencies.

Fig. 4 shows a cathode-coupled phase-splitter driven by some previous amplifier stage S. Those who studied the recent article on the Miller effect (August issue) will remember that the anode-grid capacitance c_{ag} is effectively multiplied by the gain of V_1 from grid to anode, and appears effectively between the grid of V_1 and earth. Thus, although c_{ag} may be only 3 or 4 pF, the effective input capacitance of V_1 may be up to 100 pF, and this may be serious if S is a pentode of the 6J7 type, with a high-resistance anode load.

This large input capacitance is a consequence of the fact that any signal voltage at the anode of V_1 is out of phase with that at the grid. But the signal at the anode of V_2 is fortunately in phase with

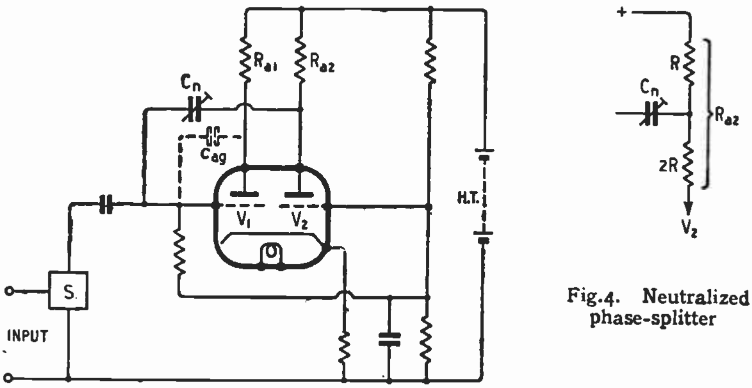


Fig. 4. Neutralized phase-splitter

* Only true when R_b is very much larger than the effective resistance of V_2.

[2] "Stabilized Power Supplies," M. G. Scroggie, *Wireless World*, Oct., Nov., Dec., 1948.

[3] W. T. Cocking, *Wireless World*, Jan., Feb., March, April, May, 1948, with particular reference to April, p. 126 and May, p. 183.

World Radio History

Electronic Circuitry—

that at the grid of V_1. Hence a neutralizing capacitance C_n equal to c_{ag} may be connected as shown and the undesirable effects of c_{ag} are neutralized at ordinary frequencies where the amplifier behaves essentially as a resistance-coupled stage. The actual capacitance of c_{ag} is practically never more than 5 pF, so that C_n must be restricted to some value not more than this. It is often convenient* to split R_{a2} (as shown at the side of Fig. 4) so that signal voltage fed to C_n is reduced by a factor of three. This enables an ordinary r.f. trimmer (e.g. 5–15 pF) to be used, and avoids the necessity for a special component.

A good method of adjusting the circuit is to apply a square waveform to the input of S (frequency about 1 kc/s for audio amplifiers), view the output on an oscilloscope and adjust C_n for the best results. This method generally leads to slight over-neutralization, but this is only undesirable if carried to excess so that the circuit is on the verge of oscillation.

This method of reducing the input capacitance of amplifiers was used in some radar circuits, and for further information the reader is referred to "Waveforms," Chance, Williams, Hughes, MacNichol and Sayre, *M.I.T.* Rad. Lab. series, Vol. 19, p. 767. McGraw Hill.

* But theoretically incorrect. However, the method is legitimate as long as the anode resistances from which c_{ag} and C_n are fed are very low compared with the reactances of c_{ag} and C_n. This is nearly always the case in practical circuits up to about 20 kc/s.

SHORT-WAVE CONDITIONS

August in Retrospect : Forecast for October

By T. W. BENNINGTON (Engineering Division, B.B.C.)

DURING August the average daytime maximum usable frequencies for these latitudes were somewhat higher than during July, whilst those for night-time were appreciably lower. This is in conformity with the usual seasonal trend, and m.u.fs should now continue this type of variation towards the winter. Daytime working frequencies were, therefore, fairly high, though not high enough to permit regular use of frequencies like the 28-Mc/s band. Night-time frequencies of 9 Mc/s were often needed on some circuits.

Sunspot activity during the month was, on the average, considerably higher than during July.

Sporadic E was prevalent during the month, though somewhat less so than during July; and medium-distance communication on high frequencies by way of the medium was frequently possible. It is expected that the rate of incidence of Sporadic E will now decrease rapidly.

August was a much more disturbed month than July, one long period of 14 days never being quite free of disturbance. This was 3rd-16th, the other disturbed period being 29th-31st. Most severely disturbed days were 3rd, 4th, 5th and 8th "Dellinger" fadeouts were reported on 5th (2), 11th, 16th, 17th 20th and 31st, those of 5th, 17th and 31st being intense.

Long-range tropospheric propagation does not appear to have been very frequent during the month.

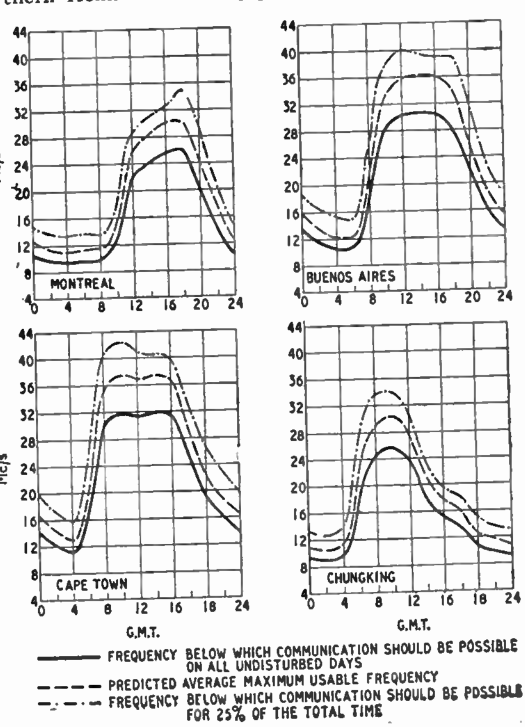
Forecast.—During October daytime m.u.fs in the Northern Hemisphere will continue to increase, and, towards the end of the month, should reach exceptionally high values. It is unlikely, however, that they will be so high as those reached during the same period of the last two years. Night-time m.u.fs should continue to decrease.

Working frequencies for long-distance communication should therefore be high by day, frequencies like the 28-Mc/s band being frequently—if not regularly—usable over most transmission paths. At night 9 Mc/s should be about the highest regularly usable frequency, and lower ones will be necessary for some circuits. It is not expected that the E or F_1 layers will control transmission over any distances from this country during October.

It is not likely that Sporadic E will be much in evidence.

Ionospheric storms are often prevalent during October and some considerable periods of poor communication are therefore to be expected. At the time of writing it appears that ionospheric storms are most likely on 8th-9th, 18th-21st and 24th-26th.

Starting this month it is intended to give the predicted working frequencies for four long-distance circuits running in different directions from this country in graphic, instead of in tabular, form, as hitherto. Although the graphs are largely self-explanatory, the following few words may be said about them. A dashed line in each graph indicates the predicted m.u.f. for the circuit for each hour of the day, *average* for the month—and thus represents the highest frequency which should be usable at each hour for fifty per cent of the total time. The full line indicates the so-called o.w.f.—the frequency below which it should be possible to maintain *regular* communication: i.e., on every day of the month except those during which ionosphere storms are in progress. The dot-dashed line is for the use of those whose primary object is the working of certain bands; it gives the highest frequency likely to be usable at each hour for about 25 per cent of the total time.



World Radio History

VENTED LOUDSPEAKER

Basis of Design to Match Existing Loudspeaker Units

By C. T. CHAPMAN (Goodmans Industries)

THE large irregular plane baffle, or, better still, a baffle of "infinite" dimensions, such as a hole in a wall, although basically representing the optimum method of loading for a direct-radiator type loudspeaker, is seldom practicable. The result is that the baffle dimensions are reduced below the minimum required for the proper development of the lower frequencies. The musical balance is upset, and, even more serious, the loudspeaker diaphragm may develop excessive amplitudes, resulting in intermodulation and harmonic distortion. This effect is often unwittingly worsened by the user, who, in an attempt to obtain increased bass output, provides bass boost in his amplifier equipment.

The problem is a very real one, for, to provide adequate loading on the diaphragm down to 55 c/s, a plane baffle 10 feet in diameter is required, with attendant difficulties of construction, maintenance of rigidity, etc.

The basic requirement is to increase the rad ation resistance at the lower frequencies, and it can be seen that the use of a Helmholtz resonator or a vented chamber provides a promising approach to the problem.

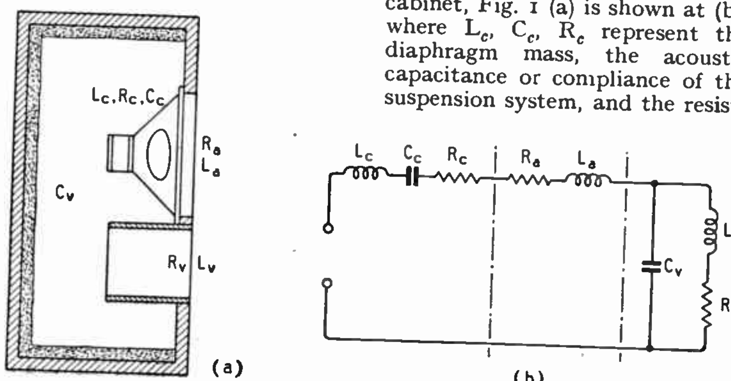


Fig. 1. Section of vented cabinet loudspeaker (a), and, (b), equivalent electrical analogue.

The equivalent circuit of a loudspeaker mounted in a vented cabinet, Fig. 1 (a) is shown at (b), where L_c, C_c, R_c represent the diaphragm mass, the acoustic capacitance or compliance of the suspension system, and the resistance of the suspension system respectively, R_a and L_a the resistance and inertance of the air loading on the front of the diaphragm. C_v is the acoustical capacitance of the enclosed volume, and R_v and L_v the acoustic radiation resistance and inertance of the vent.

C_v and L_v are proportioned to resonate at the same frequency as the effective mass and compliance (L_c and C_c) of the loudspeaker diaphragm, thus reducing the diaphragm excursions and the output directly radiated at this frequency.

Also, since the phase difference between the volume currents in L_v and those generated at the immediate rear of the diaphragm may be as much as 180°, the sound issuing from the vent may be in phase with that directly radiated.

A primary design consideration, therefore, is a knowledge of the loudspeaker resonant frequency, so that the enclosure dimensions can be determined. The exact value can be obtained from the loudspeaker manufacturer, although on a standard product, which may have a nominal resonance of say 55 c/s, the manufacturer's tolerance may well be 10 c/s. It is therefore advisable to check the resonance of the actual unit, although, as is explained later, certain variations in resonance can be obtained in the cabinet by change of vent length.

A second consideration is the area required for the vent. This should be equal to the piston area of the loudspeaker diaphragm so that

$$\text{Vent area} = \pi r^2 \quad .. \quad (1)$$

where $r = \frac{1}{2}$ piston diameter of diaphragm.

The initial enclosure volume V is obtained by equating the expressions for the reactances C_v and L_v which are equal at resonance and solving for V as originally proposed by Hoekstra. It will be shown later that this initial

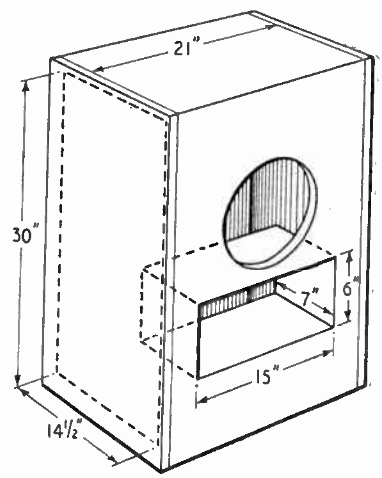


Fig. 2. Dimensions of a typical cabinet, designed to match a 12in (10in effective) diameter loudspeaker with a fundamental resonance of 57 c/s.

World Radio History

CABINETS

volume must be modified before the final enclosure volume V_1 is determined.

Thus the capacitive reactance of the enclosed volume is :—

$$X_{cv} = \frac{c^2 \rho}{\omega V} \quad \ldots \quad (2)$$

where V = the initial volume.
ρ = density of air.
c = velocity of sound in air.
ω = $2\pi f$.
f = loudspeaker resonant frequency.

and the reactance of the mass of air in the release opening is

$$X_{Lv} = \left[\frac{\omega \rho}{\pi r^4 k^3}\right] K_1(2kr) + \frac{\rho \omega l}{\pi r^2} \quad \ldots \quad (3)$$

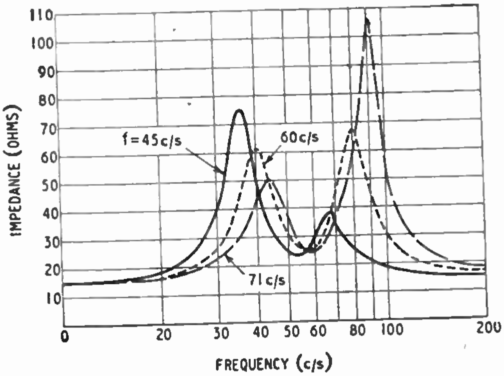


Fig. 3. Effect of cabinet of Fig. 2 on speech-coil impedance curves of loudspeaker units with resonances other than the design frequency of 57c/s.

where l = length of vent
k = $2\pi/\lambda$
λ = wavelength
K_1 = Bessel function of first order
r = radius of opening = ½ piston dia. of diaphragm

and ρ, ω and f are as defined for equation (2).

A series which may be substituted for the factor $K_1(2kr)$ is

$$\frac{2}{\pi}\left[\frac{(2kr)^3}{3} - \frac{(2kr)^5}{5} + \frac{(2kr)^7}{7} - \ldots\right]$$

If f remains less than 150 c/s and r is less than 25 cm, the second and third terms of this series may be neglected with sufficient accuracy, and equation (3) will reduce to

$$X_{Lv} = \frac{3.4 f \rho}{r} + \frac{2 f l \rho}{r^2} \quad \ldots \quad (4)$$

Equating X_{cv} and X_{Lv} an expression for V is obtained:

$$V = \frac{c^2 r^2}{4\pi f^2 (1.7r + l)} \quad \ldots \quad (5)$$

As can be seen from equation (5), changes in resonance of a given enclosure may be effected by modifying the length of the vent.

Although it is desirable to obtain the minimum volume, the vent should only be extended to the centre of the enclosure as shown in Fig. 1 (a), so that it may be lengthened or shortened as necessary to obtain the final adjustment to compensate for the cabinet makers' tolerances, and the exact loudspeaker resonance.

It must be remembered that both the loudspeaker and the vent will displace a volume which must be added to V to obtain the final volume V_1 on which the cabinet size is based.

The final dimensions of an enclosure of the required volume will be a matter of personal taste and convenience, but the basic design of a cabinet which has been used in various forms with reliable results is as follows :

The loudspeaker is a standard 12in model with an actual piston

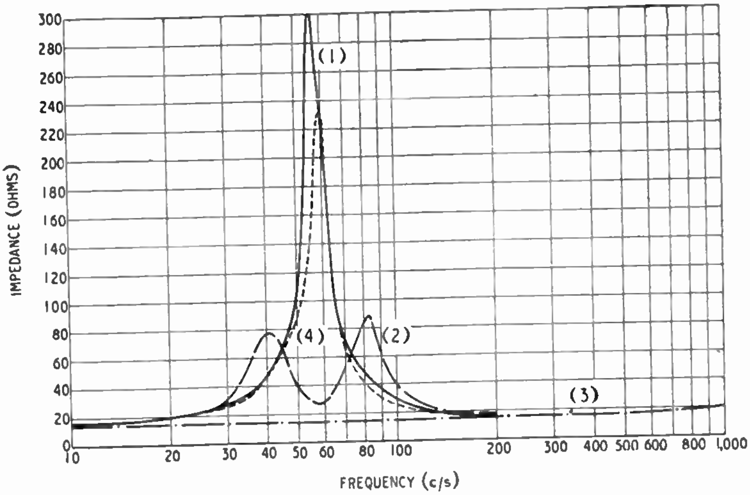


Fig. 4. Impedance curves of unit with 57 c/s resonance in various baffles. (1) No baffle, (2) Vented cabinet of Fig. 2, (3) Diaphragm clamped, (4) Infinite baffle (hole in wall).

diameter of 10in. Then with a resonant frequency of 57 c/s, suggested length of vent 7in, c = 1185ft per sec and r and l in inches.

$$V = \frac{1185^2 \times 12^2 \times 5^2}{4\pi 57^2 \times 15.5}$$

= 8,000 cu in.

Volume of vent = 540 cu in.
Volume of loudspeaker = 200 „
740 „

∴ Final cabinet volume V_1 = 8,000 cu in + 740 cu in = 8,740 cu in.

Suggested dimensions :
Height 2ft 6in
Width 1ft 9in
Depth 1ft 2in.

With area of vent 80 sq in.

When the original cabinet was made, as shown in Fig 2, it was decided to have the vent variable in length for measurement purposes, and to enable a correction to be made, if necessary, to the final resonance figure.

Fig 3 shows the effect on the impedance curve of changing the resonance of the loudspeaker. Changing the unit for the one for which the cabinet was designed, with a free air resonance of 57 c/s, various measurements were taken as shown in Fig 4. The free air impedance curve of this unit is typical of the normal high-flux 12in unit obtainable to-day, and,

World Radio History

Vented Loudspeaker Cabinets—

as can be seen at (1) of Fig 4, rises to almost astronomical heights at resonance. When put in the cabinet, however, with the anti-phase resonance at the same frequency, the result can be seen at (2) of Fig 4, with the diaphragm clamped at (3), and mounted on a baffle of "infinite" dimensions at (4). Variations of vent length from 4in to 7in and 10in give the resonances of 63.5, 58 and 53 c/s respectively, equal to those for cabinet volumes of 9,800, 8,000 and 6,700 cu in respectively, when the vent length is kept at 7in.

The basic formula in this article has been used successfully over a wide range of requirements, from a cabinet housing a 6in speaker with a bass resonance of 130 c/s up to four 18in speakers each with a resonance of 50 c/s. It is, however, imperative in all designs that the cabinet be rigidly constructed, for any resonance in the individual panels will cause a sharp attenuation at the frequency concerned, and, if the resonance is particularly severe, the panel itself will radiate.

It is necessary to line the inside of the back, top and bottom of the cabinet with felt or cotton wool in butter muslin to minimise standing waves.

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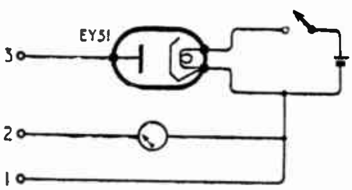
HIGH - VOLTAGE MEASUREMENT

R.M.S. and Peak Values

General view of the instrument.

IN television, it is often necessary to be able to measure high voltages, but the internal impedances of their sources are usually so high that ordinary methods are inapplicable. The electrostatic voltmeter is particularly useful because it draws no current from the source in d.c. measurements.

It consists essentially of a variable capacitor to the rotor of which is attached a pointer. The rotor is spring-loaded so that in the absence of any force acting to enmesh the vanes the capacitor is always at its minimum value. On connecting a high-voltage source to the capacitor it becomes charged and the electric field between the plates exerts a mechanical force which tends to enmesh the plates. The rotor plate actually does move, carrying with it the indicating pointer, and comes to rest when the force produced by the electric field balances the restoring force of the spring.



Circuit of electrostatic meter and peak-measuring diode.

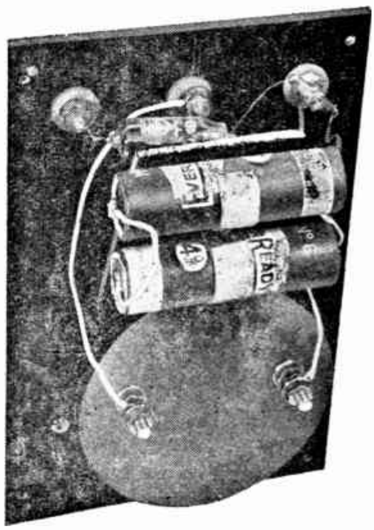
Usually the rotor has a single vane and the stator one or two. The clearance between them is considerable—often as much as ¼in—so that the capacitance is very small. It is commonly of the order of 20 pF.

With vanes of straight-line capacitance, the instrument has a square-law scale, but in practice, it is usual to shape the vanes to give an approximately linear scale. The shaping is usually such that the scale is cramped at each end and open in the middle.

The electrostatic voltmeter can be used with alternating as well as direct supplies and measures the r.m.s. value of a sine waveform. It is independent of frequency as long as its capacitance current is negligibly small.

If it is fed through a diode, it becomes a peak voltmeter indicating the peak value of alternating waveforms. An instrument of this kind is shown in the photographs and the arrangement is given in the circuit. It is built around a 3½-in meter of 5 kV full-scale reading; the instrument used was actually a Government-surplus type covering 1-5 kV.

For use as a normal electrostatic voltmeter, connection is made to terminals 1-2. For use as a peak voltmeter, connection is made to terminals 2-3. The valve is a Mullard EY51 with its filament heated from two No. 8 torch batteries. As shown in the circuit, the instrument measures the peak value when the input makes terminal 3 positive with respect to terminal 2.



Interior view showing the valve and batteries.

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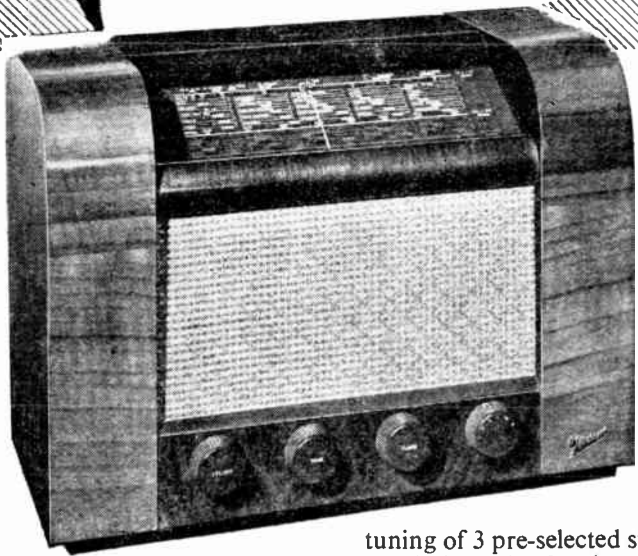

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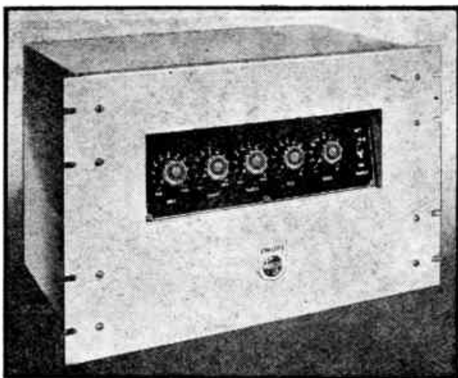

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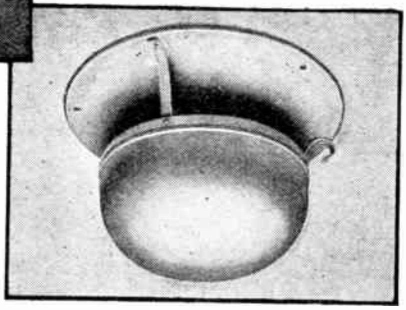

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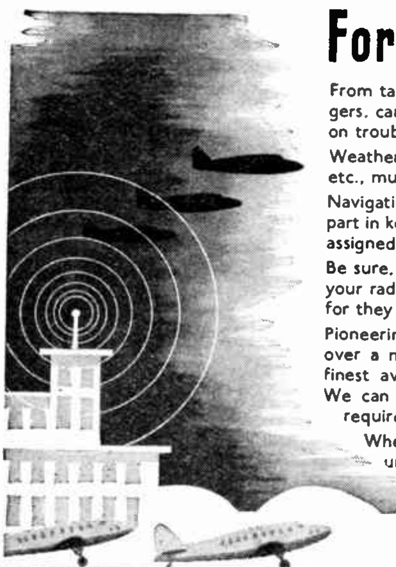

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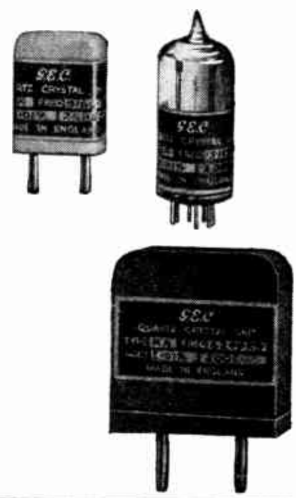

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World Radio History

REFLEX VALVE VOLTMETER

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

A Simple but Effective Method of Stabilization

MOST present-day valve voltmeters have as their basis a pair of similar valves with the meter connected between cathodes or anodes. This arrangement, which by itself is suitable for d.c. measurements, is usually supplemented by a diode rectifier for a.c. Although the effective mutual conductance of the pair of meter-driving valves used in this way is only half the actual g_m of one of them, at least they can be worked on the "straight" of their characteristics, where g_m approaches its maximum. If the valves are well matched, their comparatively large anode current under these conditions is automatically balanced out, and this balance is unaffected by changes in anode voltage. The diode gives linear rectification over a large range of input voltage, which is not limited by the supply voltage available for the instrument.

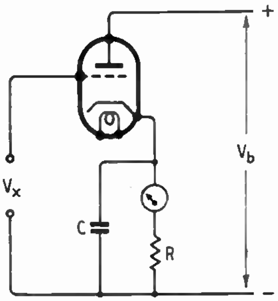

Fig. 1. Reflex (or automatic slide-back) valve voltmeter in its simplest form. V_x is the voltage to be measured. If the input terminals are liable to be open-circuited, an internal high resistance across them is desirable.

Yet for some purposes, especially for level indicators incorporated in signal generators,* etc., this three-valve voltmeter is rather more elaborate than one may wish. And although the zero setting is stable (always assuming that the valves really are similar), the calibration depends directly on the valves' g_m and hence indirectly on the anode voltage. Provided that one is not chiefly interested in measuring very low or very high voltages, there is still a lot to be said for what is generally known as the reflex valve voltmeter, but which can also be regarded as an automatic slide-back type.

* For example, the audio signal generator described in the August and September issues.

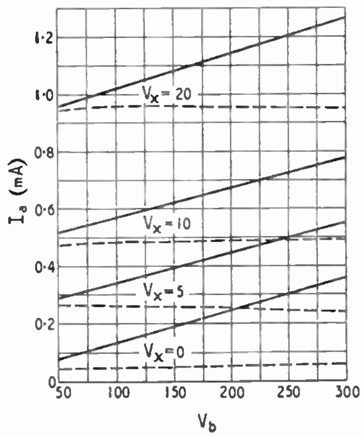

Fig. 2. The full lines, which apply to the circuit of Fig. 1, show how the meter deflection depends on the supply voltage, V_b. The readings were taken with R = 25 kΩ, μ = 30, g_m (nominal) = 3.5 mA/V, and C = 50 μF; and V_x is specified in r.m.s. values of 50-c/s sinusoidal voltage. The dotted lines show the effect of adding R′(= μR) (Fig. 4), in this case 750 kΩ.

As Fig. 1 shows, it is extremely simple. Compared with the diode type, which in some ways it resembles, it has the advantage that the "signal," V_x, is relieved of the burden of supplying the power in the load resistance, so the input impedance can be very high even although the meter current may be as much as several milliamps. On the other hand, the maximum voltage that can be measured is limited to something less—generally a good deal less—than the supply voltage, V_b.

Before discussing the functioning and design of this type of voltmeter in detail, let us note the important improvement that was incorporated in the example just cited. In its simplest form (Fig. 1), the system suffers from the disadvantage that both the zero setting and the calibration depend on V_b. This fact is shown by the full lines in Fig. 2, the results of readings taken with the circuit values stated thereunder. As we see, the "zero" current (i.e., with $V_x = 0$) is very closely proportional to V_b. In some applications V_b may be far from constant and it may not be convenient to use a voltage stabilizer. The very appreciable zero current is also a nuisance.

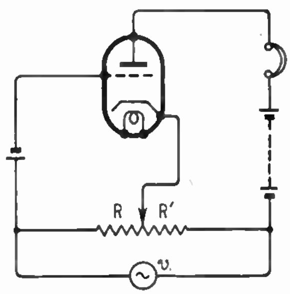

Fig. 3. Well-known method of measuring μ, showing basis of stabilizing method (Fig. 4).

A simple and effective way out of both difficulties can be derived from the classic circuit for the measurement of μ (Fig. 3). Except for the presence of R′ this is essentially the same as Fig. 1,

World Radio History

Reflex Valve Voltmeter—

the output, v, of the generator representing changes in V_b. The ratio of R′ to R is adjusted until there is no signal in the valve

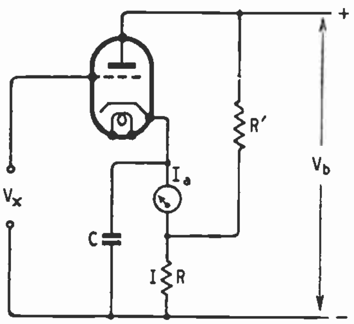

Fig. 4. Adding R′ ($= \mu$R) to Fig. 1 very effectively stabilizes the instrument against variations in V_b, as demonstrated by Fig. 2.

circuit. Then $\mu = R'/R$. Put another way, the value of R′ required in this circuit to prevent changes in supply voltage from causing changes in valve current is μR. All that is needed to stabilize the reflex valve voltmeter against variations in V_b, then, is to add R′ (Fig. 4). Even though g_m and r_a vary considerably as the working point of a valve is shifted, and also when the valve ages, μ remains nearly constant; so once R′ has been correctly set for a given R and valve it can be relied upon to remain correct.

It may not be obvious at first glance that this stabilization will necessarily hold good under signal-handling conditions, over the full range of measurement; so we shall look into that when considering the working in detail. But in the meantime the dotted lines in Fig. 2 offer experimental evidence that a fixed value of R′ does, in fact, give almost perfect stabilization not only at zero but also at any signal level. In this case at least, variations in zero setting and in calibration are hardly appreciable over a supply voltage range of 50 to 300. Not only so, but the zero current is so much reduced that devices for balancing it out are unnecessary.

Heater voltage is not likely to vary so much as V_b; a reduction of 15% (which is certainly outside good practice) was found to affect a mid-scale reading by less than 2%.

Let us first consider the voltmeter in its Fig. 1 form. *Mutatis mutandis*, the same consideration applies to the so-called infinite-impedance detector.

The zero condition is easily ascertained from the appropriate I_a/V_g curve (Fig. 5) by drawing a load line (the reciprocal of its slope representing R) from the origin O and noting the point of intersection A. This point indicates the initial meter current and the bias developed by it in R. For strict correctness the usual constant-V_a characteristic curve would have to be "de-sloped" slightly to allow for the fact that V_a becomes progressively less than V_b as the current is increased; this can easily be done, of course, but is hardly worth while in practice, as the difference is trifling.

Both for rectification and for minimizing the "zero" current it is clear that R should be large enough for its line to cut the valve curve low down.

Considering now the effect of R′, we see that the supply current flowing through it develops a bias across R equal to $V_bR/(R + R')$, which can be allowed for in the diagram by making the load line start this distance to the left of the origin, at B. With $R' = \mu R$, this bias is equal to $V_b/(\mu + 1)$. The original load line OA will from now on be ignored.

The new load line cuts the valve curve at C, and it is obvious at once how the "zero" current is greatly reduced. The rectification of small signals is not necessarily improved, because this part of the valve characteristic usually approximates to a parabola, which is notable for rectifying equally at all points. In any case the small-signal rectification is poor.

When current flows through R from the valve, the voltage across R′, and therefore the current through it, alters; so it might appear that the bias represented by OB is affected. This is not so if, making use of the Principle of Superposition, we regard the load resistance as R and R′ in parallel, which is equal to $R\mu/(\mu + 1)$, and draw the load line accordingly. In practice $\mu >> 1$, so that the slope of the new load line is hardly distinguishable from that of the old. As a matter of fact the two lines meet at the point where $-V_g = V_b$.

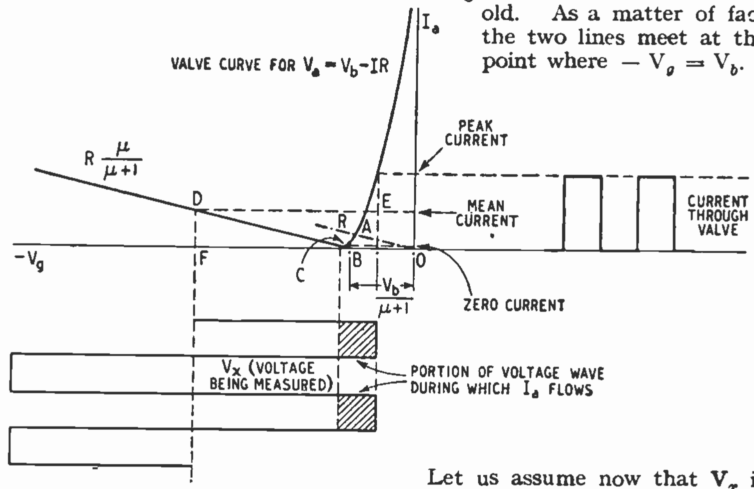

Fig. 5. Diagram illustrating detailed operation of reflex valve voltmeter and how it can be designed to fulfil given conditions. The simplest case—symmetrical square-wave input—is shown.

Let us assume now that V_x is large enough to sweep well around the bend. The negative half-cycles are almost completely suppressed in the output circuit, while the positive voltage half-cycles reach the steep part of the valve curve and produce large current pulses. These quickly charge up C, increasing the voltage drop across R, and the working point is driven up the load line to the left, reducing the current amplitude and also (except with square waves) the portion of each cycle during which current can flow. This double reduction in mean current limits the leftward movement of the working point and brings it to a stop at the position

World Radio History

(say D) where the mean value of the current pulses is equal to the value of the continuous smoothed current flowing through R.

Such a condition is represented by the input-voltage and output-current waves shown in Fig. 5. (For strict accuracy, again, the valve curve used to find point C would not be correct for tracing out the current pulses; the appropriate I in $V_b - IR$ is now the *constant* mean current at point D. The difference is unimportant qualitatively, or even quantitatively if V_x is small relative to V_b). A symmetrical square-wave input is shown, because it simplifies matters by making the mean current exactly half the peak value. If therefore the full-scale current of the meter is given, the peak current is known. At the most it ought not to be allowed to reach the point where grid current starts to flow. When, by one consideration or another, the greatest mean current has been fixed, the load resistance for a given voltage range can be determined by setting off the peak voltage along the line ED and drawing the load line through D and B. For a multi-range voltmeter the several values of R (and of course R′) can thus be quickly worked out.

With other waveforms the process is considerably complicated by the fact that the ratio of peak to mean current increases as V_x is increased, and of course one does not know exactly what V_x is without knowing the ratio of peak to mean. It can be done on the diagram by trial and error, or algebraically if one can find an equation to represent the valve characteristic; but in practice probably the best way is to use the diagram to gain a clear picture of the working and then correct the estimated departure from square-wave values by experiment. Another alternative, which is recommended for the light it sheds on the process, is the analysis described by G. L. Hamburger in *Wireless Engineer*, May, 1949, pp. 147–153.

If the portion of the signal voltage wave during which anode current flows (shown shaded in Fig. 5) could be reduced to a very small fraction of the whole amplitude, then the instrument's deflections would sensibly be proportional to peak values. They

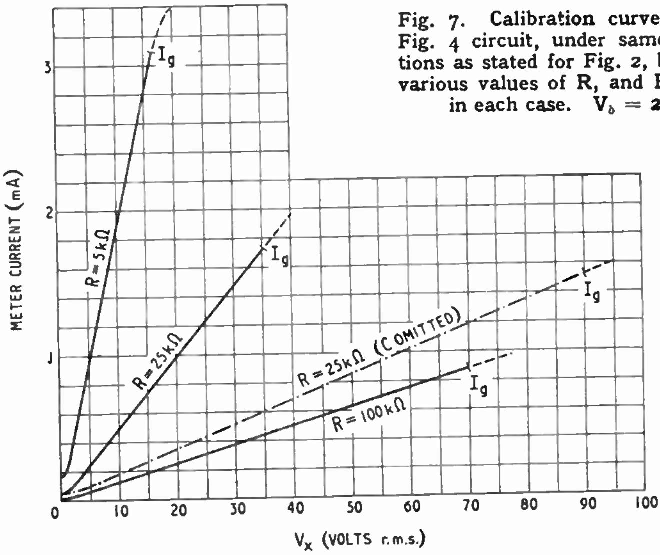

Fig. 7. Calibration curves, using Fig. 4 circuit, under same conditions as stated for Fig. 2, but with various values of R, and R′ = μR in each case. V_b = 200.

would also be almost entirely independent of the valve characteristics. It is clear from the diagram that to approach this ideal the load line slope should be very gradual compared with that of the valve curve. In other words, R should be very large compared with the mutual resistance, $1/g_m$. The ratio of the shaded portion of the voltage wave to the rest is approximately k/g_m : R, where k is the ratio of peak to mean current. This g_m is, of course, the average over the working part of the curve, which includes the bottom bend, so will be less than the figure given in the manufacturer's catalogue.

Making R very large necessitates a low-reading meter, or increases the value of V_x for a given deflection. The need for the sensitive meter can be overcome by using a second triode as a cathode-follower current amplifier; but with two triodes one might as well use the balanced type of instrument.

In practice, using a milliammeter rather than a microammeter—and especially with peaky waveforms—the response

One of the things to note is that the peakier the waveform the more the grid-current point restricts the maximum allowable amplitude of V_x. For as V_x increases, the portion of each cycle during which current flows diminishes, and the current peak has to be so much greater in order to have a given mean value. This can be seen well on an oscilloscope.

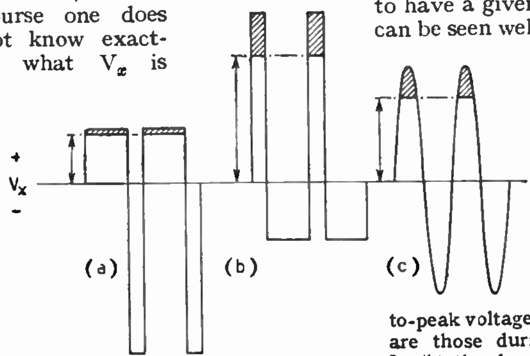

Fig. 6. The arrows indicate the relative meter deflections (i.e., mean currents) obtained with (a) an unsymmetrical square wave, (b) the same reversed, and (c) a sine wave having the same peak-to-peak voltage. The shaded portions are those during which I_a flows. In (b) the duration of current flow is one-third that in (a), so the amplitude of current would have to be three times greater to yield the same mean value. Actually the mean value is between two and three times greater. So care must be taken that peaky waves do not drive the valve into grid current. The deflection due to a sine wave is intermediate.

World Radio History

Reflex Valve Voltmeter—
of this type of instrument, although approximately peak, is more or less influenced by the mean value of the positive half-cycle of input.

With unsymmetrical square waves, the half-cycles with the greater duration have the less amplitude and therefore give the smaller reading; but this principle is partly offset by the fact that when the duration is less the shaded portions (during which current flows) must have greater area, and therefore doubly greater amplitude in order to yield the greater mean value of current to develop the greater voltage drop across R. This is shown in Fig. 6, where the arrows indicate the relative deflections in each case.

By the simple expedient of omitting C, thus converting the system to a cathode follower, the voltmeter can be made to respond fairly accurately to mean values of positive half-cycles of all except small voltages. The stabilizing resistance, R′, remains effective. The sensitivity is reduced to about one third, and since stray capacitance tends to restore the higher sensitivity at high frequencies, it is advisable to restrict this arrangement to audio and perhaps low radio frequencies.

Experimental calibration curves are shown in Fig. 7 for the conditions indicated. In each case the start of grid current is marked. For comparison, one curve with C omitted is also shown; as one would expect, the current for a given V_x is reduced to approximately $1/\pi$, that being the ratio of mean to peak of half-cycles of sine waves. In all cases the response is practically linear above about 2 V.

Fig. 8 suggests how to use a 0–1 mA meter and a typical triode to cover ranges of 5, 20, and 50 V. If required only for frequencies not exceeding about 100 kc/s it would probably be convenient to omit C and divide all the resistance values by about 3. A very simple unit would do to supply the 200 V, as only a few milliamps (peak) are needed, and the regulation can be very poor.

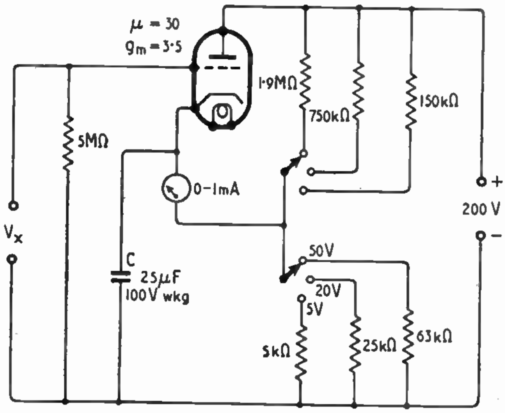

Fig. 8. Outline design for voltmeter having ranges of 5, 20 and 50 volts.

We still have not shown theoretically why the beautifully level dotted lines in Fig. 2 were just what one ought to expect.

What we have to prove is that the mean current through the valve, which we shall denote by I_a, is not affected by variations in V_b (provided of course that V_b does not fall below the level necessary to allow sufficient peak current to flow through the valve to maintain the mean current).

The effect on the valve curve of altering V_a and/or V_g is to shift it bodily to left or right, and V_g shifts it μ times as far as an equal V_a. The error involved in this assumption is small, especially as the calibration of the instrument depends only to a minor extent on the precise shape of the curve.

Now V_g (with any signal, V_x) is represented in Fig. 5 by OB + BF. OB we already know is $V_b/(\mu + 1)$, and BF is given by the effective load resistance, $R\mu/(\mu + 1)$, multiplied by the mean current, I_a. So

$$V_g = -\frac{V_b}{\mu+1} - \frac{I_aR\mu}{\mu+1}$$

Also

$$\begin{aligned} V_a &= V_b - IR \\ &= V_b + V_g \\ &= V_b - \frac{V_b}{\mu+1} - \frac{I_aR\mu}{\mu+1} \\ &= \frac{\mu V_b}{\mu+1} - \frac{I_aR\mu}{\mu+1} \end{aligned}$$

Assuming for the moment that I_a is (as we wish) constant, the only terms in the above expressions for V_g and V_a that vary with V_b are $-\frac{V_b}{\mu+1}$ and $\frac{\mu V_b}{\mu+1}$ respectively. As the latter is μ times the former and of opposite sign, their effects cancel out, and our assumption that I_a would be constant is justified.

It should not be difficult to see that varying V_b can be represented in Fig. 5 by moving the point O horizontally, carrying the voltage scale with it. The effect of increasing V_b therefore is to allow a greater scope for peak anode current and so to enable a larger V_x to be applied without running into grid current.

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Properties and Uses of Negative Temperature Coefficient Resistors

THERMISTORS

ESSENTIALLY the thermistor is a device which possesses a high negative temperature coefficient of resistance, and this unusual property makes it useful in many electrical devices.

Thermistors of many types are in regular production by Standard Telephones and Cables, and their ready availability means that they may be considered for use in modern circuitry. While many materials can be used, that which has been developed as a result of thirteen years' work in the research laboratories is made from a mixture of various metallic oxides, which are heat-treated to extremely high temperatures in an oxidizing atmosphere. By control of the mixture and firing temperature schedule, the resistivity and temperature coefficient can be varied in very wide ranges.

These thermistors, when operated within their rated limits and in neutral or oxidizing atmospheres, are quite stable with time, and no limit to their life is known.

Forms of Thermistors

To meet the majority of applications, a series of designs has been standardized and put into production. They may be divided into the following types:—

Bead Types

In these types the thermistor element is a small bead unit mounted on parallel platinum wires. The diameter of the bead is about 0.020in, and the arrangement is shown in Fig. 1. The bead types are made in two forms, directly-heated and indirectly-heated. In the directly-heated form, the bead as described is welded to stouter lead wires and the unit sealed into a glass bulb for protection. In indirectly-heated types the bead is provided with a thin electrical insulating coating, I, upon which a minute 100-ohm heater, H, is wound (Fig. 2). The whole unit is attached to suitable supports and leads, and is sealed into a small glass bulb which may be highly evacuated or gas filled, depending upon the applications.

Block Types

In these types much larger pieces of material are employed. For example, circular discs are made by sintering aggregates formed by pressing thermistor powder in moulds under hydraulic pressure; and rods are formed by firing lengths of thermistor "dough" which have been extruded through circular dies. After firing, these types are prepared for use by metallization of contacts followed by the soldering on of tinned copper lead wires.

Fig. 1. Bead-type thermistor with embedded platinum leads.

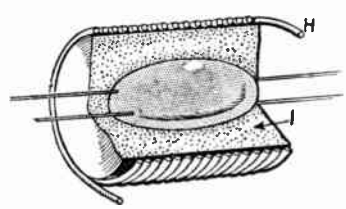


Fig. 2. Indirectly-heated thermistor with insulated auxiliary winding.

Characteristics

The thermistor at constant temperature has an "ohmic" resistance, the current being proportional to the voltage. The resistance R varies with the absolute temperature T according to the relation:—

$$R = a\epsilon^{b/T}$$

where a and b are constants.

The temperature coefficient of resistance is given by:—

$$\alpha = -\frac{b}{T^2}$$

and thus decreases as the temperature rises.

By control of the manufacturing processes, the resistivity of the material can be varied in a ratio of 500 to 1, and in general it can be said that the higher the resistivity the higher the negative value of temperature coefficient. The beads mentioned can, for example, be produced with room temperature resistances of 500 to 500,000 ohms and with temperature coefficients for the latter of the order of -4 per cent per °C. This may be compared with a value of the order of $+0.003$ for metals.

There is another rather striking property of thermistors which results from the negative temperature coefficient. Consider a thermistor connected to a source of electrical power; then energy will be dissipated in the thermistor, which will raise its temperature and decrease its resistance. For small power inputs the loss of heat by convection can equal the input, and the thermistor is maintained at a constant temperature slightly above its surroundings. When the temperature difference reaches a value usually around 30° C, a condition arises where this balance is no longer maintained, and the temperature starts to rise. This results in a greater dissipation and further temperature rise, and will ultimately result in destruction of the thermistor unless the power dissipation is limited by external resistance. With such a resistance, the current will rise to a new stable value, which may be many times larger than the initial current. The circuit has behaved rather like a relay. When the thermistor is provided with a separate heating element, the simple characteristics can be greatly modified by variation of the current flowing through the heater.

With any thermistor, therefore,

World Radio History

Thermistors—

there is a critical voltage which, if applied across it, will cause the temperature to rise and the resistance to fall until limited by some other part of the circuit. With thermistor elements of the same size, this voltage E_{max} increases with the square root of the resistance It decreases as the ambient temperature increases, and increases if the thermistor is connected to a better "heat sink."

Uses of Thermistors

The most obvious application of the thermistor is for resistance thermometry. The very small dimensions and thermal capacity of the thermistor bead result in a thermometer with a very small "bulb," and high speed and sensitivity. But because of this, care must be exercised to reduce errors which arise due to the measuring bridge current itself modifying the temperature of the thermistor, and the bridge current must be reduced to a very small value. When this is done, temperatures can be measured with an accuracy of 0.001° C and, provided the instrument is carefully handled, the resistance-temperature curve will remain stable.

Thermistors can also be used as protective devices. By use of the maximum voltage effect mentioned earlier, the circuit may be arranged so that, when the thermistor reaches a certain temperature, the current rises abruptly to a much larger value, and this may be used to operate signals.

Other types of thermistors are available for use as bolometers, and perhaps the greatest application to date has been to the measurement of power at centimetric wavelengths. For this purpose, very small beads are mounted between colinear wires which are then supported in appropriate positions, and with proper matching, in waveguides or coaxial line systems. The power dissipated by the radio frequency is absorbed in the bead, and changes its resistance. The unit may be calibrated with a.c. or d.c., which is adjusted to give the same resistance change. Much ingenuity has been applied in the development of special bridges which maintain constant resistance in the thermistor bolometer by automatically varying the amplitude of a low-frequency current superimposed upon the high-frequency current flowing in it.

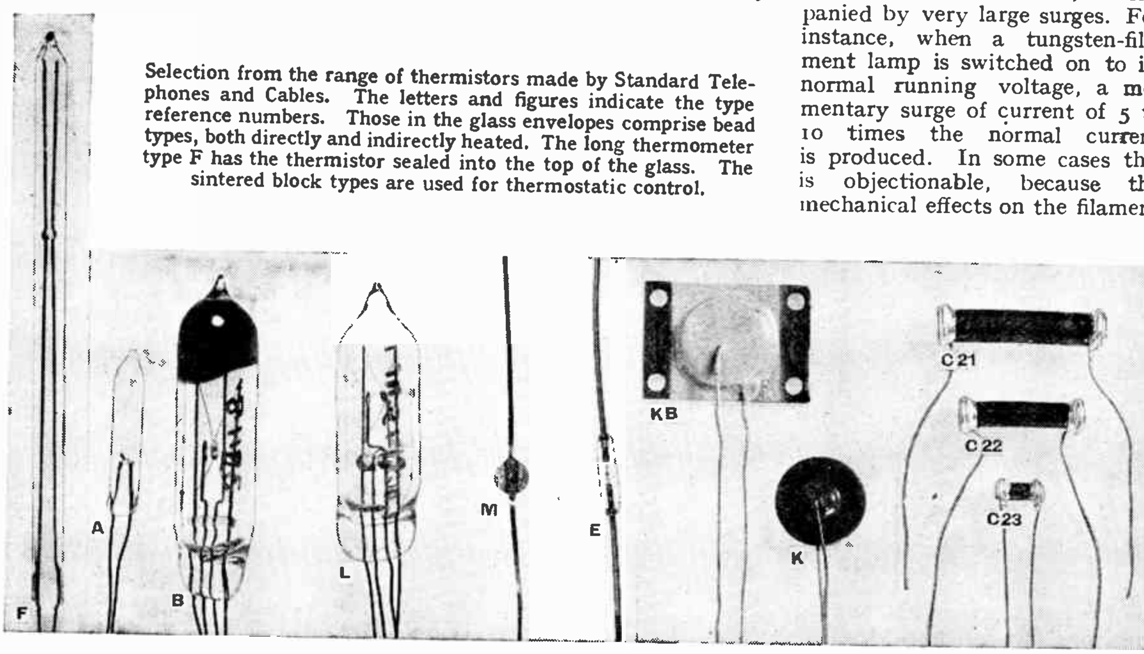
Thermistors can also be used to compensate for temperature changes of resistance of copper in measuring instruments. For example, a thermistor in series with the shunt of a voltmeter can be employed to give temperature compensation, though this can be accurately achieved only over a small range of temperature.

Surge Suppression

The properties of thermistors are well suited for the suppression of current surges of short duration, and especially those due to switching. At the moment of arrival of the surge, the thermistor must be cold and of high resistance, and after a time the resistance must be so low that it can remain in the working circuit without causing embarrassment.

The switching of tungsten filaments is a familiar case, accompanied by very large surges. For instance, when a tungsten-filament lamp is switched on to its normal running voltage, a momentary surge of current of 5 to 10 times the normal current is produced. In some cases this is objectionable, because the mechanical effects on the filament may cause distortion; in other cases the surge may render protection of the circuit by fuses very difficult. A familiar case is that of the photoflood lamp where elimination of the switching surge results in an appreciable increase of life.

Another example is provided by the series operation of valve heaters. In this case the switching surge may rise to five or six times the running current. While this may not be very serious when all the valves are alike, it may be disastrous if the heaters are dissimilar. For example, one may be a cathode-ray tube in a television receiver with a heater which comes up to operating tem-



Selection from the range of thermistors made by Standard Telephones and Cables. The letters and figures indicate the type reference numbers. Those in the glass envelopes comprise bead types, both directly and indirectly heated. The long thermometer type F has the thermistor sealed into the top of the glass. The sintered block types are used for thermostatic control.

World Radio History

perature much faster than those of the other series valves, or there may be a dial lamp which comes to full brightness in a very short time. In these cases, the heater which reaches running temperature first has to pass an overload current while at normal or higher than normal resistance for some seconds. In one actual case it was found that a cathode-ray tube designed for 6.3 volts was actually subjected to 18 volts for a few seconds during switching. Now, by the use of an appropriate thermistor in series with the heaters, the surge can be either completely suppressed or reduced to safe proportions, so that heater burn-outs of this nature are eliminated.

For this purpose the type CZ Brimistor was designed. It is in the form of a rod with end wires for direct soldering into the circuit. It is made in various sizes to suit the common heater ratings.

Similar problems occur in telephone circuits, where inductive surges from switching or dialling operations may cause annoyance.

The indirectly-heated thermistors lend themselves to many varied uses in electronic apparatus. By variation of the current through the heater, the resistance of the thermistor may be varied in a ratio of 500 : 1, and the power lost in the heater to cause this change is only of the order of 60 milliwatts. This form of thermistor can therefore be used as a remotely controlled variable resistance. Naturally, the dissipation in the thermistor element must be kept small if the resistance is to obey accurately the orders it receives from the control circuit. With this limitation, the device can be very valuable in amplifier gain-control circuits. The heater is small, and has such low inductance that the control circuit may be operated directly by radio-frequency currents, and useful arrangements for automatic control of level can be devised.

Similarly, the use of thermistors in phase shifting networks opens up many possibilities.

The trigger effect which is obtained when the critical voltage is applied to the thermistor is often made use of to provide a relay. By the application of voltages close to the critical value, the circuit behaves as a time-delay relay, and reliable timing up to periods of 10 or 15 seconds can be secured. By the use of the indirectly-heated thermistors, the time delay can be varied according to the power dissipated in the heater. It is necessary to point out that in this and some other of the applications, the sensitivity of the thermistor to temperature is such that variation of room temperature will cause variation of performance. This can be overcome by a more complex circuit in which another thermistor is provided to balance out the effects due to this cause.

Enough has been said to indicate the extraordinary versatility of thermistors. In their modern form they are reliable instruments which will continue to function without variation as long as they are correctly used. Though they are semi-conductors, their resistance at constant temperature is truly ohmic, and their use in audio- or radio-frequency circuits results in no measurable distortion. Their high sensitivity can be used to advantage in many measuring and controlling circuits, and it is safe to say that the extent of their field of application is limited only by the ingenuity of circuit designers.

ANTI-IMPLOSION

THE Radio Manufacturers Association of America has formulated the following set of precautionary rules to minimize risk in handling cathode-ray tubes when they are being fitted in a set, or a faulty one is being replaced.

1. Don't remove the tube from its carton until you are quite ready to use it.

2. Always wear goggles with safety glass, or its equivalent, when handling the naked tube.

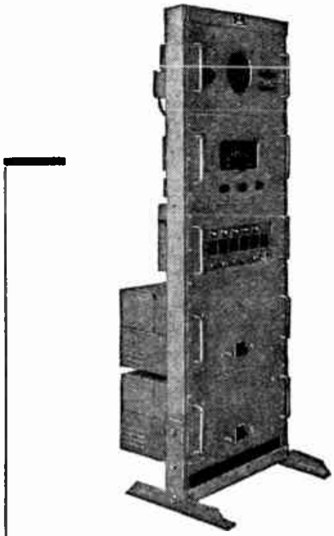
3. Keep other persons, especially children, at a safe distance when the tube is out of its container.

4. Always place the tube on a soft padding whenever it is set down, or better still, return it to its carton.

5. When replacing a defective tube put the old tube into the protective carton and dispose of it as soon as possible.

6. Never leave defective tubes lying around. One safe way of disposing of the tube is to seal it in the carton and then drive a crowbar through the closed top of the container.

7. Dummy tubes should be used when possible for display purposes.



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LETTERS TO THE EDITOR

Copenhagen Plan: B.B.C. View ♦ Leaning Television Images ♦ C.R. Tube Problems

"*Intermediate Frequency and the Copenhagen Plan*"

THE article by G. H. Russell in your September issue appears to contain serious errors, and as a result it gives an unfairly pessimistic picture of reception conditions when the Copenhagen Plan comes into operation.

Allowing the author's implicit assumption that intermediate frequencies which give rise to a whistle of 9 kc/s or less are unusable, some of his errors seem to be:—

(1) The bands of intermediate frequencies unusable because of second harmonic interference are shown in Table II to be up to 45 kc/s wide, whereas the figure should be 18 kc/s if the interfering carrier is below the oscillator harmonic frequency and 6 kc/s if the interfering carrier is above it.

(2) Intermediate frequency bands rejected because of second-channel interference have widths up to 20 kc/s. These should be 9 kc/s in every case.

After correcting Mr. Russell's tabulation it is found that the following bands are clear:—

497.6 kc/s to 499.0 kc/s
490.0 kc/s to 491.6 kc/s
458.5 kc/s to 469.0 kc/s
434.6 kc/s to 436.0 kc/s
387.0 kc/s to 388.0 kc/s
373.0 kc/s to 378.0 kc/s
309.0 kc/s to 310.3 kc/s

Incidentally it is of interest to note that, applying Mr. Russell's assumptions to the *present* distribution of B.B.C. frequencies, one of the bands of i.f. that cannot be used (among many others) is from 456.5 kc/s to 465.5 kc/s. But nevertheless he refers to "the popular intermediate frequencies of 456 and 465 kc/s"!

In addition I think it is a very debatable point whether the spurious responses due to i.f. third harmonic, the second-channel frequency at 200 kc/s, and oscillator 2nd harmonic on 200 kc/s, should have been included. Measurements we have made on typical modern superhets with one signal-frequency tuned circuit indicate that these factors are of negligible importance. However, in case where interfering signals are objectionable a simple rejector circuit, like those at present supplied by receiver manufacturers, would solve the problem.

The difficulty in some parts of the North Region due to the proximity of 668 kc/s with the combination of 200 kc/s and 465 kc/s will be eliminated under the Copenhagen Plan as the northern frequency at 692 kc/s will be sufficiently remote. Moreover, the possibility of interference from International Common Frequencies is unlikely as the transmitter powers will be so low.

A careful examination of the Copenhagen Plan shows that the likelihood of interference due to these several causes is little different from that existing under the Lucerne Plan. The margin of frequency tolerance to safeguard against ageing of i.f. circuits is also as great under the new Plan.

I am sure your readers know that agreement on a wavelength distribution plan is reached only after the most exhaustive examination of the requirements of all the participating countries; the need to have allocations which minimize interference of this kind is only one of many problems which have to be borne in mind. On the whole, I feel there are grounds for hoping that, with the orderly distribution of wavelengths in Europe, broadcasting in the United Kingdom will benefit from the implementation of the Copenhagen Plan.

H. BISHOP,
Chief Engineer, B.B.C.

[**Correction:** The author of the article referred to in this letter corrects an error in the 5th line of col. 1, p. 324: 485 should read 455.—ED.]

"*Televising Moving Images*"

MOST readers of *Wireless World* realized, I feel sure, that I was to a considerable extent trailing my coat when I wrote the article on this subject for the August issue. My great wish is to see television make rapid advances on the road towards perfection and the surest way of bringing this about is to discover just what its present imperfections are and how they come about. Any provocative article in *Wireless World* is certain to bring in constructive criticism from its wide circle of well-informed readers, whose strictures and suggestions have helped in the past to point a way to the solution of many a problem.

It is, though, but fair that a critic should read an article with understanding before girding up his loins to tear it and its author to pieces. I feel, therefore, that, as a change from the setting of traps and the springing of them of which he accuses me, I may be allowed to try my hand at rolling out the Barrell! Both television and the cinema obtain their results by deceiving the eye, a point which I stress and re-stress in my elementary book on television; but most people seem to share my view that television's methods of deception are not so successful as those of the cine. Interline flicker I find particularly annoying and that is one reason why I don't feel at all sure that interlacing provides the final answer to the viewer's prayer.

I am well aware that U.S.A. systems use 60 frames per second because that number is called for by their a.c. mains frequency. It has, however, been suggested by writers on this side of the Atlantic that this unavoidable increase of 20 per cent in the number of frames as compared with ours, is a liability (since it wastes good bandwidth) rather than an asset. I sought to show that in the case of moving objects it might not be altogether a disadvantage. But never have I suggested anywhere that we should adopt an image frequency which was not a multiple of 50 or of 25.

Another reader claims that there can be no "lean" of a moving image, since the mosaic of the television camera is an image-storing device. I would accept that were the screen of the receiver c.r.t. also image-storing. The afterglow of screen varies a little in persistence in different makes of television tubes, but it is, I understand, always a matter of a few milliseconds. The truth is that there are not two but three screens concerned in the transmission and reception of a television image; the mosaic, the fluorescent screen and the retina of the eye. Both the first and last are image-storing. The "lean" may thus occur on the screen, but not be noticed by the eye as a lean—though its presence is likely to make for reduced sharpness of the image.

R. W. HALLOWS.

"*Cathode-ray Tubes for Television*"

IN the first part of my article in the June *Wireless World* I did not make it clear that the solution of the problem of how to change a c.r. tube design and operating conditions to accommodate an increased number of lines assumes negligible deflection defocusing in the prototype tube.

When the number of scanning lines is increased the size of the spot must be proportionately reduced at *all* parts of the screen. Thus we simultaneously require (1) the undeflected spot size shall be $1/\mu$ of that on the original (this condition was satisfied in the June solution) *and* (2) the increase of spot size on deflection shall also be $1/\mu$ of that on the prototype. This second condition was not met and the solution given is not valid therefore unless the deflection defocusing of the prototype is negligibly small.

But condition (2) can be closely met by reducing the beam width in the deflecting fields to $1/\mu$ of its original value. This is most easily done by moving the whole triode towards the focusing coil (Fig. 1, June issue) until the geometrical magnification between cross-over and spot is increased μ times. a is kept constant as before.

The spot size on the derived tube will then be $\mu SM\lambda \sqrt{(V_1/V_2)}$ using the original notation: S is the cross-over size on the prototype and M its magnification. But the spot size on the derived tube (undeflected) is to be multiplied by $1/\mu$ to meet condition (1). This yields $\mu^2\lambda = \sqrt{(V_2/V_1)}$.

The condition of constant brightness yields

$I_1V_1^n = I_2V_2^n$.

We can now proceed exactly as in the article, both for the case of constant beam current and constant cathode loading.

The results are given in the accompanying table which should be compared with the last two columns of the table in the June issue. The conditions in this more general case are much more stringent.

Basic Operation.		No. of lines multiplied by μ. Tube screen dimensions held constant. Fig.1.	
Secondary Operations.		Triode scaled and moved towards focusing coil.	
Geometrical changes made.	Triode dimensions	$\times\ 1/\mu^2$	$\times\ 1/\mu^{2n/(n+1)}$
	Cathode-grid spacing*	$\times\ 1$	$\times\ \mu^{4(3+2n)/3(n+1)}$
	Triode to focusing coil distance	$\times\ 1/\mu$	$\times\ 1/\mu$
Electrical changes made	Anode voltage	$\times\ 1$	$\times\ \mu^{4/(n+1)}$
	Cut-off voltage	$\times\ 1$	$\times\ 1/\mu^{8n/3(n+1)}$
	Grid drive	$\times\ 1$	$\times\ 1/\mu^{8n/3(n+1)}$
	Scanning-coil current	$\times\ 1$	$\times\ \mu^{2/(n+1)}$
Effects produced.	Beam current	$\times\ 1$	$\times\ 1/\mu^{4n/(n+1)}$
	Spot diameter at all points	$\times\ 1/\mu$	$\times\ 1/\mu$
	Beam angle α	$\times\ 1$	$\times\ 1$
	Screen surface brightness	$\times\ 1$	$\times\ 1$
	Cathode loading	$\times\ \mu^4$	$\times\ 1$

* This adjustment to be made *additionally* to that effected by the scaling of the whole triode.

With constant voltage and beam current the cathode loading is multiplied by μ^4 instead of by μ^2. With constant cathode loading the voltage must be multiplied by $\mu^{4/(n+1)}$ instead of $\mu^{2/(n+1)}$. Taking $n = 1.67$ an increase in the number of lines from 405 to 625 demands an increase in tube voltage from 5 to 9.8 kV if the cathode loading and deflection defocusing are to remain unchanged. The scanning-coil current must be increased 1.38 times.

HILARY MOSS.

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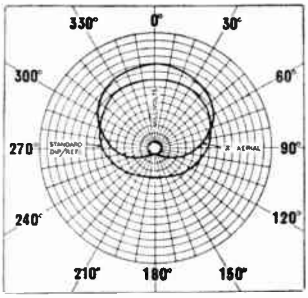

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RANDOM RADIATIONS

By "DIALLIST"

The Capacitor Puzzle

SEVERAL KIND READERS send the suggestion that the queer behaviour by certain old capacitors which I described last month may be due to the fact that with the passage of time they have gradually changed into electrets. If you remember, I told how a 17-year-old paper condenser showed a steady e.m.f. of 0.4 V when a valve voltmeter with an input resistance of 10MΩ was applied to it. Other old capacitors of the same type showed 0.1-0.2 V. An electret is formed by heating certain dielectric materials to melting point and allowing them to solidify in an electric field. The mass then develops positively and negatively charged surfaces and the charge may be retained almost indefinitely if it is wrapped in metal foil. At first sight this seems to fit in quite well with waxed-paper capacitors. If one of these had become heated whilst charged until the wax was just beginning to run, might not it have turned itself into an electret as it cooled down? There are two objections that I can see to this explanation. The first is that for an electret to be formed it appears to be necessary for the dielectric material to contain polar groups of the $-$OH, $-$COOH type and these do not normally occur in the paraffin wax used in paper condensers. It is just possible—perhaps some reader *au fait* with the chemical aspects can give information on that point—that the necessary polar groups may have been formed as time passed by oxidation of the wax. The second objection, which seems even stronger, is this. As I understand it, an electret has a purely static charge; but here we have an e.m.f., which was found to maintain a steady current of $0.4/10^7$A, or 0.04 μA. It is difficult to see how that could happen without a continuous electro-chemical reaction to bring it about.

Speaking of Electrets

The possibilities of the electret for providing biasing voltages in radio gear where no flow of current is involved don't seem to have been very fully explored. I recall reading (and a letter from a reader confirms this) that they were found to have been so used in the radio gear of some Japanese aeroplanes captured or shot down during the last war. As an electret could provide a source of steady "free" negative bias indefinitely it might be of considerable use to designers of battery-operated wireless receivers. The grid bias voltages needed in these are negative and if they do their jobs properly there should be no flow of grid current. The present practice of obtaining these voltages from the h.t.b. by means of bleeder networks is not ideal, for it means amongst other things that we have to rob Peter in order to pay Paul. In other words, if the voltage available from a new h.t.b. is 120 V, 9 V-12 V must often be used for the grids, leaving a maximum of only 108-111 V for the anode circuits. Harking back to the old paper capacitors which develop appreciable e.m.f.s, one wonders whether their conduct may not be responsible for some mystifying effects in radio receivers and other kinds of electronic apparatus that have been in use for a number of years.

Trig. Without Trig. Tables

YOU REMEMBER that a month or two ago I wrote of the excellent tip given by an American writer for the rapid evolution in your head of all sine and cosine values? I asked then if anyone could suggest an equally simple way of memorising a key to tangents. Several readers have pointed out that if you know the sine and cosine, the tangent is easy, since $\tan\alpha = \dfrac{\text{Sin}\,\alpha}{\text{Cos}\,\alpha}$. That wasn't quite what I had in mind. What I was after was a second string to one's mental bow: another series of figures, just as easy to memorize as those for cosines, which could be there as a stand-by in case the others were forgotten. One reader sends a suggestion. The series to be memorized for tangents is: 9, 9, 9, 9, 11, 11, 12, 14, 16. Place a decimal point and a nought in front of each; then successive addition to 0 gives you tangent values for every 5° up to 45°. Thus we have

$$\tan 5^\circ = 0.09$$
$$\tan 10^\circ = 0.18$$
$$\tan 15^\circ = 0.27$$

and so on to:

$$\tan 45^\circ = 1.00$$

These figures, like those for cosines, are all correct to 2 decimal places, or to $\pm 15'$ of angle. To obtain the remaining tangents simply use $\tan 50^\circ = \dfrac{1}{\tan(90^\circ - 50^\circ)}$ and so on. What it all comes to is that whether you memorize one or both simple sets of figures you have a means of arriving at all trig.

CLOUD DETECTION BY RADAR

PHOTOGRAPHS taken on the recent B.O.A.C. flight to the Far East to test the Ekco cloud and collision warning equipment. The central picture was taken at a range of 20 miles from the cumulo-nimbus formation. The cloud top was approximately 28,000 feet and the aircraft was flying at 10,000 feet. The left-hand P.P.I. picture shows responses from the dangerous cumulo-nimbus clouds at 25-40 miles range. In the right-hand picture there are additional responses at 15 miles from cumulus clouds. The cumulus cloud in the foreground did not give a response until the range was down to 10 miles.

World Radio History

ratios—sines, cosines, tangents, cosecants, secants and cotangents—for all angles, with sufficient accuracy for most electrical purposes, almost as quickly as you can look them up in a book of tables. Rather more quickly in my case, for, though I possess a variety of sets of trig. tables, I can seldom put my finger on any one of them when I want it!

Fluorescent Lamps in the Workshop

When I wrote recently of possible risks from stroboscopic effects if fluorescent lighting is used in the amateur's workshop, I had, of course, in mind the kind of fixture that one most commonly sees in homes of ordinary folks—the single 40-watt or 80-watt tube, with or without reflector. Fixtures containing two tubes connected in parallel are easier to come by now than they were and they are obtainable with a built-in phase-splitter which enables freedom from stroboscopic effects to be obtained on the normal single-phase domestic supply. A kind reader sends me a useful tip, with the aid of which anyone worthy of the name of handyman can "destrobify" a dual 40-watt fixture not already fitted with a phase-splitter. The power-factor condenser is removed. Calling the two tubes A and B, A's choke is connected direct to the phase lead of the mains and a 3.75μF capacitor is wired between the phase lead and the choke of B. In this way the e.m.f. applied to A leads the current by about 60°, whilst B's e.m.f. lags 60° on the current. The leading and lagging power factors counterbalance one another. The two tubes are now approximately 120° dephased and there is no strobing.

Chinks in the Armour

What fluorescent lighting most needs, I feel, is the development of fluorescent coating materials of longer afterglow. This would automatically put an end to strobing and to the rather annoying flicker effect which is so noticeable when an object with a reflecting surface is moved rapidly in the illuminated area beneath a fluorescent lamp. Whilst on the subject of these lamps I feel I must tell you the true story of certain happenings in Hong Kong after VJ Day. It was related to me by a friend who was chief engineer of the South China Electricity Company before the war and returned to that post after some grim years as a prisoner in Japanese hands. As soon as the war was over the reconstruction of factories and offices went ahead rapidly. The business community was fluorescent lamp-minded, and this form of lighting was installed here, there and everywhere as quickly as Chinese contractors could carry out the work. Fixtures and tubes were readily available; but there was a serious shortage of p.f. capacitors. That, however, did not daunt the Chinese. A new installation having been made, the company was asked to inspect and approve it. That having been done, the power factor capacitors were removed and used for the next installation. Presently, the company began to find that it was supplying vastly more kilowatts than the consumers' meters were ticking up and immediate strong action had to be taken. A good thing for electricity authorities the world over that the radio valve placing a chiefly reactive load on power supplies has not yet been invented!

The "Interference Act"

The Wireless Telegraphy Act of 1949 seems destined to be known popularly as the "interference act" since one of its provisions of high importance to owners of broadcast receivers and television sets is aimed at the suppression of interference of the man-made variety with their enjoyment. The original Bill was altered a good deal as it went its way through Parliament. The Act as it stands is not perhaps so strong as some would like; some, again, may think the procedure laid down by it over-leisurely. When it is proved that apparatus is causing interference the P.M.G. must serve its owner with 28 days' notice to abate the nuisance. That seems rather a long time; but the delay may not end there, for the owner, having received such notice, may then refer the matter to the Appeal Tribunal. The notice then becomes inoperative until the Tribunal has heard the appeal and unless its decision is in favour of the P.M.G. The only exception is when the P.M.G. is satisfied that the interference is upsetting "safety" services such as police radio-telephony or airport radar; he can then demand immediate action.

Whatever its shortcomings, the new Act is a long step in the right direction. It should bring about a big improvement in reception conditions. Some manufacturers have been fitting suppressors to their domestic electrical products since soon after the provisions of the Bill were first made public. Others are bound to follow suit now, for the P.M.G. has power to prohibit the sale o r hiring out of apparatus proved to cause serious interference.

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RECENT INVENTIONS

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Direction and Distance Finder

STANDARD methods of airport control rely on triangulation methods using normal d.f. equipment or on radar methods relying on reflections from an aircraft. The former require two stations while the latter methods may lead to difficulties over the identification of different aircraft, as response is automatic and not dependent on any action taken by the aircraft.

The system here described is applicable to a fixed station and a mobile station and provides for the fixed station emitting a sine modulated carrier which is received by the mobile station and used to modulate an emitted carrier wave of a different frequency. By comparing the phase of the received modulation with the transmitted modulation an indication of the distance of the mobile station can be obtained, while known d.f. methods may be used to obtain the bearing. The transmitter at the mobile station may be the normal communication equipment, and it may emit the modulated carrier at the request of airport control to assist identification.

The specification describes in outline a method of displaying the information on a cathode ray tube at the control point in the form of a radial trace, the rotary position of which indicates the bearing while the position of a "spot" on the trace indicates the distance.

Standard Telephones & Cables, Ltd., C. W. Earp and R. F. Cleaver. Application date June 21st, 1946. No. 621,575.

Pulse Communication

WHEN using pulse communication methods for transmitting several channels over one carrier it has been usual to interleave in time the signal pulses of the several channels. This normally involves synchronizing the pulses in the different channels which cannot always be easily arranged.

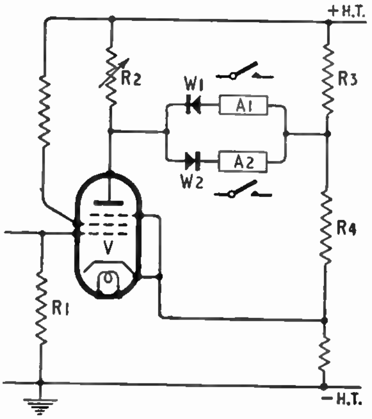
The system described utilizes several trains of pulses, each train having a different characteristic pulse width and recurrence frequency, and all the pulses are transmitted over a common communication medium, but without synchronization. Modulation may be by controlling the time positions of the pulses of each train. Unscrambling at the receiver is based on pulse width discrimination.

One method described in outline is based on providing a delay network for each channel giving a delay equal to the pulse width of the particular channel. The composite received modulation is differentiated and inverted, and fed to the delay networks. Combination of the original differentiated wave form with the inverted and delayed wave form will give a double height pulse in the correct channel circuit where the delayed and inverted peak of the leading edge of the received wave form coincides with the trailing edge of the differentiated wave form without inversion or delay. The several channels are thus selected at the receiver and may be converted into speech or other signals by normal methods.

Standard Telephones & Cables, Ltd. (assignees of E. Labin and D. D. Grieg). Convention date (U.S.A.) February 26th, 1945. No. 623,415.

A.F.C. Systems

IN broadcast receivers a discriminator circuit may be used to control the frequency of a local oscillator by means of a "reactance valve." This system



Single-valve motor control circuit for automatic frequency correction.

is not suitable for communication receivers or other apparatus where the received signal may disappear for a length of time, for then the station will be tuned out by the a.f.c. system and may not be again picked up when the signal returns. In these circumstances a motor-operated device is often used, but the known systems require two valves for the two directions of the motor.

In the system shown on the diagram R1 is the load resistance of the discriminator rectifier, which is connected to a pentode V biased to a straight part of the characteristic, and which has an anode load R2. A divider network R3R4 is connected across the h.t. supply as shown. The valve impedance and R2, R3, R4 form a bridge system across which are connected forward and reverse relays A1 A2 fed by oppositely connected rectifiers W1W2. So long as the discriminator is not supplying a control voltage there is no input to V and the bridge is balanced under these conditions so that no current flows in A1 or A2. A control voltage from the discriminator will raise or lower the potential at the anode of V and current will flow either in A1 or A2 by the action of rectifiers W1 and W2, thus energizing one relay to correct the tuning of the receiver, whereupon the control voltage drops and the relay A1 or A2 releases to stop the tuning motor.

Marconi's Wireless Telegraph Co., Ltd., and G. L. Grisdale. Application date July 2nd, 1946. No. 622,479.

Colour Television

PROPOSALS for colour television have been based on the use of a three-colour filter wheel rotated in front of the cathode ray tube. Such a filter wheel must be synchronized with the transmission. This may depend on the use of synchronized mains power, which is not always available, or of the transmission of pulses which are amplified sufficiently to drive a synchronous motor, which is wasteful and expensive.

These difficulties are avoided by driving the filter wheel by a motor running naturally at a speed slightly higher than the required speed and subjected to the action of an electromagnetic brake. The wheel drives a simple alternator the phase of which is compared with received synchronizing signals in a valve circuit to derive a current which varies with the phase difference and is applied to the brake to reduce the speed until it moves in step with the synchronizing signals.

Marconi's Wireless Telegraph Co., Ltd. (assignees of F. J. Somers). Convention date (U.S.A.) October 19th, 1944. No. 622,202.

Television

THE transmisison of a sound channel with the vision signal by modulated pulses in the interline blanking period is dealt with in this specification.

In the system described, which is not limited to transmitting sound but may be used for transmitting other intelligence, modulation pulses are positioned within synchronizing pulses and are spaced from both the leading and trailing edges of the synchronizing pulses. Modulation may be dependent on pulse height, phase, frequency, or, preferably, width. Any edge of the modulation pulses which is variable with modulation always occurs with a minimum time separation from the synchronizing edge of the synchronizing pulse, which exceeds the time period of the pulse of the so synchronized time base oscillator. Thereby time synchronization is unaffected and penetration of the sound pulse into the picture is avoided. Reference is made to the transmission of several sound channels by several successive pulses during each blanking period.

D. I. Lawson, A. V. Lord and Pye, Ltd. Application date October 12th, 1945. No. 621,479.

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 2/- each.

World Radio History

permalloy
permendur

STANDARD MAGNETIC MATERIALS have the unique advantage of being produced by a Company which itself is a large scale user of these materials, as a result of which a vast amount of direct experience in the use of magnetic alloys has become available. Permalloy Nickel/Iron Alloys are particularly suitable in cases which demand high permeability and low losses—especially low hysteresis loss: they should, however, be selected according to individual requirements. V-Permendur, one of the Cobalt/Iron alloys, should be employed where high permeability throughout a wide range of flux densities is called for, and it finds special application in diaphragms for high quality telephone receivers.

PERMALLOY C. Gives the highest initial permeability of any magnetic material yet known. *Applications:* wide frequency-band transformers: accurate current transformers, chokes, sensitive relays and magnetic shielding.

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PERMALLOY D. High resistivity without undue lowering of flux density or of the Curie Point. Very suitable for certain high frequency applications since frequency permeability variation is small.

V-PERMENDUR. A Cobalt/Iron alloy with unusually high flux density. **It can be rolled to .010 in. strip** and exhibits high permeability up to high flux densities.

	Permalloy "B"	Permalloy "C"	Permalloy "D"	V. Permendur
Specific gravity	8·3	8·6	8·15	8·2
Electrical resistivity, microhms per cm. cube ...	55	60	90	26
Temperature for heat treatment °C ...	900	1,050	900	790
Initial permeability μ... ...	1,800 to 2,400	10,000 to 30,000	1,500 to 2,000	700 to 1,000
Maximum permeability μ_{max}	10,000 to 20,000	50,000 to 100,000	6,000 to 8,000	3,000 to 5,000
Magnetising force for μ_{max} oersteds	0·30 to 0·60	0·025 to 0·04	0·5 to 1·0	2·0 to 6·0
Maximum flux density, gauss ...	16,000	8,000	13,000	23,000
Coercive force in oersteds for B_{max} = 5,000 gauss	0·25	0·03	0·5	—
Remanence in gauss for B_{max} = 5,000 gauss	4,000	3,500	3,500	—
Hysteresis loss in ergs per c.c. per cycle for B_{max} = 5,000 gauss ...	300	45	550	—
Total loss in watts /lb. B=5,000 gauss, 50 c/s 0·015 in. sheet	0·11	0·04	0·2	—

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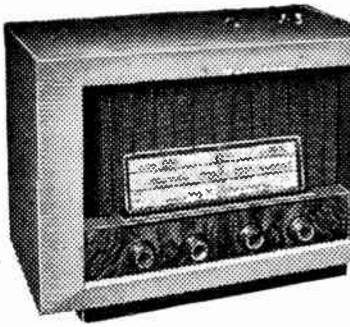

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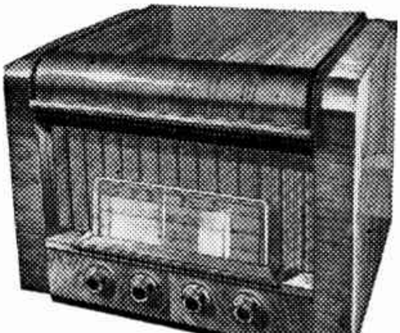

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LASKY'S PRICE, 59/6. Carriage 5/- extra.

CIRCUITS NOW AVAILABLE: Full circuit of the Receiver type 3084A. **PRICE** 1/6, plus 3d. postage.
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Full circuit diagrams giving suggested television sound and vision receivers, time bases, and all associated circuits, power packs, etc., utilising available Ex-Government equipment (3084A, VCR97, etc.). **PRICE** 3/6, plus 3d. postage.
Price for the complete set of three circuits, 7/-, postage free.

EX-A.M. RECEIVER TYPE R1132A. V.H.F., 100/126 Mc/s., receiver. These receivers are absolutely brand new, and supplied in makers' original wood transit case, complete with 11 brand new valves, circuit diagrams and calibration chart. Large tuning scale with super slow motion drive and 0-5 m/a moving coil tuning meter are incorporated. R.F. and L.F., gain controls, jack sockets for line and 'phone are also fitted. Valve line up: R.F., amplifier VR65; local oscillator VR66; three I.F. stages VR53's; second detector and A.V.C. VR54, L.F. amplifiers VR57 and 6J5, B.F.O. VR53, voltage stabiliser VS70. Totally enclosed in metal cabinet, grey enamelled with all controls clearly marked, plated handles. Size: 18in wide, 10in high, 11in. deep. Weight 54 lbs.
LASKY'S PRICE, 79/6. Carriage 7/6 extra.

AMERICAN AIR CORPS RECEIVER TYPE BC624A. 11 Valve superhet. Frequency range 100/156 Mc/s. Valve line up: three 9003; one 9002; one 12C8; three 12SG7; one 12J5; one 12AH7; one 12H6. Dozens of useful components, resistances coils, relay, condensers, etc., size 15½in x 7½in. x 6in. Weight 28 lbs. This is the receiver section of the SCR522. Less buzzer.
LASKY'S PRICE, 19/11. Carriage 5/- extra.

INDICATOR UNIT TYPE 62A. Contains 21 valves, crystal and 6in. cathode ray tube type VCR97 (short persistence). Valve line up: twelve EF50; two EB34; four SP61; three EA50; also hosts of condensers, resistances, and other components. Totally enclosed in metal cabinet, size 18in x 8½in. x 11in. Weight 46 lbs.
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EX-A.M. RECEIVER UNIT TYPE 71. Contains 8 valves: four EF50; one EL32; two EF39; one EBC33. Also many components, resistances, condensers, coils, etc. Frequency covers 124 Mc/s. This is a superhet unit with an R.F. stage and three I.F. stages. Overall dimensions: 10¾in. x 7¼in. x 5¾in. The breaking up value is well over £3.
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E.H.T. TRANSFORMER FOR THE VCR97 CATHODE RAY TUBE. Specifications: Primary 200/250 volts 50 c.p.s.; Secondary: 2,500 volts 4 m/a.; 4 volts 1.1 amp.; 4 volts (C.T.) 1.5, amp.
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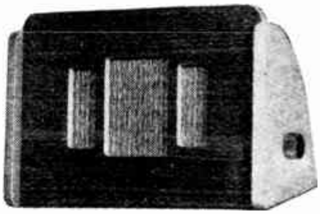

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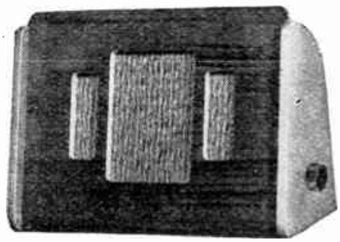

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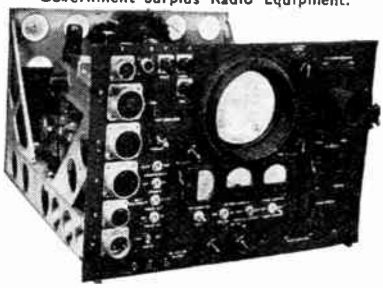

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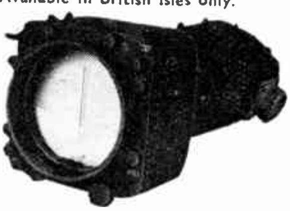

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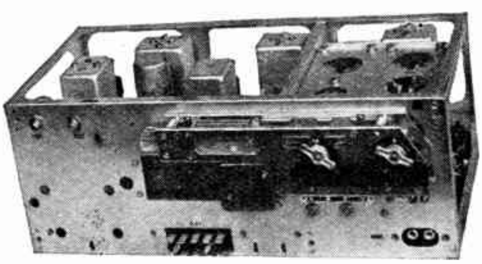

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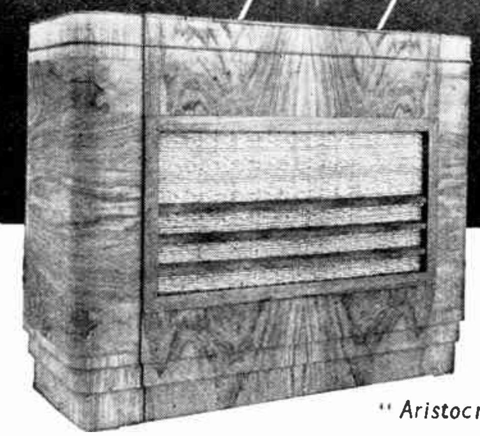

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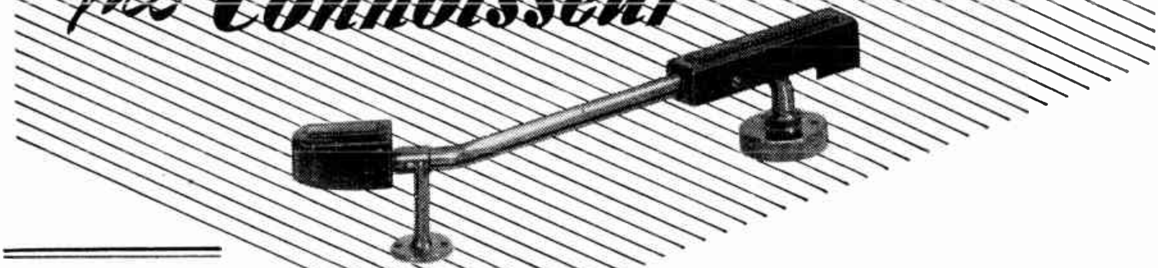

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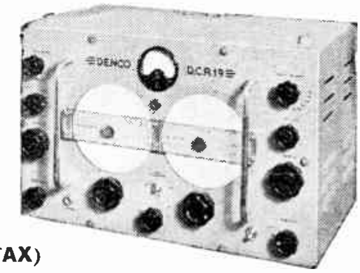

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We modestly claim that our Kit of Parts answers the prayer of all those who lack knowledge of TV technique! Its simplicity of design and construction make it a practical proposition for all, and our comprehensive instructions and easy-to-follow point-to-point wiring diagrams ensure success. Start now and send for these instructions. The price is only **5/-**, post free, refunded when the Kit is purchased.

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A demonstration model can be seen at our London premises during viewing hours. Come along and see for yourself. NOTE OUR UNIQUE "AFTER SALES" SERVICE. TESTING AND ALIGNMENT OF RECEIVERS AFTER COMPLETION OF ASSEMBLY UNDERTAKEN FOR A NOMINAL SUM.

AMPLIFIER UNIT 18/165. A neat and compact equipment incorporating the following valves: 2 EF36, 1 EBC33, 2 EL32: together with microphone transformers, intervalve transformers, countless condensers and resistors, etc. Are you looking for something to "break down"? Then here's your chance. An experimenter's gold mine for ONLY **19/6**, carriage paid.

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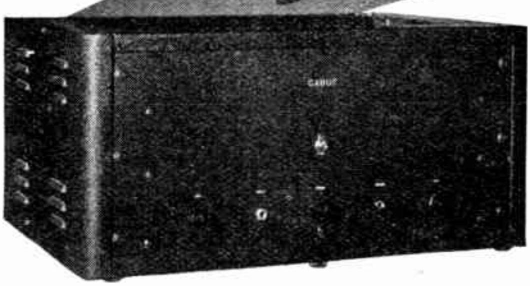
Incorporating negative feedback, suitable for any use where sound amplification is required.



SPECIFICATION:—Separate mike and gram or radio inputs for mixing. Mike input for moving coil or other types as required. Gram input suitable for standard Magnetic or Lightweight pick-up. Tone control. Output 25 Watts into 4-8 or 15 ohms. Input 110/230v 50 cps. Fitted in steel cabinet, finished in black crackle, panel engraved as illustrated. Ideal for general P.A. work, Youth Clubs, gram or radio Amplifier for the Home, etc. **VALVES:**—6SN7 Mike and Gram Mixer. 6SJ7 Amplifier. 6N7 Phase splitter, 6L6 Push Pull Power Amplifier. 5U4G Rectifier.

£16-10-0 Complete as above spec.

£15-15-0 If no moving coil 'mike' input transformer is required.

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M/Ammeter ..	round	3½"	5-0-5mA	White	m/coil	6/-
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M/Ammeter ..	square	2½"	50mA	White	m/coil	4/6
M/Ammeter ..	round	2½"	100mA	White	m/coil	5/-
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M/Ammeter ..	round	2½"	500mA	Black	m/coil	4/6
Ammeter ..	square	2½"	.5 amp.	White	T.C.	3/6
Ammeter ..	round	2½"	1 amp.	White	T.C.	3/6
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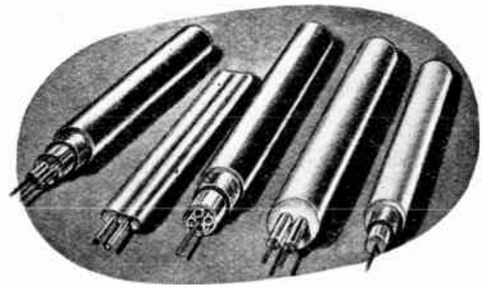

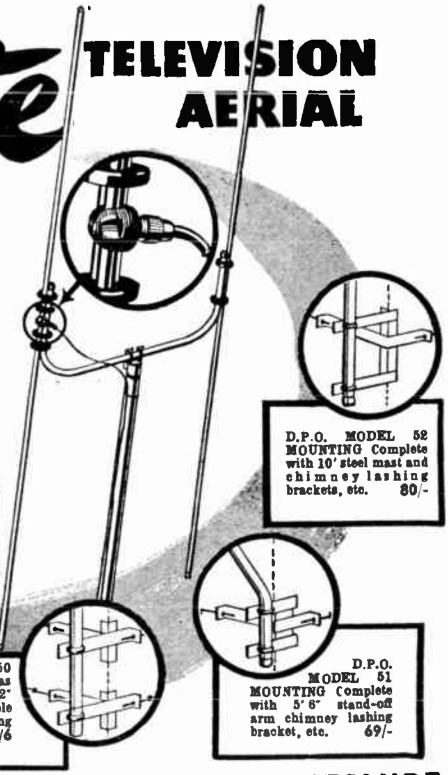

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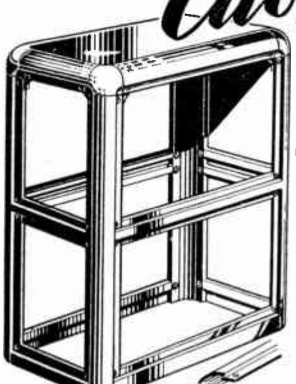

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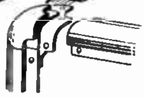

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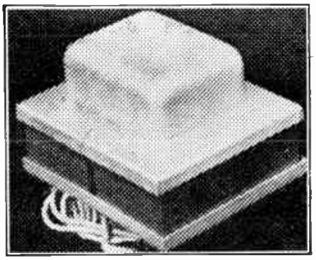

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(c) 250-0-250 v. 80 mA. 0/4/6.3 v. 4 A. C.T. 0/4/5 v. 2 A.	19 0
(d) 300-0-300 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	19 0
(e) 350-0-350 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	19 0
(f) 250-0-250 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(g) 300-0-300 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(h) 350-0-350 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(i) 350-0-350 v. 150 mA. 0/4/6.3 v. 6 A. C.T., 0/4/5 v. 3 A.	39 0
(j) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T., 6.3 v. 4 A. C.T., 5 v. 3 A.	44 6
(k) 425-0-425 v. 180 mA. 4 v. 8 A. C.T., 4 v. 4 A. C.T., 4 v. 4 A.	44 6
(l) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T. 4 v. 2 A. C.T., 4 v. 2 A. C.T., 5 v. 3 A.	47 0

Types (a) (b) (c) (d) (e) (f) (g) (h) (k) illustrated on left
Types (i) (j) (l) upright shrouded type.

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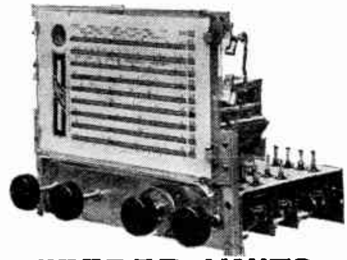

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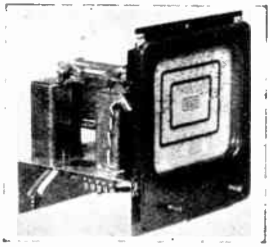

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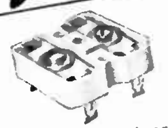

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WILLIAMSON amplifier, high-grade components, Gardner & Partridge trans., complete £14; amplifier, W/W phase splitter circuit, complete £9; sound Sales DX plus one radio feeder, as new, £13; tone control pre amp., G.E.C. design, £5; Marconi CR100, perfect condition, £25.—Tel. Ascot 707. North, 14, Trinity Crescent, Sunningdale, Berks. [4317

RECEIVERS, type 76, 3 valves, ARTH2, VR53, VR92, I.F. output 560kc/s, 22/6; modulator unit, type 76 (the I.F. and output unit for the above), 2 stages of I.F., detector, A.V.C. output, also 4 valve push-pull amplifier, 9 valves, 2 KT33C, 2 EF36, 3 EF39, 1 EBC33, 1 EF50, 49/6, plus 5/- carriage; the two units for 70/-, both brand new; Wilcox grey XTAL oscillator, 2-7mc/s, 40/-, plus 5/6 carriage; condensers, .01 Sprague, 3/- doz; .25 mfd. 500v, 3/6 doz; .01 4kv, .03 2.5kv, .05 3.5kv, 1/- each; .1 6kv 6/-; 4 mfd. micropack 10/6 per doz; transformers, R.C.A. 2,000v @ 800ma 200-50v primaries, 90/-; 500-0-500 @ 120ma 3×4v 10v, 25/6; 350-0-350v @ 200ma 5 and 6.3v, 30/-; many other items; s.a.e. list.—Cross, Skerries, Cross Lane, Grange, West Kirby, Cheshire. [4314

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ENCLOSED corner horn; E.M. unit, 20000 40/60watt field, fitted Voigt twin diaphragm, ac power pack, £40.—White, Langstone, Cobham Rd., Leatherhead. [4321

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E.D.C.C. converter, as new, 220v d.c. input. 230v 250w output, silence cabinet and filters; no reasonable offer refused; Somerset.—Box 8376. [4145

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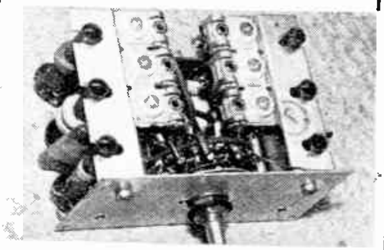

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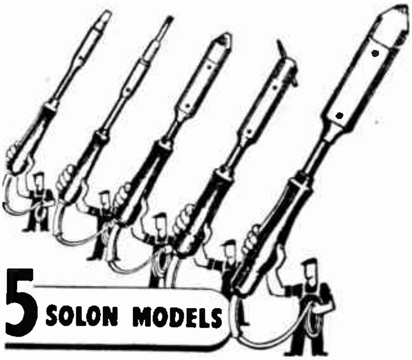

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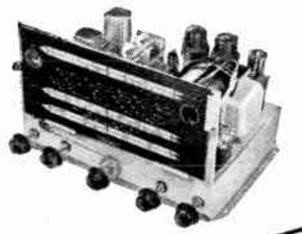

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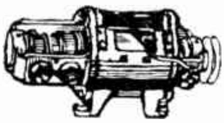

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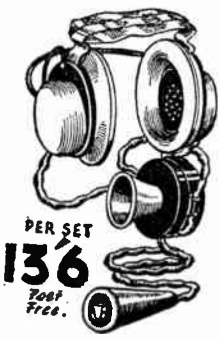

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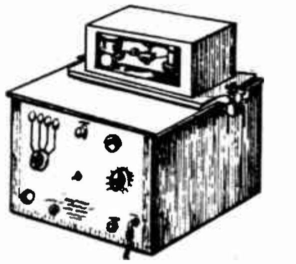

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R.U.19 6 valve straight rec. with 3 R.F. stages, using plug-in coils H.R.O. type, valves 3×78's, 2×77's, 1×1642, black crackle case 15×8×8in supplied complete with valves and 3 coil packs covering 524-844, 1285-2155, 2960-4620, 3865-6265 Kc/s, £2/15, carr. paid; personal receivers B.C.728c, 7 valve rec. using 1.4v valves, with 4 push buttons covering 2-6 Mc/s, built in L/S, supplied brand new complete with valves (IT4, IR5, etc.) 2 and 12v VIB, 2v acc., telescopic AE, instruction book, etc., £8/19/6; mains trans., all PRI 200/250v. 50c/s, sec. 230-0-230v, 100mA, 5v 2A, 6.3v, 2A, C.T., PRI tapped 110v 15/6; Sec. 275-0-0275v, 120mA, 4v 2A, 4v 3A, 13/6; Sec. 460v, 200mA, 210v 15mA, 6.3v 5A, 14/6; auto trans., 200/250v-110v, 60W rating enclosed 18/-; special line auto, 230/250-110v, 100W, 9/6; smoothing chokes 5H 120mA, 140Ω 3/3; 5H 200mA, 100Ω 4/11; 6H, 200mA, 100Ω 5/6; 5H, 250mA, 90Ω 7/6; 15H, 200mA, 150Ω (6½×4½×3¼in) 7/6; 20H, 300mA, 150Ω (7×5×5in) 18/6; electrolytics, 8mf, 150v 1/3; 8/170v 1/3; 8/350 card 1/6, can 1/11; 8/450v 2/3; 16/350v can 2/3; 16+8 450v large can or d/ended 3/6; 8+32 450v can 4/-; 16+24+8 450v can 5/-; 8+8+8 450v can 4/-; 32/450 large can 2/9; 32/450v w/e 3/6; 16+8 350v can 3/-; 60+100 350v 3/-; 32/350v card 2/3; 100mf 3v 3d; 100mf 6v 6d; 25/25v 1/3; 100/25v 1/6; 25/50v 1/3; 16/350 card 1/9; 24/350 can 2/-; 8+24 350v can 2/6; P.M. loudspeakers 5in less trans. 9/11; with trans. 4500Ω 11/6; 6½in less trans. 10/11; 10in with trans. 21/-; R.F. units type 24 8/6; type 25 10/6; with valves, used, in good condition, post 1/6 extra please; output trans 2000/2Ω, 2500/2Ω, 2750/Ω, 3000/2Ω, 3/-; 4500/2Ω 7000/4Ω, 3/6; 3 ratio 7000/3500/1750/4Ω 4/-; heavy duty 7000/2Ω 3/6; I.F. trans. 465 Kc/s small size, iron cored 7/6 pr.; 2 gang conds. .0005 ceramic ins., 1in standard spindle 4/6; ceramic switches 2p., 3w, 1B 2/-; 3p., 3w, 1B 2/6; 3p., 3w, 2B 3/-; switches, small size, 2p., 6w, 3p., 4w, 4p., 3w, single bank, 2/-; standard size 2p., 4w, 1B (additional wafer with shorting plate) 2/6; 4p., 3w, 2B 2/6; 2p., 4w, 3B 2/6; 1p., 10w, 2B 2/6; all have 3in spindles; resistors 100 assorted, 47 values ranging 180Ω ¼w -100K 3w, standard sizes, best makes 10/6, post 6d; ceramic trimmers 3/50pf, 3 on a bar 1/3; 1/15pf single 4d; 3/30pf air spaced concentric 6d; 3/25pf V.I.C. type 3d; air spaced variables ¼in spindles 25pf, 50pf, straight, 50pf diff., ceramic bases 1/-; 35pf butterfly 1/-; "Eddystone" 60pf double ended 1/6; selenium rectifiers 250v 40mA H.W. 3/6; 350v 60mA H.W. 4/6 400v 120mA H.W. 5/6; car radio vibrator packs with 12v 4 pin VIB, and OZ4 valve on chassis 5¾×3½×1½in, output 250v 65mA, output brought out on 8ft screened lead 17/6; meters moving coil, metal cased, 2in circular 0/500 microA 7/6; 0/15-600v req. ext. res. 6/6; 0/20 or 0/40A with shunt 5/-; Bakelite cased 2in square 0/1mA 7/6; 0/5mA 6/-; 0/50mA 7/-; 0/150mA 6/-; 0/300v series res. supplied 7/-; bakelite cased 2½in circular, 0/500microA 16/6; 0/30mA 7/-; 0/50mA 8/6; 0/100mA 8/6; 0/200mA 8/6; 0/15v 7/-; 100-0-100v, 1mA, F.S.D. 7/-; 1mA desk type 15/-; control units with 2 2in meters 0/5mA, 0/40v rotary and toggle sw., 5 and 7 pin sockets 8/6; visual indicators type 1 crossover needle, with 2 separate 60microA movements 5/-; type 3 with 2 300microA movements and 2 low voltage neons, 3/6; S.M. dials as on R.F.26 etc., 3/11; ex-Admiralty patt. 1257, 1¾in engraved 0-100, fast/slow (50-1), panel mounting, fits ¼in spin., 2/6; rotary power units type 104 12v D.C. input, outputs 250v 60mA, 6.5v 2.5A, P.M. rotary mounted on chassis with supp. 6/11; type 87, outputs as above, but 24v input 5/11; 10 valve receivers, R28/ARC5, cover 100-150 Mc/s, brand new with valves (inc. 4-717 A's) 42/6; modulator and mixer units W6332A, with 7 valves (1-5U4G, 2-6J5, 2-P61, 1-VR65, 1-VR54) on chassis 10½in×11½in also 5H 200mA choke, large trans. 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(Continued in third column)

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World Radio History

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Full size Blue Prints for our new T.R.F. television receiver. Magnetic, black and white picture tube. Built on one chassis, **measuring only 14in. deep, by 11in. wide,** x 16in. high with picture tube in position.

Brief Specification

16 valves including two double valves. Four stages of R.F. amplification on both sound and vision. (E.F.50's) T.R.F. circuit, wide band stagger tuned. Diode detection. One stage of V.H.F. Interference suppressors on both sound and vision. Synchronising valve (E.F.50). Gasfilled line and frame oscillators (T41's), line output valve (E.L.38), frame output valve (E.L.33).

E.H.T. is taken from a voltage doubler "Westinghouse" rectifier system in the line output transformer circuit.

An infinite impedance detector is used for quality sound, feeding an output tetrode (6V6) with negative feedback.

H.T. for sound, vision and timebase is taken from a mains transformer with an extremely well smoothed output. Full wave rectification. 4 control knobs in front—Brightness, Volume, Focus, Contrast. Variable controls at rear—for sensitivity, sound interference and vision interference. Pre-set controls for width, eight, speed and linearity.

EASY TO BUILD

Chassis ready drilled, all best quality components. When made properly, we claim for this receiver—GOOD detail, good interlacing, a good bright picture, steady, interference free and exceedingly good quality on sound.

Working well outside the fringe area given a good aerial and geographically well situated. BLUE PRINTS, one theoretical, and two full size practical, and priced list of parts. 10/-.

OUR NEW HIGH FIDELITY TUNING UNIT

Brief specification.

One R.F. stage, F.C. with separate oscillator, 1 stage of I.F., using our new I.F. transformers, iron cored, permeability tuned, with a "Q" of 155, feeding into second detector of the cathode follower type, using our new Audio Filter Unit. Fitted with its own power pack and smoothing ready to attach to any good L.F. amplifier.

Main tuning control, no band-spreading required, sensitivity control working on the first R.F. valve. I.F. gain control with selectivity control incorporated, 6 wave-band switch. The chassis is built of 16 s.w.g. aluminium, rigid corners, box type 6 wave-band coil unit, fitted with our latest iron cored high "Q" coils, completely screened. A.V.C. Magic Eye tuning indicator. Measurements $9\frac{1}{2}$ x $8\frac{1}{2}$ x 11in. high. We honestly believe this to be the finest tuning heart on sale, for sensitivity, selectivity, and the high fidelity obtained on the medium wave-band, due in measure to the cathode follower detector valve with its distortionless output, in conjunction with its filter system. Price £25 including purchase tax.

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GOVERNMENT OF IRAQ.

CHIEF Radio Engineer required for Basrah Port Directorate for one tour of three years in first instance. Salary I.D.80 rising to I.D.110 a month. Cost of living allowance between I.D.10 and I.D.14 a month. (Iraq Dinar 1 equals £1.) Provident Fund. Free passages. Candidates must possess P.M.G. 1st class certificate in wireless telegraphy and be A.M. Brit. I.R.E. or hold City and Guilds Final Certificate in Radio Communication; or alternatively be A.M.I.E.E. with specialist knowledge of telecommunication work. They must have practical experience of commercial wireless transmitters and receivers and electrical equipment. Experience at large civil airport an advantage. Apply at once by letter, starting age, whether married or single, and full particulars of qualifications and experience and mentioning this paper to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/24877 (3B) on both letter and envelope. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration. [4160

CROWN Agents for the Colonies.

WIRELESS operator/mechanic required for the Nyasaland Government Aviation Department for 2 to 3 years with prospect of permanency; commencing salary according to age, qualifications and experience in the scale £490 to £865 a year; outfit allowance £30; free passages; candidates, over 25 and preferably single, must have had at least 4 years' secondary education and be able to transmit and receive Morse at 25 words per minute in plain language, and code groups at 20 groups per minute; they must have a knowledge of the maintenance of radio transmitters and of diesel electric plants up to 15kva, the installation and maintenance of V.H.F.D./F. equipment, the theory and design of aerial systems, and of radio theory and workshop experience.—Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/24898 (3B) on both letter and envelope. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration.

THE RADIOCHEMICAL CENTRE.

APPLICATIONS are invited for the following appointments:—

(a) A PHYSICIST to take charge of health services concerned with the detection and control of radiation hazards in radiochemical laboratories.

(b) A PHYSICIST to take charge of a section engaged in the standardisation of natural and artificial radioactive substances.

APPLICANTS should be men or women of good professional standing, preferably with previous experience of radioactive work, who are capable of developing the work on their own initiative. They will be required to pass a medical examination, and should be between the ages of 25 and 45. Good salaries will be offered to those having the required experience and qualifications. A superannuation scheme is in force, and in some cases houses will be available at Amersham. Successful candidates will be appointed to the staff of Thorium, Ltd. (Managing Agent to the Minister of Supply) to whom applications should be sent at 10, Princes St., Westminster, London, S.W.1. [4162

HIS MAJESTY'S Colonial Service, Northern Rhodesia.

VACANCIES exist for recording engineers to operate and maintain mobile and static recording equipment on both tape and disc types; the appointments are on contract/gratuity terms for one tour of approximately 3 years; the salary scale is £670 to £900 per annum, point of entry depending on age, qualifications and approved war service; where Government quarters are provided 10% of salary is deducetd for rent; free passage is provided for the officer on first appointment and on leave; income tax is at local rates, which are very much lower than those in the United Kingdom; leave on full salary is granted at the rate of 5 days for each completed month of resident service; candidates must be between the age of 25 and 40 and possess qualifications at least equivalent to the B.B.C.D. Grade examination for broadcasting engineers and should have at least 7 years' experience of all systems of sound recording, including disc and tape; they should have a fair knowledge of design and construction, installation and maintenance of apparatus both mechanical and electrical for the recording of sound on both mobile and static equipment; an aptitude in the use of tools is necessary and ability to drive a car essential; married men should not apply; men of initiative, capable of working on their own, are required; preference will be given to candidates with ability and experience in programme production.—They should write forthwith for form of application and further particulars to the Director of Recruitment (Colonial Service), Sanctuary Building, Great Smith St., S.W.1, quoting the reference No. 27323/19. [4170

SENIOR television engineer required by progressive manufacturers in North London area; only applicants with responsible experience need write. Box 8335. [4195

MAINS TRANSFORMERS, FULLY INTERLEAVED, SCREENED AND IMPREGNATED. ALL PRIMARIES ARE 200/250 v.

Half Shrouded

HS63. Output 250/0/250v. 60 m/a. 6.3v. at 3 amps. 5v. at 2 amps.	15/6
HS40. Windings as above. 4v. at 4 amps. 4v. at 2 amps.	15/6
Output	
HS2. 250/0/250v. 80 m/a.	17/6
HS30. 300/0/300v. 80 m/a.	17/6
HS3. 350/0/350v. 80 m/a.	17/6
HS2X. 250/0/250v. 100 m/a.	19/6
HS30X. 300/0/300v. 100 m/a.	19/6
HS3X. 350/0/350v. 100 m/a.	19/6

Fully Shrouded

Output	
FS2. 250/0/250v. 80 m/a.	19/6
FS30. 300/0/300v. 80 m/a.	19/6
FS3. 350/0/350v. 80 m/a.	19/6
FS2X. 250/0/250v. 100 m/a.	21/6
FS30X. 300/0/300v. 100 m/a.	21/6
FS3X. 350/0/350v. 100 m/a.	21/6

All the above have 6.3–4–0v. at 4 amps., 5–4–0v. at 2 amps.

FS43. Output, 425/0/425v. 200 m/a. 6.3v. 4 amps. C.T. 6.3v. 4 amps. C.T. 5v. 3 amps. Fully shrouded	42/6
FS50. Output, 450/0/450v. 250 m/a. 6.3v. 2 amps. C.T., 6.3v. 4 amps. C.T., 5v. 3 amps. Fully shrouded	62/6
F30X. Output, 300/0/300v. 80 m/a. 6.3v. 7 amps. 5v. 2 amps. Framed, Flying leads	26/6
F35X. Output, 350/0/350v. 250 m/a. 6.3v. 6 amps., 4v. 3 amps., 0–2–6.3v. 2 amps. Fully shrouded	59/6

FILAMENT TRANSFORMERS

F4. Output, 4v. 2 amps.	7/6
F6. Output, 6.3v. 2 amps.	7/6
F12. Output, 12.6v. tapped 6.3v. at 3 amps	15/6
F24. Output 24v. tapped 12v. at 3 amps.	21/6
F12 and F24 framed with Flying Leads	
FU6. Output, 0–2–4–5–6.3v. at 2 amps.	9/-
F29. Output, 0–2–4–5–6.3v. at 4 amps.	15/-
FU6 and F29 clamped with Flying Leads.	
F5. Output, 6.3v. at 10 amps., 5v. at 10 amps., 12.6v. at 5 amps., 10v. at 5 amps.	31/6
F6/4. Output, Four at 6.3v. tapped at 5v. at 5 amps. per winding, giving by suitable series and parallel connections 24v. at 5 amp.; 20v. at 5 amp.; 18v. at 5 amp.; 15v. at 5 amp.; 12.6v. at 10 amp.; 10v. at 10 amp.; 6.3 v. at 20 amp.; 5v. at 20 amp.	47/6
F5 and F6/4 framed with Flying Leads	

OUTPUT TRANSFORMERS

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OP1. Midget Power Pentode, ratios 30, 60, 90–1, 40 m/a, Secondary 2/3 ohms. each	3/2
OP2. Midget Pentode, ratios 45–1, Secondary 2/3 ohms, 40 m/a. per doz.	33/-
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OP30. 30 watts output, 20 ratios on Full and Half primary	23/9
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EHT.1. 1000v. 5 m/a. 2–0–2v. 2 amps., 4v. 1.1 amps.	32/6
EHT.2. 2000v. 5 m/a. 2–0–2v. 2 amps., 4v. 1.1 amps.	35/-
EHT.25. 2500 v. 5 m/a. 2–0–2v. 2 amps., 4v. 1.1 amps.	36/6

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My health recovery rate has slowed down.
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A LEADING manufacturer requires the full time services of a qualified outside mobile service engineer; must be able to drive; this is an important position and only men of wide technical experience are asked to apply.—Submit in writing your full particulars and state salary required to Mr. Shepherd, Manager, Service Department, E. K. Cole, Ltd., Somerton Works, Southend-on-Sea. [4173

UNIVERSITY OF GLASGOW.

APPLICATIONS are invited for the post of special technician for work in the field of electronics as applied to the biological sciences; salary scale £450-£550 per annum.—Applications should be sent to the Secretary of the University Court, The University, Glasgow, W.2. [4168

CROWN Agents for the Colonies.

WIRELESS operators required for Government of Falkland Islands Dependencies Survey for service in the Antarctic for one tour of 18 or 30 months; salary £325 a year, free quarters, food and clothing and free passage in research ship leaving United Kingdom in October; candidates, unmarried and not over 30, must be able to transmit and receive morse at 25 words a minute and be capable of maintaining internal combustion engines and diesel generator sets.—Apply at once by letter stating age and full particulars of qualifications and experience and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1., quoting M/N/24761(3B) on both letter and envelope. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration.

HIS MAJESTY'S COLONIAL SERVICE. NORTHERN RHODESIA.

A VACANCY exists for an Assistant Broadcasting Engineer. The appointment is non-pensionable but on completion of at least 30 months' residential service the officer appointed will receive a gratuity of £25 for each completed 3 months' service. The salary scale is £870 to £1,000 per annum, point of entry depending on age, qualifications and approved war service. Where Government quarters are provided 10% of salary is deducted for rent. Free passages are provided for officer and wife on first appointment and on leave. Children's passages are provided up to the cost of one additional adult passage. Free rail fare from port of disembarkation to Northern Rhodesia for officer, wife and family on first appointment and on leave. Income tax at local rates, which are very much lower than those in the United Kingdom.

THE tour of service is 3 years. Leave with full salary is granted at the rate of 5 days for each completed month of residential service.

CANDIDATES must be Corporate Members of the Institution of Electrical Engineers or hold equivalent qualifications exempting them from Parts A and B of the examination for Associate Membership. In the case of candidates with long experience the B.B.C. Grade D Examination for either transmitter or Television Engineers will be accepted. They should also have had at least 7 years' experience of radio broadcasting in all its branches, preferably with the B.B.C., administrative experience, and experience of installation and use of mobile units for outside broadcasting and recording purposes is desirable. Candidates who are Established Officers of the British Broadcasting Corporation should apply through their Establishment Officer; others should write forthwith for a form of application and further particulars to the Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith St., London, S.W.1, quoting reference No. 28323/18. [4167

MINISTRY OF CIVIL AVIATION.—Appointment of radio mechanics, Grade II.

APPLICATIONS are invited for appointment as radio mechanics Grade II at Civil Aviation Radio Stations in the United Kingdom. Candidates will also be liable for tours of duty overseas. Candidates must be at least 21 and under 40 years of age at the time of application, and must possess a knowledge of one or more of the following radio aids for navigation: Direction finding, Loran, Gee, radar beacons, A.C.R. or G.C.A. They should also have had practical experience in the use of tools, filing, drilling, hard and soft soldering, cabling and wiring, and be experienced in the use of electrical and radio measuring instruments, including cathode ray oscilloscopes. The possession of City and Guilds Certificates in radio communication and technical electricity will be an advantage. The weekly rates of pay (inclusive London rates, subject to abatement for service in the provinces) will be 125/- on appointment at age 25 or over, then by annual increments of 5/- to a maximum of 145/-. The entry rates will be subject to a deduction of 3/- for each year of age below 25. Candidates should apply by postcard for a form of application to the Ministry of Civil Aviation, Establishment Branch (B), 10, Fleet St., London, E.C.4, quoting reference Est/174. [4190

H.M.V. dealer (S.E. London) requires television engineer, able to drive; wages £6 to £7.—Full details to Box 8480. [4227

SERVICE engineer, experienced in commercial servicing, good conditions; student considered. —R.T.S., Ltd., 5, Gladstone Rd., Wimbledon, S.W.19. [4331

Lyons Radio

CALIBRATORS RANGE CD/CHL. This unit contains a complete A.C. power pack comprising mains transformer for 230 v. 50 c.p.s. input, with outputs of 250-0-250 v. at 25 mA. 6.3 and 4 v. at 2 A.L.F. Choke rated at 50H. at 25 mA. and rectifier valve type UU5 other useful gear fitted are 3 valves type ARP36 (SP61) a 163.86 Kc. crystal resistors etc. Fitted in case 10½in. × 7½in. × 9in. (in new condition). PRICE **32/6**. Carriage 3/-.

RADIOLYMPIA. We are holding a special sale during the period of the Radio Show. R1155's with valves from **85/-**, communications receivers at **£5**, meters from **2/6**, ex-Gov. transmitter chassis from **3/-** etc. We are only a 1½d. ride from Olympia (No. 11 bus passes our door), why not call round and secure some bargains at clearance prices?

INDICATOR UNIT TYPE 157. A radar unit fitted with C.R. tube type VCR97, 16 VR65's, 2 VR54's, 2 VR92's, condensors, resistors, Muirhead slow-motion, drive etc. Condition practically as new. PRICE **£3/17/6**. Carriage 7/6.

ELECTRIC MOTORS. These useful motors are for 12 or 24 v. D.C. operation. They are brand new Gov., surplus, and measure approx. 2½in. dia. by 4in. long. PRICE, either voltage **12/6**. Post 1/-.

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FERRANTI, Ltd., have vacancies at their radio works, Moston, Manchester, for:—
(a) SENIOR development engineers with responsible experience in the design of domestic television receivers.
(b) DEVELOPMENT engineers with honours degree or equivalent technical qualifications; preferably with some experience of circuit design for domestic television and radio.
SALARY on a liberal basis, according to qualifications and experience.—Application forms from the Staff Manager, Ferranti, Ltd., Hollinwood Lancs. [4029

APPLICATIONS are invited by the Ministry of Supply for the following appointments in the Division of Atomic Energy:—
WINDSCALE WORKS, Sellafield, Cumberland.—Shop manager (electrical) to be responsible to the assistant manager (electrical) for the operation and maintenance of the electrical distribution system, the maintenance of all electrical apparatus in the factory, and installations serving the factory comprising 132, 33, 11, 6.6 and 0.415kv distribution systems with supervisory control, 11kv motors with automatic control gear, small motors, mercury arc rectifiers, emergency diesel generating sets, d.c. motor generators and large nickel cadmium batteries. Candidates must have served a recognised apprenticeship and must either have an honours degree in engineering, corporate membership of one of the Institutions of Civil, Mechanical or Electrical Engineers, or have passed examinations recognised by any of these Institutions as granting exemption from Sections A and B of their examination for associate membership; they should have had experience in the type of duties specified. Salary will be assessed according to qualifications and experience within the range £570-£720 per annum (if over 30) and according to age within the range £330-£545 (if under 30). Candidates will normally be confined to natural born British subjects, born within the United Kingdom or one of the self-governing Dominions, of parents similarly born.—Applications should be addressed to Staff Section, Division of Atomic Energy (Production), Risley, Warrington, Lancs. [4250

SERVICE and installation engineer required for electronic equipment, previous experience essential.—Apply Furzehill Laboratories, Ltd. Elstree 1137. [4164

MINISTRY OF SUPPLY invite applications from radio engineers for appointment as technical author in the Air Technical Publications branch at Malvern, Worcs.
THE duties involve collecting information from research, design, manufacturing, and other sources and preparing therefrom official publications for the instruction of technical personnel in the Services on the theoretical and practical aspects of airborne and ground centimetric radar equipment; applicants should possess good instructional ability in scientific or technical subjects, or experience in writing or editing publications on such subjects.
A DEGREE in engineering, or in physics is required, but applicants holding lower qualifications, such as Higher National Certificate in radio or radar engineering will be considered: in any case attainment of a good standard in physics and mathematics is essential; preference will be given to candidates holding corporate membership of the Institution of Electrical Engineers or who have passed examinations recognised by the Institution as granting exemption from sections A and B of their associate membership examination.
APPLICANTS must have had either: (i) several years experience of centimetric radar apparatus and techniques in the research and development department of a leading manufacturer or in a Government research establishment, or (ii) extensive experience in a position of technical responsibility in the Services on the operation and maintenance of such equipment. The salary offered will be up to £720 per annum, depending on age, qualifications and experience. The post is unestablished, but opportunities to compete for established posts may occur later. Write, quoting D 316/49-A, to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for forms of application, which must be completed and returned within 14 days of the appearance of this notice. [4251

EX-RADAR mechanics with experience on ground radar equipment in the Forces, on installation or maintenance work, are invited to write quoting Ref. 704 to Box 7771. [4050

VACANCY exists for scientifically minded person, preferably with experience, to undertake the processing of quartz crystals.—Write, stating wages required, to Box 8484. [2626

ELECTRICAL engineer wanted, specialist in high frequency work, hardening and heat treatment of metals; should have experience in general power engineering.—Box 7978. [4082

REQUIRED by well-known radio manufacturers in West London, television and radio service engineers for both field and workshop; remuneration for 5-day week dependent on qualifications.—Apply Box 8384. [4181

SENIOR, junior engineers and boys required (pref. radio amateurs) for transmitters/receivers, etc.—Write only full details of experience, sal. req., etc., to "Q-MAX" (Electronics), Ltd., 10, Little Turnstile, W.C.1. [4180

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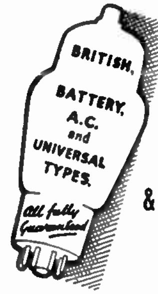

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EASY TERMS again on all **TAYLOR** meters. Please ask for illustrated catalogue and application form.
TELEVISION. A modern home-built *TELEVISOR*, its Design and Construction, published by "Electronic Engineering," illustrated, 2/6. Blueprint for above, 3/6. All components supplied are true to specification. List sent.
BOOKS on every aspect of Radio in stock. We shall be pleased to send special list Valve Equivalent charts with quick reference Index, 2/8 post free.

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Pocket Sports Binoculars	17/6
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Compass (Magnetic)	4/-
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10ft. Rods (Fishing or Aerial)	5/6
14ft. 7-section Rods, Aerial	7/6
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TAYLOR ELECTRICAL INSTRUMENTS, Ltd., have a vacancy for a senior development engineer, with experience in design of radio and electrical testing equipment.—Write, giving full particulars of experience and salary required, to Montrose Av., Slough, Bucks. [4185

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TELEVISION service engineers required by manufacturers to carry out servicing, instruct in service technique and take charge of servicing workshops; previous experience essential; must be able to drive; location Birmingham. —Apply, quoting Ref. 711, to Box 8391. [4206

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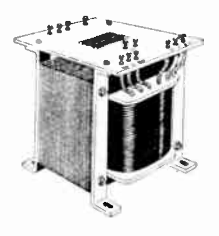

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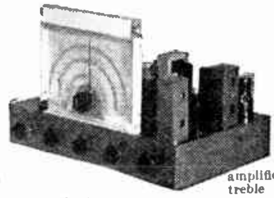

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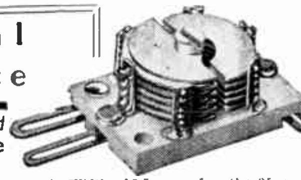

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